The Antiquities Act, National Monuments, and Regional Per Capita Income

Paul M. Jakus

Dept. of Applied Economics
UMC 4835
Center for Society, Economy, and the Environment
Utah State University
Logan, UT 84322-4835

Sherzod B. Akhundjanov

Dept. of Applied Economics
UMC 4835
Center for Society, Economy, and the Environment
Utah State University
Logan, UT 84322-4835

JEL Codes: R11, Q58, O13

Corresponding Author:

Paul M. Jakus
UMC 4835
Utah State University
Logan, UT 84322-4835
435-797-2309
Paul.jakus@usu.edu

The Antiquities Act, National Monuments, and Regional Per Capita Income

Abstract: Since 1906, the Antiquities Act has provided U.S. Presidents with the unilateral authority to protect objects of historic, pre-historic and scientific interest in National Monuments. In recent years, Presidents Clinton and Obama established a number of landscape-scale national monuments in excess of 100,000 acres. The economic effects of such monuments have been debated heatedly: some claim that large monuments harm local economies by restricting economic development of primary commodities, whereas others assert that large monuments aid economic growth by fostering the tourism industry. In response to this debate, President Trump recently reduced the size of two National Monuments. This study uses a synthetic control approach to measure the effect of monument designation on growth in regional per capita income. We find no statistical evidence that monument designation has affected the time path of per capita income in seven counties that host three national monuments in three different states. The claims of both advocates and critics regarding the aggregate economic effects of national monuments have no empirical support.

The Antiquities Act, National Monuments, and Regional Per Capita Income

1. Introduction

In the final year of his presidency, President Barack Obama used the Antiquities Act to proclaim five landscape-scale national monuments (NM) totaling nearly 3.5 million acres in California, Maine, Nevada, and Utah. Each proclamation unequivocally stated that the new monument would be “subject to existing valid uses” of federal land and, as such, was crafted to minimize disruption to ongoing economic activities that remain compatible with protection of the historic and scientific objects contained within the monument. However, as had happened with landscape-scale monuments designated by President Clinton under similarly crafted proclamations, numerous industry and government officials immediately denounced the monuments as imposing regional economic hardship. Large, landscape-scale national monuments are alleged to curtail grazing, mining, logging, and energy activities, thus diminishing economic development alternatives or even causing regional economic ruin. In contrast, others claimed these same landscape-scale national monuments will support a growing tourism sector, accelerate economic growth, and free local economies from dependency on volatile commodities markets. Clearly, both claims cannot hold true for the same national monument.

Early in his administration, President Donald Trump issued Executive Order 13792, which directed Interior Secretary Ryan Zinke to review all monuments greater than 100,000 acres and designated since January 1, 1996. Secretary Zinke was to assess, among other things, the "...economic development and fiscal condition of affected States, tribes, and localities" (Trump 2017a). Subsequent to Secretary Zinke’s report, on December 4, 2017 President Trump issued Proclamations 9681 and 9682 which asserted that President Obama’s Bears Ears NM and President Clinton’s Grand Staircase-Escalante NM were not confined to the smallest area compatible with protection of monument resources (Figure 1; Trump 2017b, 2017c). Bears Ears was reduced from a single monument of 1.3 million acres to two monuments totaling 202,000 acres; the 1.9 million acre Grand Staircase-Escalante was divided into three new monuments totaling 1.0 million acres. Although Proclamations 9681 and 9682 did not specifically cite negative economic effects of the landscape-scale monuments as a rationale for reducing the size of the monuments, President Trump stated that these monuments had "…threatened your local economies…" (Davidson and Burr 2017). Upon publication of the new monument boundaries, some noted that the new borders were compatible with those proposed by mining interests (see, for example, Tabuchi 2018).

Despite two decades of heated political rhetoric about the broader economic effects of landscape-scale national monuments, a survey of the peer-reviewed literature yields only one study that has studied the aggregate economic effects of such monuments. Jakus and Akhundjanov (in press) find that the time path of per capita income in the two counties that host the Grand Staircase-Escalante NM—established in 1996—had not changed as the result of monument designation. The authors concluded that any economic harm to one set of industries caused by monument designation had been offset by growth in another industry group. No other study has isolated the aggregate economic effect of large national monuments. Instead, most studies have lumped national parks, wilderness areas, national recreation areas and other land classifications, such as national monuments, into a single category of "protected land" (see, for example, Rasker et al. 2013 or Lewis et al. 2003). However, visitation at national parks has long been supported by public and private promotional campaigns and is known to be a strong regional economic driver (*e.g.*, Gabe 2016; Wilkerson 2003). One cannot conclude that national monuments—whose management is not driven by tourism—will provide a positive aggregate economic effect similar to National Parks. Further, landscape-scale monuments can be very large relative to national parks: for example, in 2017 each of Utah's two largest monuments was larger than the combined acreage of the state's five national parks. The large, local footprint of a landscape-scale monument, with its relative lack of tourism and attendant restrictions on land use and access, means a monument could have, as President Trump asserted, a negative effect on local economic well-being.

The results presented by Jakus and Akhundjanov (in press) do not support such an argument, but their research is limited to only Grand Staircase-Escalante NM. This study examines whether their result is more general by extending their analysis to three similar monuments established by President Clinton in 2000 and 2001: California's Carrizo Plain NM, Colorado's Canyon of the Ancients NM, and Montana's Upper Missouri River Breaks NM. Each monument proclamation honors "existing valid uses" and thus should have minimized any possible negative economic effects of monument-designation. Further, each monument has been in place for more than a decade and any positive or negative effect on the regional economy should be measurable today. We begin by presenting a brief history of the controversial Antiquities Act, as well as its use in recent decades. After an explanation of our statistical approach, we report the effect of landscape-scale national monuments on county-level per capita income. Our synthetic control analyses of county-level per capita income are similar for all three monuments: we can detect no statistically significant effect of monument designation on the time path of per capita income.

2. The Antiquities Act and National Monuments

After more than a century in which the federal government used land sales to finance its operations and encourage western settlement, its policy of aggressive disposal to private ownership began to be challenged in the late 19th century. The nascent conservation movement successfully lobbied to establish Yellowstone National Park in 1872. Rampant, and often illegal, exploitation of timber and forage resources led to the Forest Reserve Act of 1891, which allowed the President to withdraw forested land from entry (Gates 1968, chapter 19). Within a decade almost 50 million forested acres had been withdrawn by Presidents Harrison, Cleveland and McKinley (Gates 1968, p. 580). Though effective in preventing future homesteading and logging, the Forest Reserve Act did not forestall mining claims, construction of railroads or other commercialization of public lands, or the looting of archaeological artifacts (Rothman 1989 pp. 64-67).

By the late-19th century, destruction of historic and pre-historic artifacts at Chaco Canyon (New Mexico), Mesa Verde (Colorado), and other sites had generated great concern amongst practitioners of the emerging disciplines of archaeology and anthropology. Land claims were sometimes made fraudulently; throughout the west some claims were made not to establish a homestead but instead to excavate artifacts and profit by selling them to museums and private collectors. In response to the destruction of sites rich in heritage, scientists, historians and others pressed for federal protections that would allow for careful and orderly excavation and assessment of archaeological sites (Lee 2006 pp. 22-27). Their efforts over more than two decades culminated in the Antiquities Act of 1906.

The Antiquities Act allows the President to withdraw federal land from disposal and establish management guidelines needed to protect resources of historic, pre-historic, and scientific interest. Such resources are then managed in National Monuments, a land classification created by the Act. Two features of the Antiquities Act have reverberated over the years. First, the Act does not outline the process by which important cultural and scientific resources are to be identified and designated as monuments. Given the speed with which archaeological sites were being damaged, the lack of a formal process was intended by Congress to provide a means by which the federal government could respond rapidly to the threat of destruction. Rasband (2006) notes that the lack of a public designation process has been controversial since the Act's earliest days.

Second, the Act does not limit the size of monuments, instead stating that monuments "…shall be confined to the smallest area compatible with the proper care and management of the objects to be protected." Following the expansive use of Presidential withdrawals under the Forest Reserve Act, early versions of what would become the Antiquities Act had proposed limited withdrawals of 160, 320, or 640 acres (Rothman 1989 pp.46-48). These limits were removed as fears on the part of Western states that the Act would result in large-scale federal land withdrawals were allayed by assurances that the archaeological and scientific objects to be protected by the Antiquities Act would be typically restricted to relatively small areas.

Initial Presidential proclamations under the Antiquities Act simply made permanent many of the small and temporary land withdrawals made previously (*e.g.*, Devil's Tower National Monument, Wyoming). In 1907, though, Congress constrained the ability of the President to use the Forest Reserve Act to withdraw large tracts of federal land from entry. President Theodore Roosevelt enthusiastically turned to the Antiquities Act to establish the Grand Canyon NM (808,000 acres in 1908) and Mount Olympus NM (639,000 acres in 1909). Although these monuments (as well as Jackson Hole NM, established in 1943) were challenged on the basis of the scientific importance of the objects contained therein, subsequent court decisions have granted the President wide latitude in defining the cultural and scientific resources to be protected and the land area needed to achieve that goal (Squillance 2003).

Early national monuments were administered by a mix of government agencies, but from 1933 until 1996 new monuments were transferred to the National Park Service (NPS) to be managed under its preservation doctrine (Rothman 1989 pp. 202-203). The NPS often improved the tourist infrastructure of monuments deemed to have outstanding scenery, such as Grand Canyon, Mount

Olympus (Olympic) and Mukuntuweap (Zion), many of which were subsequently reclassified by Congress as National Parks (Rothman 1989 p. 70-71). Thus, while national parks have long enjoyed a distinct and well-defined identity amongst the general public, national monuments have never benefited a clearly defined role and are often viewed by the public as 'less than' national parks.

A major overhaul of the nation's land laws occurred with the passage of the Federal Land Policy and Management Act (FLPMA) in 1976. FLPMA stripped from the books over 2000 public land laws and formally reversed the federal government's policy of land disposal. Absent a compelling reason to dispose of its lands, the government would retain federal lands to which it held title. The unambiguous implication of the new policy was that public lands had value beyond that associated with its disposal (Daly and Middaugh 2006). Further, FLPMA gave the Bureau of Land Management (BLM), an agency long-associated with management of grazing and mining activities on public lands, a mandate to manage its lands with regard to environmental values as well as values associated with market commodities. Significantly, the expansive overhaul of federal land management laws did not alter the Antiquities Act.

In 1996, President Clinton designated almost 2 million acres of BLM land in southern Utah as the Grand-Staircase Escalante National Monument, with its management to follow landscape-scale planning principles developed by then Interior Secretary Bruce Babbitt (Ranchod 2001). First, rather than being subject to the NPS' preservation principle, landscape monuments were to remain the responsibility of the federal agency managing the land at the time of designation. Second, landscape-scale management required the responsible agency to honor "existing valid rights", *i.e.*, to allow active grazing and extractive operations to continue so long as these activities do not threaten the historic and scientific objects protected by the monument. Third, any government-run visitor services were to be located in communities adjacent to the NM (not within NM boundaries) so that local communities would directly benefit from monument designation and management. Further, recreational amenities within monument boundaries were to be limited. The numerous landscape-scale national monuments designated under Presidents Clinton and Obama have followed the management principles developed by Secretary Babbitt. Further, NMs administered by the BLM are now included in its National Landscape

Conservation System (NLCS) and managed in cooperation with local communities (Daly and Middaugh 2006).[1]

3. Measuring the Economic Effect of Landscape-Scale National Monuments

Roback (1982) is credited with the seminal study of how wages in urban areas respond to changes in non-market amenities, initiating a stream of research that remains active to this day (see, for example, Albouy 2016). Numerous authors have extended this work to rural regions, noting that land protections such as those conferred by national monument status can lead immediately to restrictions on land use, especially in the agricultural, timber, mining, and energy industries, plus support industries (*e.g.*, road or pipeline construction). This loss in a region's economic base may be offset by other gains accruing in the region. For example, a growing tourism industry offers employment alternatives to those who may have lost jobs in industries constrained by an Antiquities Act proclamation. Second, although designation-related employment losses may lead to out-migration, protected lands may induce amenity-based in-migration. In-migration may bring in those seeking to establish businesses associated with the protected land (creating new jobs) or retirees who bring non-wage income.

Relative to landscape-scale national monuments, the only land protection changes of similar scale have occurred in the nation's forested lands. In 1994, the Pacific Northwest Forest Plan (NWFP) removed 11 million acres from timber production in three states, significantly reducing employment in the timber industry. Chen and Weber (2011) found that population growth increased in communities located within 10 miles of a forest managed under the NWFP, but saw no measurable change in community wealth. Eichman et al. (2010) found reduced employment in counties affected by the NWFP; employment losses were not offset by in-migration. Pugliese et al. (2015) examined the effects of reduced timber harvest on county level population and employment in 12 western states. Similar to the Lewis et al. (2003) study of northern forests, Pugliese et al. found no relationship between the percentage change in timber sales volumes and employment growth. Finally, Chen et al. (2016) recently used a community level analysis to find

[1] Prior to President Trump's recent proclamations, BLM's National Landscape Conservation System was comprised of 27 National Monuments located in 10 of the 11 contiguous western states. Nineteen of these monuments exceeded 100,000 acres.

that communities located within 5 miles of a NWFP forest had greater income and population growth, as well as greater property values, relative to matched control communities.

These empirical studies demonstrate that evidence of the net effect of land protections on population, employment, income and wealth is rather mixed. The bulk of the literature has focused on population and employment, which would seem to obscure other effects of land restrictions on economic well-being. For example, in 2017 wages for production and nonsupervisory employees wages in the mining and logging sector ($27.50 per hour) were more than twice the hourly wage ($13.34 per hour) received by production workers in the leisure and hospitality sector (BLS 2017a). If land use restrictions result in a tradeoff between these two sectors, a region could see increasing employment accompanied by a falling average wage.[2] Per capita income is an alternative measure of economic well-being that captures wage income, non-wage income and transfer payments. As such, this measure succinctly captures the structural effects of the changing mix of employment opportunities, the wages available, and net migration in response to monument designation.[3]

4. Methodology

Measuring the treatment effect of monument designation on a local economy requires a set of control economies that serve as a basis of comparison. Traditional econometric methods, such as difference-in-differences, rely upon the analyst's judgement as to which units are valid comparisons and which are not. Moreover, all control units are given an equal weight in the analysis and are assumed to closely match the treatment unit in all or most of its attributes in the pre-treatment period. Within the context of our study, per capita income could be driven by county-level attributes, such as population density, employment growth, sex ratio, racial mix, educational attainment, etc., and we would want to choose control counties that closely match the treatment county in the most important attributes during the pre-designation period. It is highly unlikely that any given comparison unit will closely approximate the treatment unit in all, or even many, of the attributes. Further, applying one's best professional judgment to selection

[2] At the wage rates cited in the text, a loss of 25 jobs in the mining and logging industry would require an additional 52 jobs in the leisure and hospitality sector to keep wage income constant. Employment growth, by itself, is not fully indicative of regional economic well-being.

[3] Per capita income does not measure wealth effects that may be associated with amenity-migration, such as increased property values.

of control units is a rather arbitrary process; a different set of comparison units would result in a different treatment effect. To avoid such limitations, we implement the synthetic control method that both accounts for unit attributes and removes the analyst from the selection process by relying upon a data-driven procedures to select suitable comparison units (Abadie et al. 2010). We briefly describe the intuition behind the method within the context of our application; Appendix A provides methodological details.

A synthetic control is, in essence, a weighted average of a set of control units (called donor units), where the weights are determined based on how closely the characteristics of the control unit match those of the treatment unit during the pre-treatment period. As a result, such a synthetically composed unit can approximate the treatment unit (in the pre-intervention period) better than any single control unit because it is a weighted combination of available control units, each of which may closely capture one or more attributes of the treatment unit.

Methodologically, synthetic control can be thought of as a two-step procedure. The first step focuses on the pre-treatment time frame; in our case, this is the time period preceding designation of a national monument. At the first step, county characteristics for both treatment and control units are used to estimate two sets of weights: (i) *covariate weights*, which are assigned to county characteristics based on their predictive power on the outcome of interest, i.e., per capita income and, (ii) *county weights*, which are assigned to control counties based on their similarity (in terms of measurable county characteristics) to the treatment county. Donor counties that closely match the treatment unit on per capita income and important county attributes in the pre-intervention period are considered close comparisons and will receive a large donor weight whereas units that do not match up well receive a weight near or equal to zero. The county weights are then used to construct a synthetic control unit. The optimal sets of weights are selected to minimize the root mean squared prediction error (RMSPE), which measures the difference between the treatment and synthetic control unit during the pre-designation time path (Abadie and Gardeazabal 2003; Abadie et al. 2015). A good synthetic control will track the pre-designation path of a treatment county's per capita income closely; a poor synthetic control will have large deviations from the pre-designation path.

The second step directly answers the question, "What would have happened to the path of per capita income had the landscape-scale monument not been designated?" by using the post-intervention outcomes of the synthetic control unit to recover counterfactual outcomes. Assuming all other exogenous post-treatment events (such as recessions) affect the synthetic control and the treatment unit equally, the difference between the predicted outcome for the synthetic control and the actual outcome of the treatment unit measures the treatment effect.

The measured treatment effect is not amenable to a standard parametric tests of statistical significance. Instead, one conducts a series of falsification tests by assigning the treatment to each donor county (equivalent to treating control units with a placebo) and then evaluating the ratio of the post-designation RMSPE to the pre-designation RMSPE (Abadie et al. 2010). The post-treatment RMSPE for placebo units should be similar to the pre-treatment RMSPE (since there is no treatment effect), so the ratio of the two should be relatively small. If a treatment effect is present, one should observe a larger deviation between actual and synthetic outcomes in treatment counties during the post designation period, thus yielding a larger post/pre RMSPE ratio. A treatment effect would be considered statistically significant if it is one of very few large post/pre RMSPE ratios. Ordering post/pre RSMPE ratios from largest to smallest, a significant treatment effect would appear at or near the top of the list. One can interpret the percentage ranking as a proxy for p-value, i.e., an RMSPE ratio ranking third out of 30 possible placebo tests would be equivalent to p-value=0.10 (Abadie et al. 2010).

5. Data and Study Regions

We examine the effects of monument designation on the time path of county-level per capita income for three landscape-scale national monuments: Carrizo Plain (California), Canyon of the Ancients (Colorado), and Upper Missouri River Breaks (UMRB, Montana). Analysis is based on data collected by the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Bureau of Census from 1970-2015. Each monument was established by Antiquities Act proclamations of the Clinton administration and has been managed by the BLM both before and after the designation (Figure 1; Table 1). The Presidential Proclamations establishing each monument included language designating archaeological resources as the scientific objects to be protected and explicitly stated that active oil and gas operations were existing valid uses. All monuments had active grazing leases, but none of the proclamations explicitly listed grazing as a valid use. The ecosystems of Carrizo Plain NM and UMRB NM were designated as scientific objects to be protected; additionally, the geological and paleontological resources of Carrizo Plain were also protected.

Carrizo Plain NM. Carrizo Plain NM is located at the eastern end of San Luis Obispo county, approximately 150 miles southwest of Sequoia National Park.[4] Approximately 16% of the monument is non-federal land. Similar to other monuments, Carrizo Plain has active grazing leases; oil and gas rights are held on 30,000 acres. The monument is also home to a single Wilderness Study Area (WSA). San Luis Obispo county had a population of 281,401 in 2015, with a per capita income of $49,873 (about 93% of California's per capita income). During the post-designation period San Luis Obispo county grew more slowly than pre-designation, as did the remainder of the state (Table 2). The set of donor counties was composed of 53 California counties. The counties excluded from the analysis were Fresno, Kern, and Tulare counties, home to Giant Sequoia NM, and Riverside county, home to Santa Rosa and San Jacinto NM. Both were designated in 2000. Descriptive statistics and time plots of per capita income for the Carrizo Plain NM analysis appear in Appendix B (Table B-1 and Figure B-1).

Canyon of the Ancients NM. Canyon of the Ancients NM is in the Four Corners portion of southwestern Colorado, about 20 miles west of Mesa Verde NP (which received 547,000 visitors in 2015). The monument, located in counties that border Arizona, New Mexico, and Utah, surrounds three Colorado portions of the smaller, previously established Hovenweep NM and also encompasses three WSAs. At the time of designation, most of the monument's area had been leased for grazing and/or energy development. In 2015, Dolores county was home to 1,978 people whereas the population of Montezuma county was 26,168. County per capita incomes in the region were $38,393 and $42,715 for Dolores and Montezuma counties, respectively. Colorado's per capita income in 2015 was $50,899. Similar to the state as a whole, Montezuma county had slower population, employment and per capita income growth after designation of the monument, but Dolores county bucked this trend for population and employment growth (Table 2). Per capita income growth in Dolores county was slower in the post-designation period. The Canyon of the Ancients data set is composed of 2 treatment counties and 67 donor counties. The set of donor counties include 57 counties in Colorado, plus 10 border counties in Arizona (Apache), New Mexico (Colfax, Rio Arriba, San Juan, Taos, Union), and Utah (Daggett, Grand,

[4] A very small portion of Carrizo Plain NM is in Kern county.

San Juan, and Uintah).[5] Descriptive statistics and time plots of income appear in Appendix B (Table B-2 and Figure B-3).

Upper Missouri River Breaks. The Northern Great Plains of eastern Montana host the UMRB NM (UMRB), about 175 miles southeast of Glacier National Park. The Upper Missouri River within the monument enjoys designation as a Wild and Scenic River; the monument also includes portions of the Lewis and Clark and Nez Perce National Historic Trails. Unlike our comparison monuments, the UMRB includes substantial private inholdings on which livestock are grazed. The four counties on which the UMRB is located make up 2.7% of Montana's total population, by far the largest proportion of the three study monuments. Host county per capita incomes in 2015 ranged between 65% (Blaine) and 92% (Fergus) of Montana's 2015 per capita income of $41,809. Three of the four treatment counties had negative population growth prior to designation while the fourth had zero growth. Population losses have continued in all counties during the post-designation period (Table 2). Employment growth was essentially nil both before and after designation of the monument. In all cases, population and employment growth lags substantially behind the growth rates of the state as a whole. Perhaps due to population and employment losses, per capita income growth in the treatment counties has kept pace with that of Montana in the post-designation time frame. The donor pool for the UMRB analysis consists of the other 52 counties in Montana. Descriptive statistics and income time plots are reported in Appendix B (Table B-3 and Figure B-3).

6. Empirical Results

The weights for the donor counties comprising each synthetic control were selected following the procedure outlined in Section 4 and detailed in Appendix A. The empirical estimates of those weights for each host county's synthetic control are reported in Appendix C.

Carrizo Plain NM. The dashed line in the graph on the left of Figure 2 illustrates the time path of per capita income for the synthetic control whereas the solid line illustrates the actual time path for San Luis Obispo county. The synthetic control closely tracks the actual path during the pre-designation period, after which the two lines depart from one another. The actual path of per

[5] Five Colorado counties were dropped from the donor pool due to data discontinuity when Broomfield county was formed from portions of Adams, Boulder, Jefferson, and Weld counties in 2001.

capita income is consistently greater than that of the synthetic control during the post-designation period, suggesting that designation of the monument has increased per capita income in the county. One can think of the mean difference between actual income and the income predicted by the synthetic control in the post-designation period as a point estimate of the mean annual effect of monument designation. The mean annual percentage difference between the actual path and the counterfactual path is +3.69%, with a minimum gap of +0.20% and a maximum gap of +7.53% (Table 3).

The dark line in the graph on the right side of Figure 2 shows the (actual minus synthetic) gap for the treatment county; the gray lines show the (actual minus synthetic) gaps for the placebo tests as applied to the 53 control counties. It is apparent that San Luis Obispo county is not the only county to demonstrate a consistently positive designation effect, and many control units show similar, or larger, income gaps. Of course, these counties did not have a monument designated within their borders, and the variation in the observed gap is due to other common factors that affect both treatment and control counties. The post-designation/pre-designation RMSPE ratio for San Luis Obispo county was 2.94, but with that San Luis Obispo was ranked only 22nd out of the 53 units, yielding a P-value of 0.415 (Table 4). Therefore, the mean difference in predicted per capita income for the synthetic control unit and what actually occurred in the county is not statistically significant.

Canyon of the Ancients NM. In Figure 3, the difference between the dashed synthetic control line for Dolores county and the actual income suggests that monument designation caused a fall in income (top left). The mean annual difference was in excess of −27% (Table 3). In contrast, the actual-synthetic gap for Montezuma county (bottom left of Figure 3) has a mean post-designation actual-synthetic gap of +2.30% (Table 3). The populations of the two counties are quite different, with Montezuma having more than 13 times the population of Dolores in 2015. Weighting the annual income gaps by population in each year yields a region-wide mean estimated gap of +1.38%, with a minimum of −3.40% and a maximum of +11.64%. The falsification tests for each county (on the right side of Figure 3) show relatively fewer placebo counties matching the magnitude of the gap observed for Dolores county than Montezuma county. The post/pre RMSPE tests showed Dolores county ranked behind 14 placebo counties and Montezuma ranked behind 58 placebo counties. Consequently, the income gaps in both

Dolores and Montezuma counties are statistically insignificant, with p-values of 0.224 and 0.881, respectively (Table 4).

Upper Missouri River Breaks NM. The UMRB NM covers portions of four Montana counties. The graphs on the left side of Figure 4 show that in all four counties the synthetic control unit had a higher predicted per capita income than actually occurred. This suggests that monument designation has hurt the region's economies. Mean annual income gaps in the post-designation period were −14.82%, −9.09%, −2.28%, and −1.31% for Blaine, Chouteau, Fergus, and Phillips counties respectively (Table 3). Weighting by county population over the post-designation period yields a predicted mean region-wide fall in per capita income of −5.88%, with a minimum of −18.60% and a maximum of +0.81%. However, falsification tests indicate that these point estimates are statistically insignificant, with numerous placebo counties exhibiting income gaps of a similar or larger magnitude as those for treatment counties (right side of Figure 4). Nonetheless, Blaine county comes closest to being statistically significant, with its post/pre RMSPE ratio of 5.01 ranked 9th out of 52 counties, for an implied p-value of 0.17 (Table 4).

7. Discussion and Conclusions

We have examined the effect of landscape-scale national monuments on county-level per capita income in seven counties in three states. In every case, the measured treatment effects were statistically insignificant. The results presented here closely corroborate those found for Grand Staircase-Escalante NM in Utah, where the treatment effect on its two host counties was also statistically insignificant (Jakus and Akhundjanov in press). Thus, based on analysis of four national monuments located in nine counties, it would appear that the economic effect of landscape-scale national monuments on local economies has been exaggerated by both advocates and critics of national monuments. One might counter this statement by noting that these analyses are restricted to BLM-managed monuments with oil and gas leases, and grazing. What about, say, monuments with timber resources and co-managed by the US Forest Service?

Based on the history of settlement in the western states and how landscape-scale NMs are managed, we suspect that similar results will be found for many other landscape-scale NMs. In its application for statehood, a western territory had to give up legal claim to all "unappropriated" land within its boundaries. Federal land laws, such as the Homestead Act of 1862, encouraged western settlement by offering the unappropriated land to settlers in return for a small fee and satisfying certain land improvement conditions. Crucially, land laws were not written with regard to the rugged and arid nature of most western states, and land claims were legally restricted to relatively small acreage (generally, 160 acres). Settlers naturally chose the federal government's best, most arable land on which to establish a homestead, and it is these lands that land passed into private ownership. The arid climate of the west (and western water law's doctrine of prior appropriation) often meant that even if public land were available for settlement, the lack of water would economically doom any homestead claim. Finally, western landscapes are are often topographically challenging, making a good portion of public land unsuitable for homesteading. Jakus et al. (2017) estimated econometric models of county–level land ownership patterns in western states, and found that lands left under federal ownership are concentrated in topographically rugged counties with little arable land and below-average energy potential. Energy resources discovered on federal lands in the post-settlement era have, in many cases, never been exploited, or exploitation has been modest. Agriculture in regions with large proportions of public land is dominated by grazing, an industry offering most workers limited wages. Thus, during the pre-designation period, the federal land available to be designated as a national monument had never contributed much to local economies.

Further, the management principles promulgated by former Interior Secretary Babbitt have meant that the land has had little economic impact in the post-designation period. Landscape-scale national monuments have management plans that emphasize protection of historic and scientific objects and restrict development of recreational resources within the monument. In a typical landscape-scale national monument, roads are not paved and campgrounds are limited in number and spartan in character. Trails are not well-maintained and a visitor may need to rely upon navigational skills rather than following a well-signed and well-trodden trail. This management approach limits tourism to only the most intrepid, so that landscape-scale monuments do not generate the broad economic impact that, say, designation and management as a national park can confer on a local economy (see, for example, Cline et al. 2011). In general, the public lands on which a monument resides contributed little to the local economy before designation, and have continued to contribute little after designation. Thus, there is no observable aggregate economic effect of designation.

We do not claim that designation of national monuments has not had economic effects within the local economies. For example, it would seem clear that ranchers with allotments within a newly designated NM suddenly would be subject to more costly and restrictive management guidelines, thus negatively affecting ranch income. Conversely, an increase in tourism associated NM designation would boost the fortunes of the local leisure and hospitality industry. While the analysis presented here suggests that the negative and positive effects of monument designation wash out over a relatively small geographic area, future research may wish to focus on the distributional aspects of landscape-scale national monuments, and not the aggregate effect.

Finally, the primary focus of this paper has been on what is essentially a political question and does not address a question that may be more germane to economists: does designation of a landscape-scale national monument satisfy a benefit cost test? In this case, one must measure the use and nonuse benefits associated with the protections afforded by designation, and compare these to the incremental cost of managing public land as a national monument and the opportunity cost of foregone commercial activity on the land (primarily agriculture, forestry, and mining). It is in this calculation that one might expect to observe greater variation across landscape-scale national monuments, with some monuments passing a benefit cost test and others failing.

References

Abadie, A., A. Diamond, and J. Hainmueller, (2010) Synthetic control methods for comparative case studies: estimating the effect of California's tobacco control program. *Journal of the American Statistical Association*, 105(490): 493-505.

Abadie, A., A. Diamond, and J. Hainmueller, (2015) Comparative politics and the synthetic control method. *American Journal of Political Science*, 59(2): 495-510.

Abadie, A. and J. Gardeazabal, (2003) The economic costs of conflict: a case study of the Basque country. *American Economic Review*, 93(1): 113-132.

Albouy, D., (2016) What are cities worth? land rents, local productivity, and the total value of amenities. *Review of Economics and Statistics*, 98(3):477-487.

Bureau of Economic Analysis, (2017) Interactive data tables. Available at https://www.bea.gov/iTable/index_regional.cfm

Bureau of Labor Statistics, (2017a) Average hourly and weekly earnings of production and nonsupervisory employees on private nonfarm payrolls by industry sector, seasonally adjusted. https://www.bls.gov/news.release/empsit.t24.htm

Bureau of Labor Statistics, (2017b) Local area unemployment statistics. Available at https://www.bls.gov/lau/

Chen, Y., D.J. Lewis, and B. Weber, (2016) Conservation land amenities and regional economies: a postmatching difference-in-difference analysis of the northwest forest plan. *J. Regional Science* 56(3):373-394.

Chen, Y. and B. Weber, (2011) Federal policy, rural community growth, and wealth creation: the impact of federal forest policy and rural development spending in the Pacific northwest. *American J. Agricultural Economics* 94(2):542-548.

Cline, S.A., S. Weiler, and A. Aydin, (2011). The value of a name: estimating the impact of public land designation. *The Social Science Journal* 48:681-692.

Daly, E. and G.B. Middaugh, (2006) The Antiquities Act meets the Federal Land Management Policy Act. Chapter 13 in, Harmon, D., F.P. McManamon, and D.T. Pitcaithly (eds). *The Antiquities Act: A century of American archaeology, historic preservation, and nature conservation.* Tucson, AZ: Univ. of Arizona Press.

Davidson, L. and T. Burr, (2017) Trump greeted by cheers and protests as he visits Utah, trims 2 million acres from Bears Ears and Grand Staircase-Escalante national monuments. Salt Lake Tribune, December 4, 2017, https://www.sltrib.com/news/politics/2017/12/04/trump-is-coming-to-utah-to-perform-dramatic-feat-monday-make-big-national-monuments-mostly-disappear/.

Eichman, H., G.L. Hunt, J. Kerkvliet, and A.J. Plantinga, (2010) Local employment growth, migration, and public land policy: evidence from the Northwest Forest Plan. *J. Agricultural and Resource Economics*, 35(2):316-333.

Gabe, T., (2016) Effects of the October 2013 U.S. federal government shutdown on National Park gateway communities: the case of Acadia National Park, and Bar Harbor, Maine. *Applied Economics Letters* 23(5):313-317.

Gates, P.W., (1964) *History of public land law development.* Washington, D.C. Public Land Law Review Commission.

Jakus, P.M., J.E. Stambro, M. Hogue, J. Downen, L. Pace, and T.C. Grijalva, (2017) Western public lands and the fiscal implications of a transfer to states. *Land Economics*, 93(3):371-389.

Jakus, P.M. and S.B. Akhundjanov, (In press) "Neither boon nor bane: the economic effects of a landscape-scale national monument. *Land Economics*.

Lee, R.F., (2006) The origins of the Antiquities Act. Chapter 1 in, Harmon, D., F.P. McManamon, and D.T. Pitcaithly (eds). *The Antiquities Act: A century of American archaeology, historic preservation, and nature conservation.* Tucson, AZ: Univ. of Arizona Press.

Lewis, D.J., G.L. Hunt, and A.J. Plantinga, (2003) Does public lands policy affect local wage growth? *Growth and Change* 34(1):64-86.

Minnesota Population Center, National historical geographic information system: version 11.0 [Database]. Minneapolis: University of Minnesota. 2016. http://doi.org/10.18128/D050.V11.0

Partridge, M.D., D.S. Rickman, M.R. Olfert, and K. Ali, (2012) Dwindling U.S. internal migration: evidence of spatial equilibrium or structural shifts in local labor markets? *Regional Science and Urban Economics*, 42:375-388.

Pugliese, A., L. McCann, and G. Artz, (2015) Impacts of national forests in the west on county population. *Forest Policy and Economics* 50:62-69.

Ranchod, S., (2001) The Clinton national monuments: protecting ecosystems with the Antiquities Act. *Harvard Environment Law Review* 25:535-589.

Rasband, J.R., (2006) Antiquities Act Monuments: the Elgin Marbles of our public lands?" Chapter 8 in, Harmon, D., F.P. McManamon, and D.T. Pitcaithly (eds). *The Antiquities Act: A century of American archaeology, historic preservation, and nature conservation.* Tucson, AZ: Univ. of Arizona Press.

Rasker, R., P.H. Gude, and M. Delorey, (2013) The effect of protected federal lands on economic prosperity in the non-metropolitan West. *J. Regional Analysis and Policy* 43(2):110-122.

Roback, J., (1982) Wages, rent, and the quality of life. *J. Political Economy* 90(6):1257-1278.

Rothman, H., (1989) *America's National Monuments: The politics of preservation*. University of Illinois.

Squillance, M., (2003) The monumental legacy of the Antiquities Act of 1906. *Georgia Law Review*, 37:473-610

Tabuchi, H., (2018) Uranium miners pushed hard for a comeback. They got their wish. New York Times January 13, 2018), https://www.nytimes.com/2018/01/13/climate/trump-uranium-bears-ears.html.

Trump, D.J., (2017a) Review of designations under the Antiquities Act. *Federal Register* 82(82):20429-20431.

Trump, D.J., (2017b) Proclamation 9681—Modifying the Bears Ears National Monument. Online by G. Peters and J.T. Wooley, The American Presidency Project, http://www.presidency.ucsb.edu/ws/index.php?pid=128878

Trump, D.J., (2017c) Proclamation 9682—Modifying the Grand Staircase-Escalante National Monument. Online by G. Peters and J.T. Wooley, The American Presidency Project, http://www.presidency.ucsb.edu/ws/index.php?pid=128896

Wilkerson, C., (2003) Travel and tourism: an overlooked industry in the U.S. and Tenth district. *Federal Reserve Bank of Kansas City Economic Review* 2003(3rd quarter):45-71.

Table 1: Characteristics of National Monuments Studied

	Carrizo Plain, California	**Canyon of the Ancients, Colorado**	**Upper Missouri River Breaks, Montana**
Established	January 12, 2001	June 9, 2000	January 17, 2001
Acres	204,107	163,892	377,346
Resources protected	Archaeological, Ecosystem, Geological, Paleontological	Archaeological	Archaeological, Ecosystem
Existing Valid Uses Explicitly Protected	Oil and gas, geothermal	Oil and gas	Oil and gas
Host counties (2015 Population)	San Luis Obispo (281,401)	Dolores (1,978) Montezuma (26,168)	Blaine (6,577) Chouteau (5,767) Fergus (11,427) Phillips (4,169)
# of comparison counties	53	67	52

Table 2: County and State Compound Annual Growth Rates (%), Pre- and Post-Designation (1970-2015)[a]

	Population Growth		Employment Growth		Per Capita Income Growth	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
Carrizo Plain (2001)						
San Luis Obispo	2.82	0.81	4.23	1.36	2.51	1.65
State of California	1.77	0.91	2.48	1.13	2.03	1.41
Canyon of the Ancients (2000)						
Dolores	0.41	0.46	1.63	1.96	3.49	2.40
Montezuma	2.35	0.49	3.81	0.36	3.47	1.17
State of Colorado	2.59	1.23	4.08	1.06	3.16	0.59
Upper Missouri River Breaks (2001)						
Blaine	0.00	−0.18	0.07	−0.44	1.26	1.27
Chouteau	−0.29	−0.16	0.01	−0.69	0.21	1.72
Fergus	−0.24	−0.19	0.75	0.24	2.89	1.62
Phillips	−0.58	−0.54	0.56	−0.04	1.56	2.04
State of Montana	0.85	0.93	2.02	1.20	1.89	1.95

[a] Pre-designation growth rates calculated from 1970 through the year-of-designation; post-designation growth rates calculated from year-of-designation through 2015.

Table 3: Mean annual treatment effect (Actual − Synthetic) as % of per capita income ($2015)

	Mean	Min	Max
Carrizo Plain			
San Luis Obispo	3.69	0.20	7.53
Canyon of the Ancients			
Dolores	−27.33	−50.13	5.36
Montezuma	2.30	−1.45	8.22
Population-weighted	1.38	−3.40	11.64
Upper Missouri River Breaks			
Blaine	−14.82	−41.39	−3.83
Chouteau	−9.09	−25.36	6.88
Fergus	−2.28	−10.00	2.72
Phillips	−1.31	−17.55	7.82
Population-weighted	−5.88	−18.60	0.81

Table 4: Root Mean Square Prediction Error (RMSPE) Tests

Monument/Host county	Post/Pre RMSPE ratio	Treatment unit rank / # of all units	Percentage
Carrizo Plain			
San Luis Obispo	2.94	22/53[b]	41.5%
Max / min ratio (all units)	11.31 / 0.72		
Canyon of the Ancients			
Dolores	3.85	15/67[a]	22.4%
Montezuma	1.24	59/67[a]	88.1%
Max / min ratio (all units)	22.73 / 0.60		
Upper Missouri River Breaks			
Blaine	5.01	9/52[c]	17.3%
Chouteau	1.23	44/52[c]	84.6%
Fergus	2.23	24/52[c]	46.2%
Phillips	2.12	25/52[c]	48.1%
Max / min ratio (all units)	18.03 / 0.79		

[a] The synthetic control method did not converge for Mineral county.
[b] The synthetic control method did not converge for El Dorado county.
[c] The synthetic control method did not converge for Wibaux county.

Figure 1: Map of study region: Monuments over 100,000 acres and designated since January 1, 1996. The five monuments shown with boundaries are discussed in the text; circles are scaled to show relative size of other landscape-scale national monuments.

Figure 2: Carrizo Plain NM, California (San Luis Obispo county)

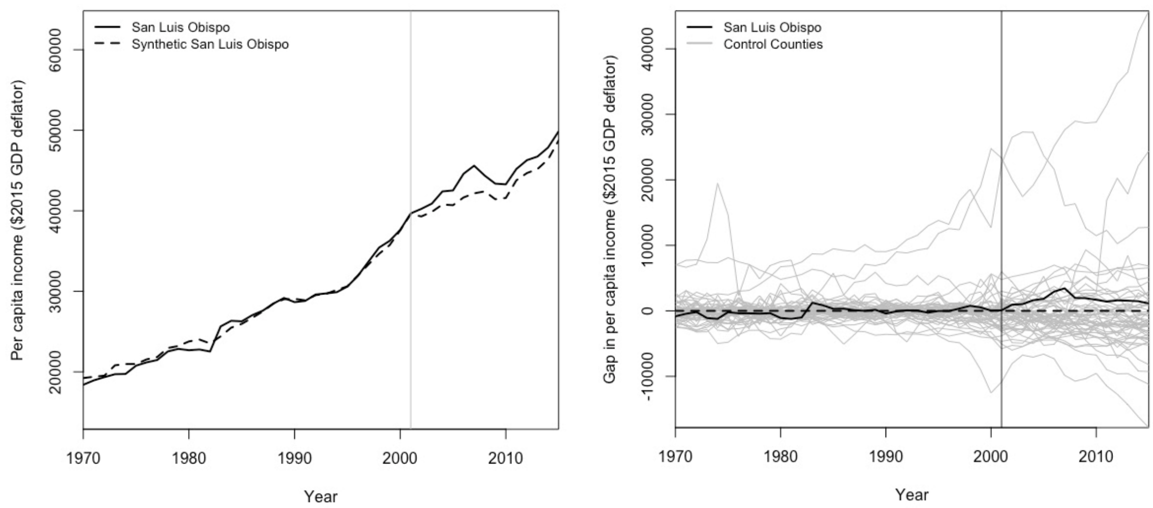


Figure 3: Canyon of the Ancients NM, Colorado (Dolores and Montezuma counties)

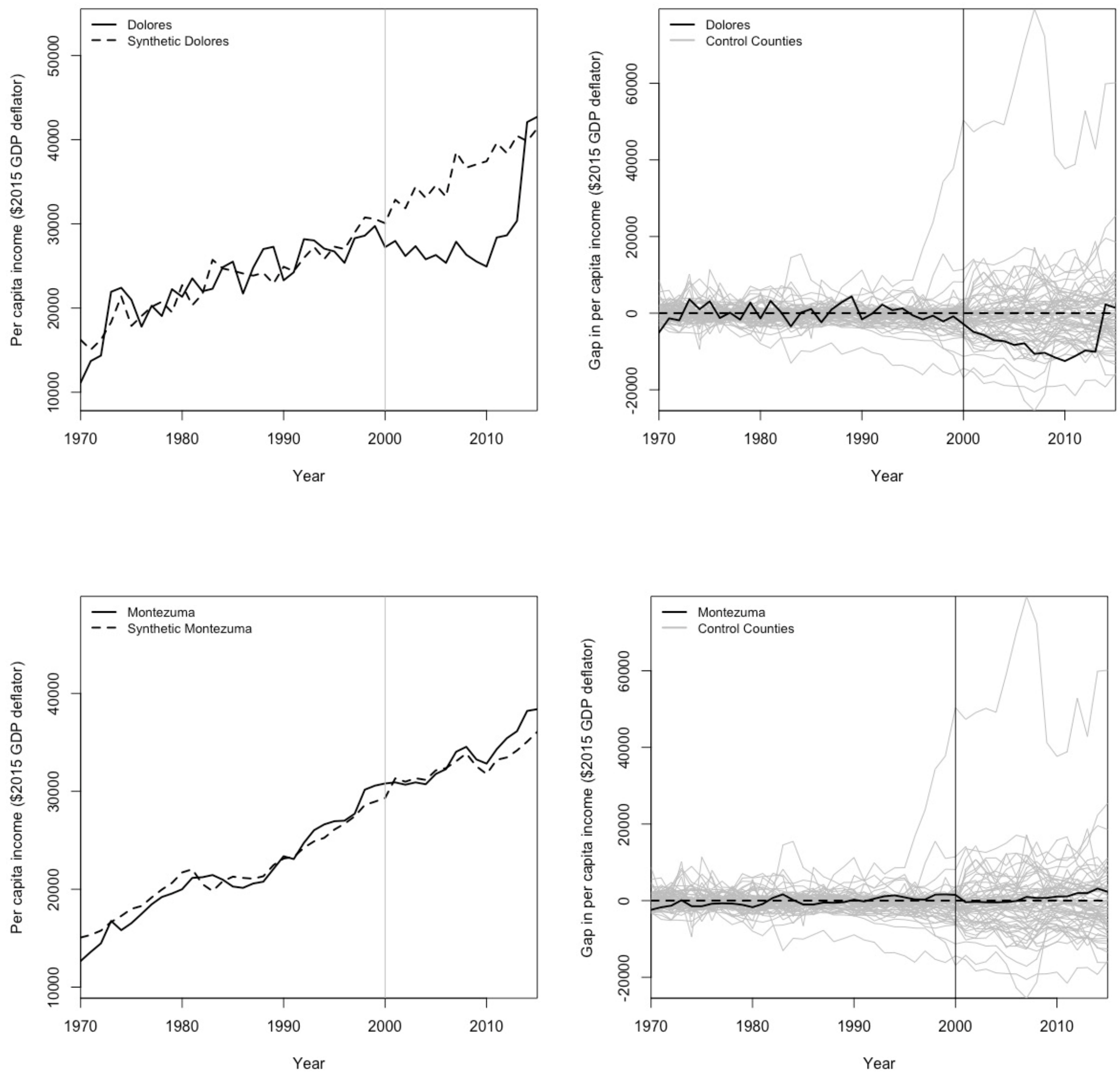


Figure 4: Upper Missouri Breaks NM, Montana (Blaine, Chouteau, Fergus, and Phillips counties)

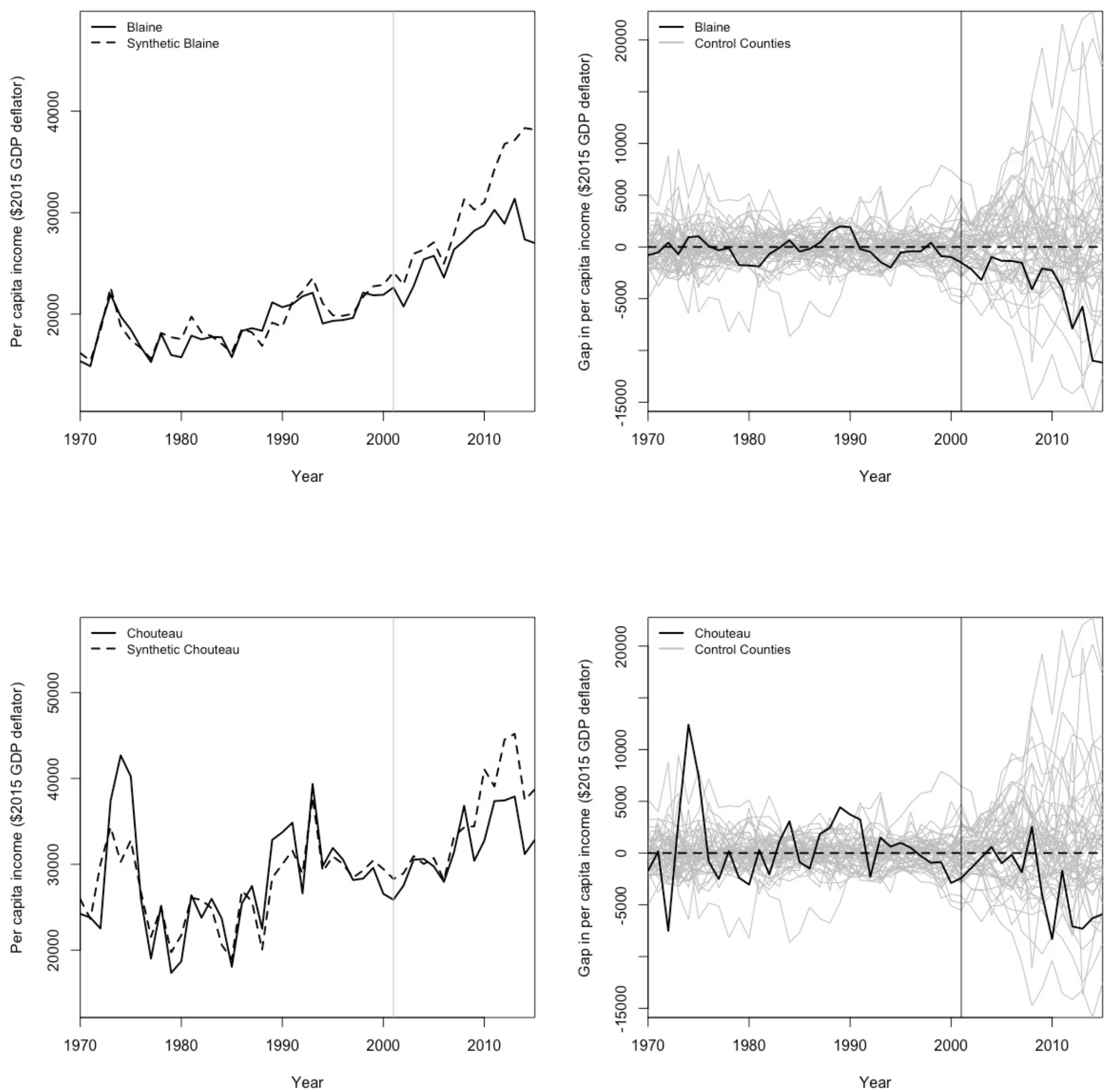
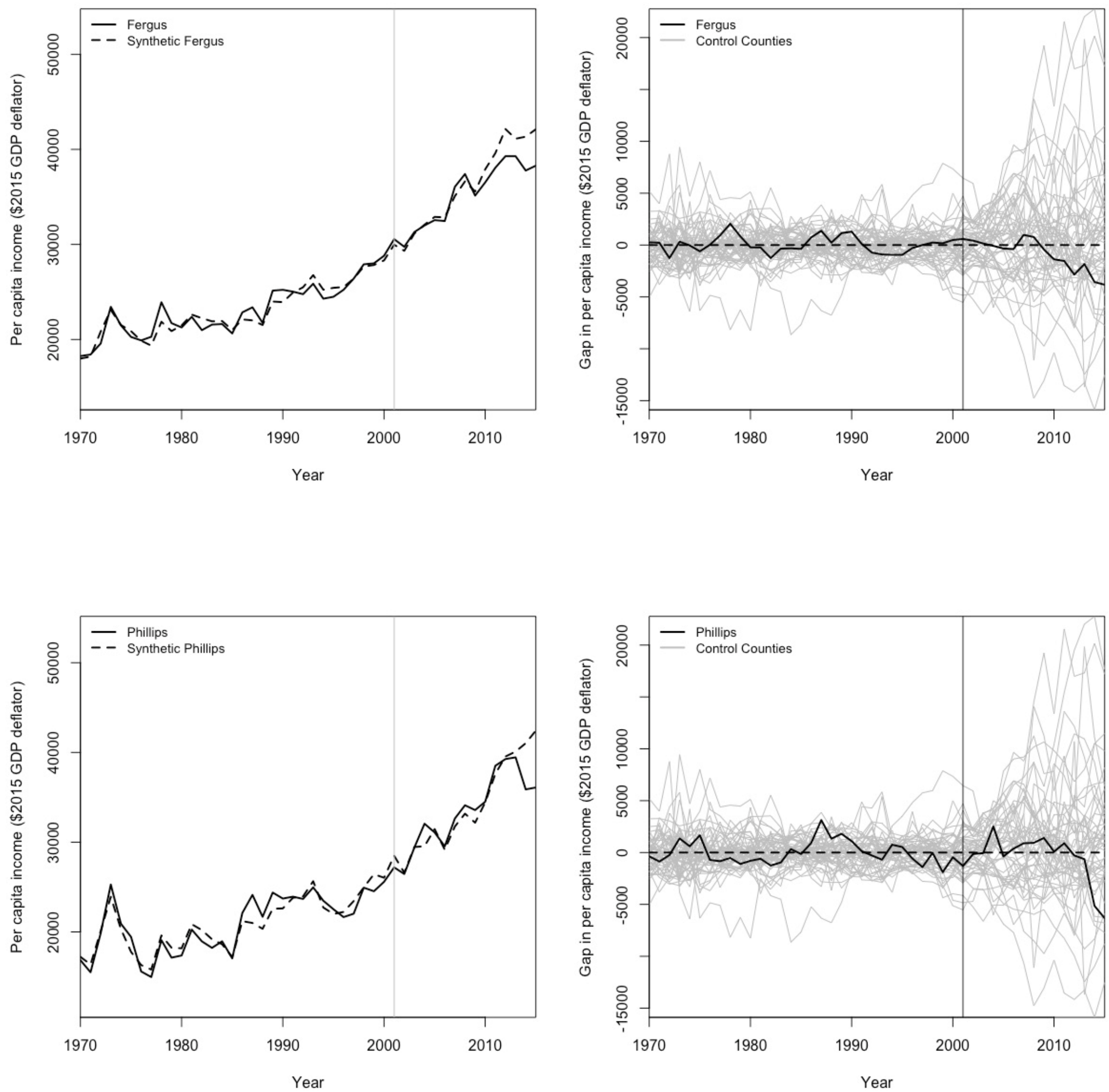


Figure 4 (continued): Upper Missouri River Breaks, Montana



Appendix A: Statistical Details of the Synthetic Control Method

Consider $N+1$ units, for $i = 1, \dots, N+1$, that are observed for T time periods, for $t = 1, \dots, T$. Assume that only the first unit, $i = 1$, is exposed to the event of interest (monument designation), while the remaining N units serve as potential controls. Treatment can affect one or more units so the methods presented here are applied separately to each unit. Suppose the intervention occurs at time period $T_0 + 1$, so that $1, 2, \dots, T_0$ are the pre-intervention periods and $T_0 + 1, T_0 + 2, \dots, T$ are the post-intervention periods, where $1 \leq T_0 < T$. Let Y_{it}^{NI} denote the outcome of interest (per capita income) for unit i in period t if unit i is not exposed to the intervention up to time t, for $i = 1, \dots, N+1$ and $t = 1, \dots, T$. Let Y_{it}^{I} denote the outcome of interest for unit i in period t if unit i is exposed to the intervention in periods $T_0 + 1$ to T. Hence, for the pre-intervention periods, the outcomes satisfy $Y_{it}^{I} = Y_{it}^{NI}$, for all $t = 1, \dots, T_0$ and $i = 1, \dots, N+1$.

Let $\alpha_{it} = Y_{it}^{I} - Y_{it}^{NI}$ represent the intervention or treatment effect for unit i in period t. Since in our setting only the first unit is affected by the intervention, subscript i in the treatment effect can be replaced with one. The interest is in estimating the effect of the treatment on the outcome for the treated unit in the post-intervention period

$$\alpha_{1t} = Y_{1t}^{I} - Y_{1t}^{NI} \quad \text{for} \quad t > T_0 \tag{1}$$

Equation (1) is ill-posed in that, while Y_{1t}^{I} is observed, the counterfactual outcome, Y_{1t}^{NI}, is unobserved and unobservable for $t > T_0$. The goal of the synthetic control method is to replace the missing Y_{1t}^{NI} with a synthetic counterfactual outcome.

Ideally, a synthetic control should closely approximate the exposed unit in all relevant quantifiable characteristics in the pre-intervention period. We formalize this idea by defining $\boldsymbol{Z}_i$ as a $r \times 1$ vector of observed explanatory variables of the outcome variable. Moreover, suppose $\bar{Y}_i^{\boldsymbol{K}} = \sum_{t=1}^{T_0} k_t Y_{it}$ is a linear combination of pre-intervention outcomes for unit i, where $\boldsymbol{K} = \left(k_1, \dots, k_{T_0}\right)'$ is the set of weights, of which there are M of them, $\boldsymbol{K}_1, \dots, \boldsymbol{K}_M$. These M linear combinations of outcomes can be used to control for the effect of unobservable common confounders that vary with time (Abadie et al., 2010). Therefore, the synthetic control method improves on traditional fixed effects or difference-in-differences methods, which can control only for time-invariant unobservable confounders.

Let $\boldsymbol{W} = (w_2, \dots, w_{N+1})'$ be $N \times 1$ vector of weights, with $w_i \geq 0$ for $i = 2, \dots, N+1$ and $w_2 + \cdots + w_{N+1} = 1$, that are assigned to unexposed units in the pre-intervention period to obtain a synthetic control. Notice that different values of the $\boldsymbol{W}$-vector yield potentially different weighted averages of control counties, and thus potentially different synthetic controls. The optimal weights $\boldsymbol{W}^* = (w_2^*, \dots, w_{N+1}^*)'$ must thus satisfy

$$\sum_{i=2}^{N+1} w_i^* \bar{Y}_i^{\boldsymbol{K}_1} = \bar{Y}_1^{\boldsymbol{K}_1}, \dots, \sum_{i=2}^{N+1} w_i^* \bar{Y}_i^{\boldsymbol{K}_M} = \bar{Y}_1^{\boldsymbol{K}_M} \tag{2}$$

$$\sum_{i=2}^{N+1} w_i^* \boldsymbol{Z}_i = \boldsymbol{Z}_1 \tag{3}$$

In words, $\boldsymbol{W}^*$ produces a weighted average of the available control units such that it closely mimics the exposed unit (in terms of outcome and predictor values) during the pre-intervention periods. In practical applications, there usually exists no set of weights for which (2) and (3) hold exactly. Hence, the weights are chosen such that these conditions hold approximately.

Abadie et al. (2010) propose to select the vector $\boldsymbol{W}^*$ that minimizes the overall discrepancy in characteristics of the exposed and synthetic control units, measured by

$$\|\boldsymbol{X}_1 - \boldsymbol{X}_0\boldsymbol{W}\| = \sqrt{(\boldsymbol{X}_1 - \boldsymbol{X}_0\boldsymbol{W})'\boldsymbol{V}(\boldsymbol{X}_1 - \boldsymbol{X}_0\boldsymbol{W})} \tag{4}$$

where $\boldsymbol{X}_1 = \left(\boldsymbol{Z}_1', \bar{Y}_1^{\boldsymbol{K}_1}, \dots, \bar{Y}_1^{\boldsymbol{K}_M}\right)'$ is a $k \times 1$ ($k = r + M$) vector of pre-intervention characteristics of the exposed county; $\boldsymbol{X}_0$ is a $k \times N$ matrix of pre-intervention characteristics of the control counties, with the jth column of $\left(\boldsymbol{Z}_j', \bar{Y}_j^{\boldsymbol{K}_1}, \dots, \bar{Y}_j^{\boldsymbol{K}_M}\right)'$; and $\boldsymbol{V}$ is some $k \times k$ symmetric and positive semidefinite matrix that assigns weights to the variables in $\boldsymbol{X}_1$ and $\boldsymbol{X}_0$ depending on their predictive power on the outcome. Similar to Abadie and Gardeazabal (2003) and Abadie et al. (2010), we select the matrix $\boldsymbol{V}$ such that the mean squared prediction error of the outcome variable is minimized for the pre-intervention periods.

The synthetic control unit obtained from the optimal weights $\boldsymbol{W}^* = (w_2^*, \dots, w_{N+1}^*)'$ can then substitute Y_{1t}^{NI} in equation (1) to produce the estimator of the treatment effect

$$\hat{\alpha}_{1t} = Y_{1t}^{I} - \sum_{i=2}^{N+1} w_i^* Y_{it}^{NI} \quad \text{for} \quad t > T_0 \tag{5}$$

Appendix B: Descriptive Statistics for Each Study Region

Table B-1: County characteristics, Carrizo Plain National Monument, California (1970-2015, 1 treatment county, 53 donor counties)

Variable	Source	N	Mean	Standard Deviation
Per capita income ($2015)	BEA	2484	33,605.05	12,999.35
Population density	BEA	2484	609.26	2,195.04
% total income from farms	BEA	2484	3.70	6.38
Annual growth, all employment	BEA	2484	2.23	3.65
Annual growth, farm employment	BEA	2484	0.42	8.42
Annual growth, private nonfarm employment	BEA	2484	2.64	4.65
Annual growth, government employment	BEA	2484	1.46	4.00
% farm employment	BEA	2484	5.83	6.51
% private nonfarm employment	BEA	2484	74.55	10.85
% government employment	BEA	2484	19.62	8.19
Industrial mix employment growth (farm, private nonfarm, gov't)*	BEA	486	1.06	0.05
% population, female	Census**	270	49.58	1.96
% population, nonwhite	Census**	270	18.99	13.76
% population over age 15, married	Census**	270	57.25	7.23
% population, college graduate	Census**	270	17.70	8.90
% population over age 16, in labor force	Census**	270	59.58	6.86
% population, living in poverty	Census**	270	12.83	3.98
Unemployment rate	Census** (1970, 1980); BLS (1990-2015)	1512	8.81	4.24

*Industrial mix measured at five-year intervals following Partridge et al. (2012).
**BEA data downloaded from interactive data tables (BEA 2017). Census data downloaded from Minnesota Population Center (NHGIS.org). Unemployment data from BLS (2017b).

Table B-2: County characteristics, Canyon of the Ancients National Monument, Colorado (1970-2015, 2 treatment counties, 67 donor counties)

Variable	Source	N	Mean	Standard Deviation
Per capita income ($2015)	BEA	3174	29,099.81	12,352.98
Population density	BEA	3174	73.27	424.33
% total income from farms	BEA	3174	6.25	10.49
Annual growth, all employment	BEA	3174	2.54	7.54
Annual growth, farm employment	BEA	3174	0.47	8.51
Annual growth, private nonfarm employment	BEA	3174	3.22	9.69
Annual growth, government employment	BEA	3174	1.91	4.94
% farm employment	BEA	3174	11.77	11.72
% private nonfarm employment	BEA	3174	69.38	15.30
% government employment	BEA	3174	19.06	8.19
Industrial mix employment growth (farm, private nonfarm, gov't)*	BEA	621	1.05	0.05
% population, female	Census**	345	49.07	2.66
% population, nonwhite	Census**	345	11.02	13.95
% population over age 15, married	Census**	345	60.53	8.03
% population, college graduate	Census**	345	18.35	10.67
% population over age 16, in labor force	Census**	345	61.58	10.30
% population, living in poverty	Census**	345	15.35	7.71
Unemployment rate	Census** (1970, 1980); BLS (1990-2015)	1932	5.59	2.94

*Industrial mix measured at five-year intervals following Partridge et al. (2012).
** BEA data downloaded from interactive data tables (BEA 2017). Census data downloaded from Minnesota Population Center (NHGIS.org). Unemployment data from BLS (2017b).

Table B-3: County characteristics, Upper Missouri River Breaks National Monument, Montana (1970-2015, 4 treatment counties, 52 donor counties)

Variable	Source	N	Mean	Standard Deviation
Per capita income ($2015)	BEA	2576	26,672.67	8,223.30
Population density	BEA	2576	6.58	10.77
% total income from farms	BEA	2576	8.76	12.08
Annual growth, all employment	BEA	2576	0.92	3.73
Annual growth, farm employment	BEA	2576	−0.33	3.93
Annual growth, private nonfarm employment	BEA	2576	1.53	6.03
Annual growth, government employment	BEA	2576	0.63	4.10
% farm employment	BEA	2576	18.71	13.20
% private nonfarm employment	BEA	2576	62.50	14.01
% government employment	BEA	2576	18.79	6.17
Industrial mix employment growth (farm, private nonfarm, gov't)*	BEA	504	1.04	0.05
% population, female	Census**	280	49.51	1.53
% population, nonwhite	Census**	280	7.66	13.47
% population over age 15, married	Census**	280	62.00	5.81
% population, college graduate	Census**	280	15.21	6.28
% population over age 16, in labor force	Census**	280	60.19	5.81
% population, living in poverty	Census**	280	15.88	5.35
Unemployment rate	Census** (1970, 1980); BLS (1990-2015)	1568	5.19	2.46

*Industrial mix measured at five-year intervals following Partridge et al. (2012).
** BEA data downloaded from interactive data tables (BEA 2017). Census data downloaded from Minnesota Population Center (NHGIS.org). Unemployment data from BLS (2017b).

Figure B-1: Time path of per capita income, Carrizo Plain

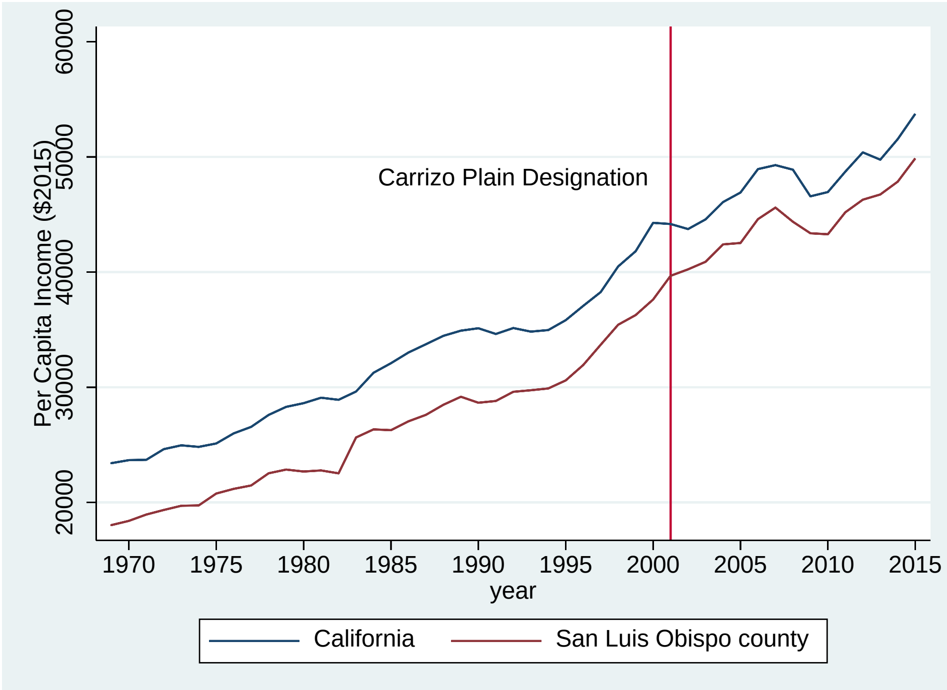


Figure B-2: Time path of per capita income, Canyon of the Ancients

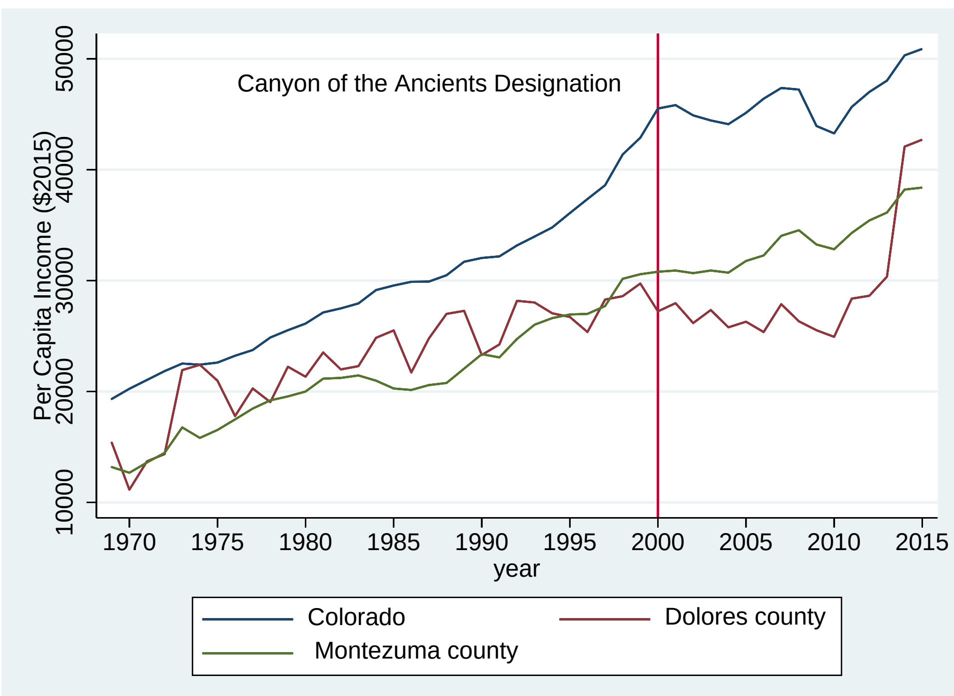
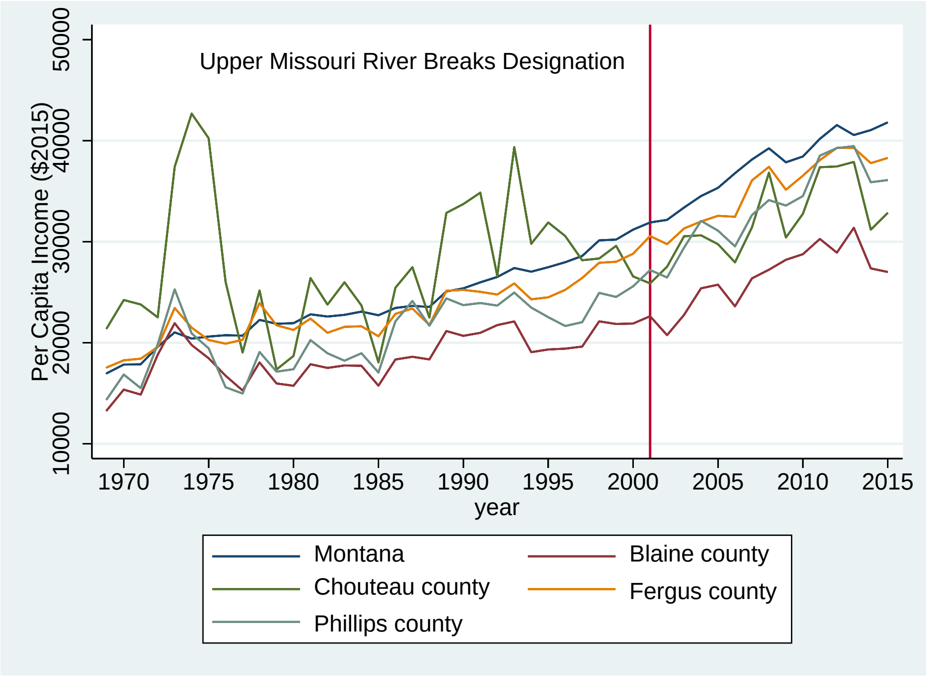


Figure B-3: Time path of per capita income, Upper Missouri River Breaks



Appendix C: Synthetic Control Weights of Donor Counties, by Host County

Table C-1: Carrizo Plain NM, California

Host County	
San Luis Obispo	
Donor	*Weight*
Butte	0.735
Alpine	0.078
Santa Cruz	0.067
Napa	0.063
Marin	0.057
Others	0.000

Table C-2: Canyon of the Ancients NM, Colorado

Host Counties			
Dolores		Montezuma	
Donor	*Weight*	*Donor*	*Weight*
Jackson	0.317	Lake	0.252
Kiowa	0.213	Fremont	0.117
Costilla	0.180	Conejos	0.095
Daggett (UT)	0.162	San Juan (NM)	0.094
Elbert	0.091	Gilpin	0.059
Others	0.037	Others	0.383

Table C-3: Upper Missouri Breaks NM, Montana

Host Counties							
Blaine		Chouteau		Fergus		Philips	
Donor	*Weight*	*Donor*	*Weight*	*Donor*	*Weight*	*Donor*	*Weight*
Roosevelt	0.353	Liberty	0.593	Custer	0.188	Meagher	0.332
Bighorn	0.300	Daniels	0.288	Musselshell	0.137	Wibaux	0.156
Petroleum	0.157	McCone	0.085	Carbon	0.110	Garfield	0.152
Glacier	0.104	Judith Basin	0.027	Yellowstone	0.081	Rosebud	0.091
Carter	0.087	Garfield	0.004	Wibaux	0.068	Sanders	0.082
Others	0.000	Others	0.001	Others	0.415	Others	0.187