Evaluating Industry Impacts and Externalities of the US National Park System*

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Abstract

This paper studies the industry impacts and externalities associated with conservation in the context of the US National Park System (NPS), the largest national conservation entity in the world. We investigate the potential negative impacts of the NPS on the mining, forestry, and farming sectors, as well as on traffic and air pollution in the local economy. We find little evidence of large negative effects on income or employment at the industry level. However, the results are consistent with costly adaptation within these industries, and also provide evidence of some negative externalities from increased traffic.

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1 Introduction

The economic winners and losers of environmental conservation have been top of mind for policymakers shaping US conservation efforts for the past 150 years. In the early days of the National Park System, the economic costs of parks on the mining, logging, and farming industries were perceived to be so large that supporters often had to demonstrate that an area was economically "worthless" before a new park would be approved (Runte, 2010, Ch 3). Today, by contrast, parks are often perceived to be a magnet for economic development driven by tourism. In 2021 the Biden administration's "30 by 30" directive declared a goal of conserving 30 percent of US lands and waters by 2030, stating that this will create "immense economic benefits."[1]

In this paper we study the potential costs of conservation in the context of the US National Park System (NPS), the largest national conservation entity in the world. Specifically, we investigate the potential negative impacts of the NPS on the mining, forestry, and farming sectors, as well as on traffic and air pollution in the local economy. This analysis complements Szabó and Ujhelyi (2023), which finds positive overall impacts of parks on local employment and income.

Our starting point is the dataset on the NPS introduced in Szabó and Ujhelyi (2023), which contains detailed information on the location and administrative history of each park, creating a park-level panel. The sample used here spans 1970-2017 and is restricted to parks in the lower 48 states.

Our main source of county-level economic measures is the Bureau of Economic Analysis (BEA), which publishes information on industry-level employment and income beginning in 1969. We complement this data with a variety of other sources to get a more detailed look at each industry. For the mining industry, we add to our dataset mine level information from the Mine Safety and Health Administration. For the forestry sector, we include data on the number of establishments from the County Business Patterns database of the Census Bureau, and on the annual volume of timber cut in national forests from the Forest Products Cut and Sold reports of the US Forest Service. For farming, we add data from the USDA Census of Agriculture on farm product sales, inventories, and the number of farms.

To measure some of the possible externalities associated with parks, we include data on traffic accidents from the Fatality Analysis Reporting System of the US Department of Transportation. Finally, we use data on the average annual concentration of NO2 and ozone, two major pollutants linked to motor vehicles, published by the EPA.

[1] https://www.doi.gov/sites/doi.gov/files/report-conserving-and-restoring-america-the-beautiful-2021.pdf

Following Szabó and Ujhelyi (2023), our first exercise estimates the impact of changing a park's designation to National Park (NP). National Parks are the best-known and most visible areas of the NPS, and during our period of study almost all NP's were established by upgrading an already-existing park. This treatment may be interpreted as an "intensive-margin" increase in conservation. Our second exercise estimates the impact of changes on the "extensive margin," namely, the opening of a new park. In a third exercise, we consider the impacts of large park expansions.

Our empirical strategy uses event study specifications: we compare the *path* of an outcome in areas experiencing a treatment (e.g., NP designation) to areas not experiencing the treatment. The event study specification allows us to measure dynamic treatment effects (e.g., the impact of NP designation on local employment may develop gradually over time), and to directly inspect pre-trends in order to assess whether the estimates warrant a causal interpretation.

We find that park openings lead to mine closures: the number of mines suffers a permanent decline of just under 10%. At the same time, there is little evidence that this affected total mining employment. This is consistent with a story where the remaining mines soak up many of the workers displaced from the mines that shut down.

As expected, NP designation is less disruptive on the mining sector, with no evidence that the number of mines declined. Interestingly, we find an increase in total mining employment around NP's, which is consistent with anecdotal evidence on the mining sector strategically ramping up its activity in order to offset, or prevent, future restrictions.

There is no evidence that either NP designation or park opening has significant negative impact on the forestry sector as a whole. For NP designation, this result is not surprising as logging is generally prohibited in all parks of the NPS, including non-NP's. For park opening, we find evidence that the lack of negative effects could be due in part to offsetting substitution effects. In particular, we show that following the opening of a new park, there is an increase of 20-50% in the amount of timber extracted from nearby national forests (federal lands managed by a different agency). This finding points to a limitation of conservation policies that focus on limited geographic areas and/or specific government agencies.

Finally, there is also no evidence that either NP designation or park opening has significant negative impact on the farming industry as a whole. Here too, a possible explanation is heterogenous effects and adjustments within the industry: while parks may limit grazing, the resulting increase in visitors and economic activity may benefit the local farming sector.

Lastly, we explore some of the potential negative externalities associated with increased tourism and economic development resulting from parks. The impact on pollution is small and statistically insignificant. However, there is some evidence that the opening of parks

leads to more traffic accidents. Traffic fatalities increase by 10% 3-4 years following the opening of a park - an effect that seems driven by areas far from large population centers.

In the rest of the paper, Section 2 provides the relevant background on the National Park System and describes the construction of our dataset. Section 3 describes our empirical strategy and specification. Section 4 presents our results for the mining, forestry, and farming sectors. Section 5 estimates some of the negative externalities of parks. Section 6 discusses some of the economic benefits of parks, and Section 7 concludes. The paper is accompanied by an Online Appendix that presents further details on our analysis and documents our dataset.

2 Background and data

2.1 Background

The NPS contains over 400 parks with natural and/or historical significance. It is managed by the National Park Service, an agency established in 1916 under the US Department of the Interior. Most parks are large natural areas - the median park in our data has 3400 acres (5.3 square miles). Many parks also have historical significance, containing, e.g., Native American dwellings, petroglyphs, Civil War battlefields, US presidents' family estates, or prehistoric fossils.[2]

The mission of the Park Service is both to conserve the parks and to make them accessible to the public in a sustainable manner. As stated in the act establishing the Park Service, the goal is to "conserve scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (Organic Act of 1916).

Parks in the NPS have different titles or "designations." Designations have no clear definition,[3] but the flagship parks of the system are undoubtedly the National Parks, which are often referred to as the "crown jewels" of the park system. Lesser natural areas have designations such as National Preserve, National Recreation Area, or National Seashore. Parks that are primarily of historic importance mostly carry designations like National Historic Park (typically considered to be the most prestigious designation in this category), National

[2] The NPS also contains some historic buildings and museums in metropolitan areas: we will drop most of these by excluding large cities from our analysis. Virtually all units of the NPS are open to the public. The few exceptions include areas located on Native American land that require special permits for access.

[3] In the 1960s an attempt was made to clearly categorize parks into "natural," "historical," and "recreational" but because most parks contain areas that fall into each of these categories, this attempt was abandoned by the mid 1970s (Rettie, 1995, 42-43). See Rose (2017) for a detailed discussion of the nomenclature and its implications.

Historic Site, or National Battlefield. National Monument (NM) is a designation that is given to both natural and historic areas, and it is sometimes a temporary designation that later may be converted to National Park or National Historic Park.

Designations are suggestive of what type of activities are allowed in a park, but the exact restrictions are set on a park-by-park basis, and they vary over time. National Parks face the most restrictions. In general, activities that extract or consume resources are forbidden, but there are exceptions. For example, new mining operations are forbidden, but the Mining in the Parks Act of 1976 guaranteed existing mining claims. Typically, mining companies must submit a plan of operations for approval by the Park Service, and post a bond to guarantee that they conform to the plan (Buono and West, 1986). National Parks also limit motorized access, including commuting or commercial traffic on roads located inside the park.

Most parks become part of the NPS through legislative action by Congress followed by the president's signature.[4] In particular, only Congress can designate a National Park. Both the process of including an area in the NPS and of changing a park's designation to National Park involve multiple decision makers, including local stakeholders, Congress, the Park Service, and the President. Rettie (1995, p29) summarizes the process as follows:

> "Somewhere somebody becomes convinced that something should become part of the national park system. That somebody gathers the support of other individuals and groups [...] Letter writing and personal visits to state and federal legislators seek to gain public support and sponsorship of proposed legislation to create a new park. [...] A bill is introduced in Congress. [The Park Service] may already have an opinion on the subject or it may then undertake a new area study. [...] Hearings are held. [...] Administration and public witnesses express their views. If successful, the bill is reported out of committee and sent to the floor of Congress. The Senate may do essentially the same thing. [...] The bill is voted on in the House and Senate."

Because of the multiple decision makers involved, this process typically takes several decades. In our sample, the median length of time before changing a park's designation to NP is 58 years since the park's opening. An important implication is that economic shocks are unlikely to have a contemporaneous impact on park opening or designation.[5]

[4] The president has discretionary power to establish National Monuments under the Antiquities Act of 1906.

[5] As noted by a referee, the opening of *historic* parks could in principle be timed to coincide with an important event such as the death or inauguration of a president, which could independently increase visitor interest in the site. We reviewed the history of all historic parks that opened during our sample period and found no obvious coincidences. For example, of the two presidential boyhood homes, President Clinton's opened as a National Historic Site nine, and President Carter's seven years after the president left office.

The process by which an area becomes a *candidate* for inclusion in the park system or for NP designation (or indeed what being a candidate means) is not clear-cut, as virtually anyone can propose a park, and many US counties have parks that could be proposed (Rettie, 1995; Dilsaver, 2008). This implies that an empirical strategy that relies on comparing chosen locations and candidate locations would not be practical in our case (Greenstone et al., 2010).

In the overwhelming majority of cases, once a park becomes part of the NPS, it will remain part of it permanently. During our period of study, only one park was moved out of the NPS (Oklahoma City National Memorial, established in 1997, moved out in 2004). Prior to this, the last park moved out of the NPS was Flaming Gorge NRA, in 1968. National Parks being moved out of the NPS is even less common. Since 1940, no National Park has been moved out of the NPS, and only one National Park was downgraded to a lesser designation (Platt NP, established in 1906, became Chickasaw National Recreation Area in 1976).[6]

2.2 Data

Our starting point is the dataset on the NPS introduced in Szabó and Ujhelyi (2022), which contains detailed information on the location and administrative history of each park, creating a park-level panel. The sample used here spans 1970-2017 and is restricted to parks in the lower 50 states, excluding units located in large metropolitan areas. The NP designation exercise focuses on the 188 parks established before 1970, while the park opening exercise includes all 269 parks. The location of these parks is shown on Figure 1

We merge a number of different datasets to our NPS data - details are Section 6 of the Online Appendix. Our main source of county-level economic measures is the Bureau of Economic Analysis (BEA), which publishes information on population, and industry-level employment and income beginning in 1969. Our measure of income is earnings by place of work, which consists of compensation of employees and proprietors' income generated in the given county. This is consistent with the employment measure, which is also calculated on a place-of-work basis.

We consider three industries that may lose from increased conservation (mining, farming, and forestry and logging[7]). In the Appendix, we also consider three industries which

[6] Prior to this, the last downgrade was in 1940, when two parks were downgraded, Abraham Lincoln Birthplace (NP between 1919-1940, redesignated to National Historic Site) and Fort McHenry (NP between 1925-1940, redesignated to National Monument).

[7] Throughout we use the term "forestry" as a shorthand for a set of industries referred to as "Agricultural services, forestry, and fishing." This category includes timber production and nurseries, forestry services, fishing, hunting and trapping as well as some support services for agriculture.

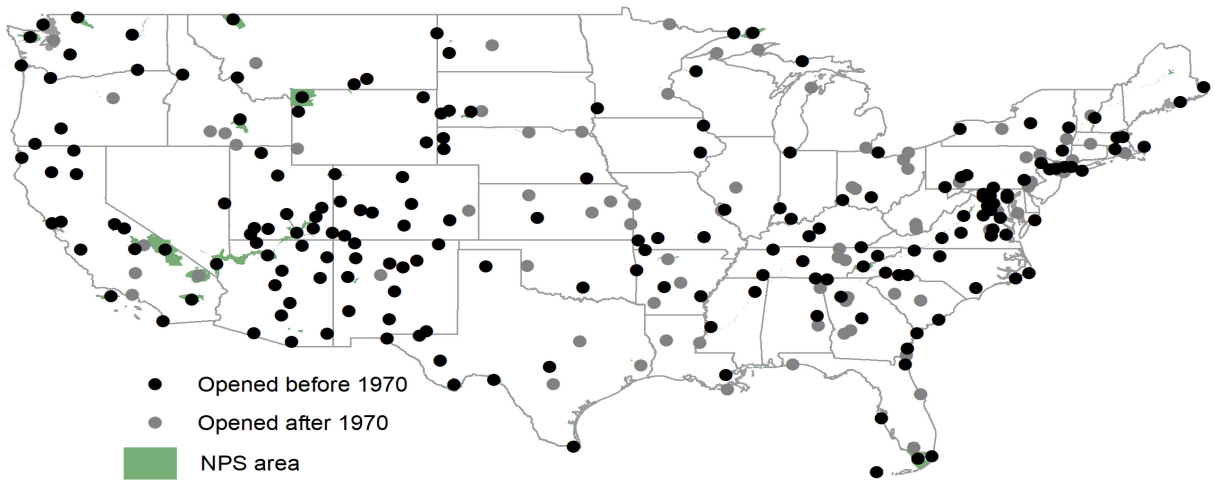

Figure 1: Location of parks in the sample

Markers indicate the centroid of each park. When a park's geographic footprint is larger than the marker, the park's area is shaded in green.

could gain from increased tourism and infrastructure development associated with the NPS (hotels, retail, and construction). For the hotel sector, we can only look at income because employment is not available. In addition, changes in the industry classification in 2000 require adjustments for two of the series we use, retail and forestry, to make them consistent over time. The adjusted retail series always contains restaurants, while the adjusted forestry series always contains logging, as well as lumber and wood products manufacturing. For both series, these adjustments can only be done for income, we do not have data on employment that is consistent over time in these categories. Detailed summary statistics of all employment and income variables are in Tables A.1-A.4 in the Appendix.

As we show below, our results warrant taking a closer look at some of these industries. For a closer look at the mining industry, we add to our dataset mine level information from the Mine Safety and Health Administration, available for 1983-2017. We use this data to calculate the number of mines, as well as employment in the average mine, in each county. In contrast to the BEA mining data, the mine level data does not include oil extraction. For more details on the forestry sector, we include data on the number of establishments from the County Business Patterns database of the Census Bureau. This data is available in consistent form for 1974-2016. Data on the annual volume of timber cut in each national

forest is obtained from the Forest Products Cut and Sold reports of the US Forest Service, available starting in 1977. For a closer look at farming, we add data from the USDA Census of Agriculture on farm product sales, cattle inventories, and the number of farms in the county. During our period of study, this data is available in 1974, 1978, 1982, and every 5 years after that. Finally, for a closer look at construction, we add the house price index published by the Federal Housing Finance Agency (available since 1975) and the number of building permits issued in the county from the Census Bureau (beginning in 1990).

County level information on population age groups comes from the Census Bureau and starts in 1970. County level weather information is from the National Climatic Data Center of the U.S. Department of Commerce.

To measure some of the possible negative externalities associated with parks, we collected data on traffic accidents and pollution. Data on traffic accidents comes from the Fatality Analysis Reporting System of the US Department of Transportation. This can be used to compute the annual number of accidents and the number of fatalities in each county beginning in 1975. Data on the average annual concentration of various air pollutants is published by the EPA starting in 1980. We use data on NO_2 and ozone, two major pollutants linked to motor vehicles.

All county-level datasets can be matched by county FIPS codes. This data is matched to our dataset on the NPS using GIS boundary files. All monetary values are transformed to real 1982-84 dollars using a consumer price index from the Bureau of Labor Statistics.

3 Empirical strategy

3.1 Treatments

In practice, the creation of a National Park or any other unit of the NPS is a process rather than a binary event. In most cases, the area that will eventually become the park has been there for many years (e.g., in the case of the Grand Canyon, 5-6 million years). Prior to the creation of the park, the area may not be easily accessible: there may be no paved roads, or visitation may be possible only by appointment (as in the case of some caves and historic sites). When the federal government authorizes the creation of the park, this may mean the transfer of federal land to the National Park Service from another agency (such as the Bureau of Land Management), followed by the development of park infrastructure.

This means that studying the impact of parks requires defining what the treatment is. Following Szabó and Ujhelyi (2023), we study three treatments: an existing park acquiring National Park (NP) designation, the opening of a new park, and (in the Appendix) a large

expansion in the area of an existing park.

Treatment 1: NP designation. To study the impact of national parks, the most visible units in the system, we estimate the impact of NP designation for an existing park, i.e., a park that is already part of the NPS but has a different designation. The comparison group for these estimates consists of other parks in the NPS that are not receiving NP designation in the given period.

By focusing on existing parks, we are not subject to the potential confounds that may arise in connection with a park being newly established. These may include political and economic factors that affect the federal government's ability to acquire land or establish a local jurisdiction, as well as developments in the local economy that may make the park more accessible to tourists (since we are focusing on existing parks that tourists are already visiting). Studying existing parks also offers a clear counterfactual: in the absence of NP designation, the park would still be part of the NPS - for example, it would not undergo commercial or industrial development.

Of the 46 national parks in the contiguous 48 states, 17 acquired their NP designation during our sample period, and an additional national park (Platt NP) lost its NP designation. Thus, there are a total of 18 designation changes involving national parks in our period of study. Of these, 3 involve parks established after 1970, so we drop them from the analysis when focusing on parks that existed throughout our period of study. We drop an additional park, Theodore Roosevelt NP, where an oil discovery adjacent to the park in the year of the designation would confound our estimates of economic impacts (biasing our main results *upwards*). Our identification will thus come from designation changes in 14 parks, listed on Figure 2.

Treatment 2: Opening of a new park. Our second treatment is the inclusion of a new park in the NPS ("park opening"). Compared to NP designations, this event is more frequent but also more heterogenous. Typically, the opening of a new park will mean that the federal government has authorized the Park Service to begin spending money on developing the park. In practice, changes range from mere formalities to the start of actual construction and development of park facilities. At the same time, there are a number of common elements: all parks included in the NPS are managed by the same agency, are listed in the same publications, and are generally distinguished by the NPS "brand." Because parks can be expected to remain in the NPS indefinitely, a park's opening also represents a commitment on the part of the federal government regarding the future prospects of the area. To exclude events that were mere formalities, we will drop parks that did not begin reporting visitors within 5 years after opening.[8]

[8] The median park begins reporting visitors within 4 years after being included in the NPS.

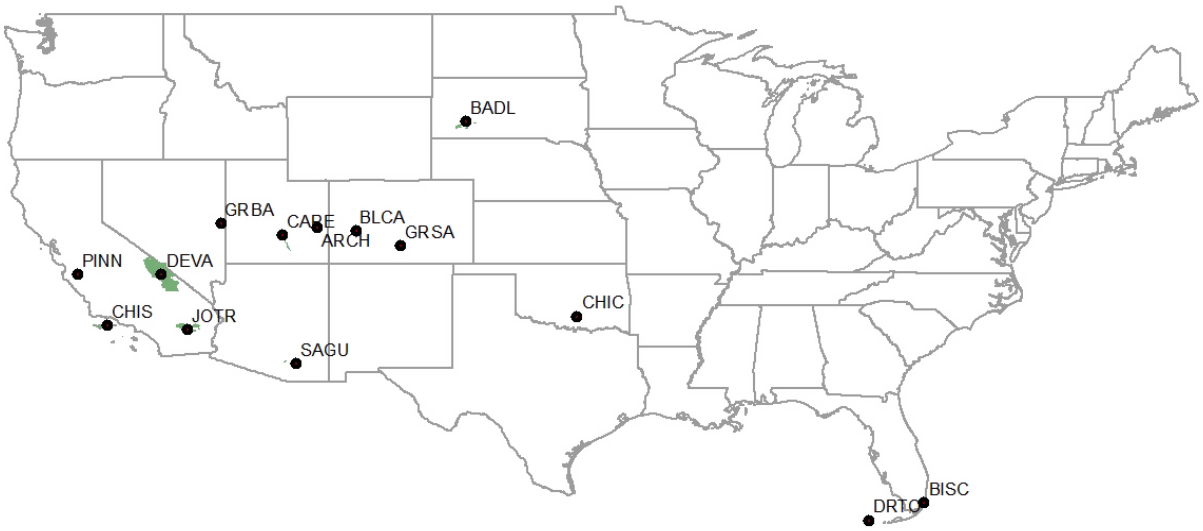

Figure 2: Parks experiencing an NP designation change in the sample

Markers indicate the centroid of each park. When a park's geographic footprint is larger than the marker, the park's area is shaded in green. ARCH: Arches, BADL: Badlands, BISC: Biscayne, BLCA: Black Canyon of the Gunnison, CARE: Capitol Reef, CHIC: Chickasaw National Recreation Area, CHIS: Channel Islands, DEVA: Death Valley, DRTO: Dry Tortugas, GRBA: Great Basin, GRSA: Great Sand Dunes, JOTR: Joshua Tree, PINN: Pinnacles, SAGU: Saguaro.

For this exercise, we extend the sample to parks included in the NPS after 1970 (i.e., we consider all parks on Figure 1) and also include counties without any parks (subject to various restrictions).[9] The comparison group for our estimates are areas that do not experience a park opening in a given period.

This treatment helps answer the question of the economic impacts of conservation compared to a counterfactual without conservation. This is different from the NP designation treatment: in that case, an area also enjoys some protection in the counterfactual. In this sense, the opening of a new park represents an increase in conservation on the "extensive margin," while NP designation increases conservation on the "intensive margin."

Our sample starts after Project 66, an intense period of park construction. Of the parks opened between 1966-2017, over 40% opened in the period 1966-74. This poses a challenge

[9] Just like for parks, we follow counties backward in time, from 2017 to 1970. Counties that share a park in 2017 are aggregated into one observation throughout the period (including any years in which they do not yet have the park). Counties that never have a park enter the data individually.

for our analysis, because given that our data starts in 1970, parks opened in 1966-1974 do not have all their lags and leads observed in the $[-5, +5]$ event window. Including all these parks would result in large imbalances in the observations used to estimate the different coefficients. To avoid this issue, we estimate the impact of parks created between 1975 and 2013 (i.e., we drop parks created between 1966-74 or after 2013[10]). This leaves 31 opening events in our sample.

Treatment 3: Large park expansions. As an alternative measure of the impact of parks, in Section 3 of the Appendix we consider large additions to their area.[11] Several parks receive a major addition at least once after their establishment. Figure 3 shows the location of parks with major (at least 50%) additions during our period of study. To study the impact of large additions in an event study, we define the treatment as additions of least 60% to a park's area (we also present results for thresholds of 50, 70, and 80% that are substantively similar).[12] Using this threshold, we have 31 expansion events in 27 parks (some parks experience multiple large expansions).

Like the NP designation measure, this measure also focuses on already existing parks so the estimates will not be confounded by factors that may affect the establishment of new parks. An advantage of this measure is its higher frequency. Its disadvantage is that it is unknown exactly what the change represents: the new areas added to the parks may be a combination of additional recreational opportunities and infrastructure (e.g., roads and campsites), as well as remote natural areas that are less relevant for tourism and economic activity.

3.2 Specification

We estimate the impact of parks using event studies specified at the park level. This approach has several advantages. First, specifying the estimating equation at the same level as the treatment (made possible by the large number of parks observed in our dataset) explicitly accounts for the fact that most parks affect clusters of counties (Bertrand et al., 2004).[13] Second, treatment effects in this context are likely to be dynamic - for example, the impact

[10] Only 5 parks opened after 2013, and only 2 after restricting to parks reporting visitors within five years.

[11] Conceptually, this treatment features elements of both the NP designation and the park opening treatments: it affects already existing parks (intensive margin) and increases the footprint of the NPS (extensive margin). Several previous studies (e.g., Sims, 2010; Sims et al., 2019) use land area to measure the impact of conservation - our approach here is a variant of this strategy.

[12] The advantage of using an event study here is twofold. First, using the same estimation framework as for NP designation and park opening allows our results to be easily compared across the different measures. Second, the acreage data contains small fluctuations over time, likely due to the difficulty of precisely measuring the size of large natural areas. Using a threshold for "large" changes rather than a more parametric specification makes our results robust to these fluctuations.

[13] 43% of the parks in our analysis are located in 2 or more counties.

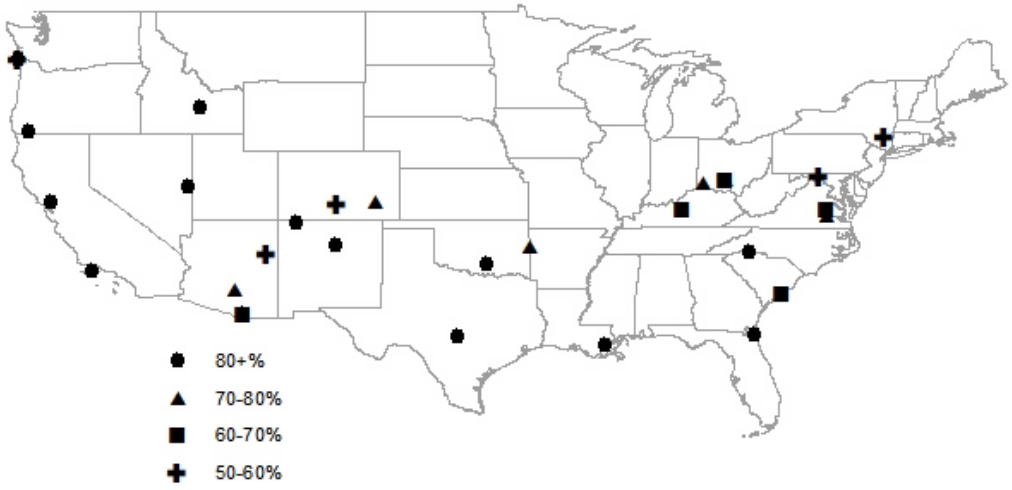

Figure 3: Parks with large area additions in the sample

Parks receiving large area additions during our period of study. Our main analysis uses additions of 60 percent or above.

of park designation on the construction industry is likely to occur gradually over time. An event study is the appropriate specification in such cases.[14] Finally, the event study allows us to directly inspect the *path* of the treatment effects around the treatment and evaluate if a causal interpretation is warranted.

Our baseline regression is specified as

$$Y_{pt} = \sum_{j=-4, j\neq -1}^{4} \beta_j \mathbf{1}(\tau_{pt} = j) + \widetilde{\beta}_5 \mathbf{1}(\tau_{pt} \geq 5) + \widetilde{\beta}_{-5} \mathbf{1}(\tau_{pt} \leq -5) + \boldsymbol{\gamma} \mathbf{X}_{pt} + \delta_p + \lambda_t + \varepsilon_{pt}, \quad (1)$$

where Y_{pt} is an outcome of interest for park p in year t. The variable τ_{pt} denotes time since the event, with $\tau_{pt} = 0$ if the park experiences the event in year t, $\tau_{pt} = -1$ if it will experience the event in year $t + 1$, $\tau_{pt} = 1$ if it experienced the event in year $t - 1$, etc. We estimate the impact of each event using a window of +/-5 years around the event, with "binned" indicators for 5 or more years before/after the event. Our excluded category is $\tau_{pt} = -1$, the year before the event.

If a park experiences a negative event (a loss of NP designation), we include these in equation (1) with coefficients $-\beta_j$, i.e., we assume that the impact of negative and positive

[14] A number of recent papers emphasize the limitations and possible bias in static specifications in the presence of time-varying treatment effects (see Goodman-Bacon (2021), de Chaisemartin and D'Haultfoeuille (2020), and studies cited therein).

events is symmetric (see Schmidheiny and Siegloch (2019)).

The time varying controls $\mathbf{X}_{pt}$ are log population density (to normalize our dependent variable, also in logs),[15] as well as variables that could conceivably affect government policy towards the parks as well as tourism and the local economy: the share of the population under age 19, the share above 65, a precipitation and a drought severity index, and, for the NP designation regressions, the park's age squared to control for reputation effects.[16]

For variables observed at the county level, we take the average across counties that overlap with a particular park p (since we take logs and control for park fixed effects, this is equivalent to taking the total across these counties).

Sector-level analyses of the BEA data must deal with the well-known issue of missing cells. This arises because, for privacy reasons, the BEA suppresses sectoral income and employment information for counties with few establishments in that sector. The set of suppressed cells varies across years, creating artificial variation over time in the values of these variables when we aggregate across counties. To fix this issue, for each year that is part of an event window, we only use counties with no missing observations in the *entire* event window when we create a park-level measure. This does not affect the internal validity of our sectoral estimates, but does mean that our results for, e.g., mining, may not be representative of counties with very few mining firms, since those are likely to appear as missing in the BEA data.

Standard errors reported in the main text are asymptotic standard errors clustered at the park level. For the different industry outcomes the Appendix also reports multiple-inference adjusted p-values.

Unless noted otherwise, our regressions cover the years t from 1970 to 2017.

4 The impact of parks on mining, forestry, and farming

Three industries are typically highlighted as potential losers of US conservation programs: mining, forestry, and farming (e.g., Walls et al., 2020). While it is intuitive that restrictions on drilling, logging, and grazing are costly for these industries, in principle there is also scope for some positive effects if firms benefit from improved infrastructure (e.g., roads) around the parks, or if they experience an increase in demand (e.g., local farms may see higher demand as a result of tourism; forestry companies may be hired to provide services to the Park Service). Furthermore, conservation may not lead to immediate restrictions, creating

[15] As it turns out, the coefficient on population is always close to 1, so using (log) per capita values as dependent variable instead of controlling for population yields almost identical estimates.

[16] Note that a linear function of the park's age is subsumed in the year and park fixed effects.

opportunities for various adjustments in these industries over time. Indeed, according to anecdotal evidence opposition to the parks is often based on fears of a "slippery slope" leading to more *future* restrictions.[17]

4.1 Mining

We first look at the effect of parks on the mining industry. As discussed in Section 2.1, although no *new* mining operations are allowed in national parks, NP designation does not prohibit existing mining operations. Consistent with this, the first panel of Figure 4 shows no evidence of a decline in the number of mines following NP designation.[18]

On the next panel, we find a *positive* effect of NP designation on mining employment. A possible explanation for this is suggested by anecdotal evidence on the "slippery slope" mentioned above. Fearing future restrictions, mining companies may ramp up their activities either to extract as much revenue as possible before restrictions are implemented, or to improve their bargaining position relative to the government for when such restrictions might be considered. For example, Rothman and Miller (2013) describe how, in the case of Death Valley National Monument, "[m]ining companies responded to the prospect of legislation by aggressively trying to expand development, identifying and exposing additional mineral fields, and by increasing the transfer of stockpiles to areas outside of monument boundaries." This kind of response would explain an increase of *both* employment and income.[19]

[17] See, for example, "Wilderness Proposal Criticized at Medora," *The Bismarck Tribune (Bismarck, ND)*, Sep. 16, 1978, p1.

[18] Every treated park has some mining activity (positive number of mines, mining employment and income).

[19] Estimates for income are on Figure A.5. We also look at employment at the mine level. There is no evidence that employment in the average mine decreased - if anything, we see the opposite. An increase in mine-level employment would be consistent with increased mining activity in response to NP designation.

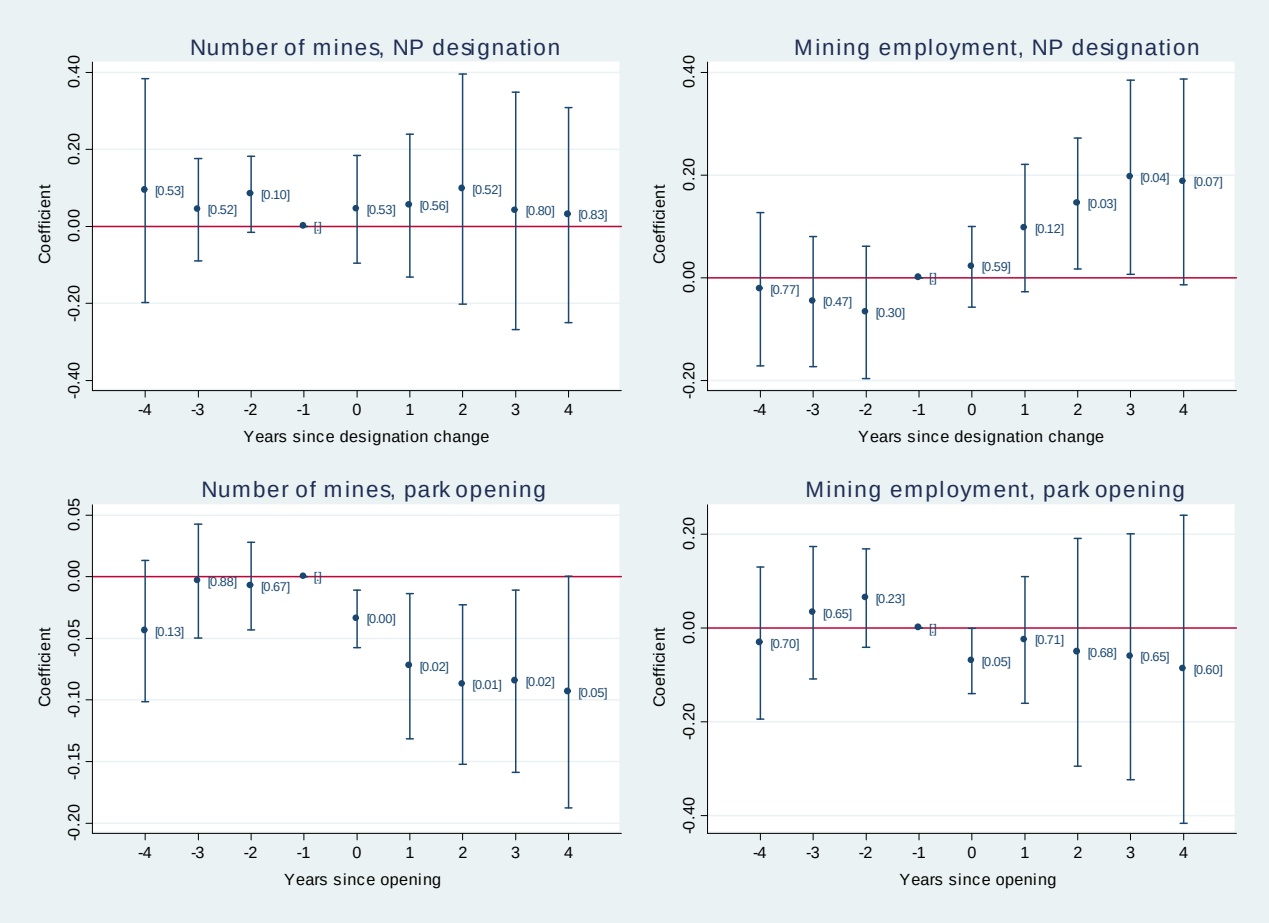

Figure 4: The impact of parks on the mining sector

Event study coefficient estimates for the impact of NP designation or park opening. Estimates are relative to the year before the designation change. Standard errors are clustered at the park level. Bars indicate 95 percent confidence intervals, p-values are in brackets. Data on the number of mines begins in 1983. N = 6545, 7567, 87885, 92116.

Another potential explanation for increased mining activity could be that some mining companies gain cheap labor or market share as other companies are being driven out of business. However, this would suggest that the number of mines should decrease while total mining employment should decrease or stay the same. The patterns in Figure 4 are not consistent with this. Yet another possibility is if the increased conservation efforts resulting in NP designation were a response to increased mining activity. However, given the fact that designation change is a multiyear process, if NP designation was the effect rather than the cause, we would expect to see a clear pre-trend, with mining activity starting to increase several years before the designation change and continuing on the same path after the change. Again, this is not what the estimates on Figure 4 indicate.[20]

As expected, the estimates for park opening look different from the NP designation results. The bottom panels of Figure 4 show that park openings lead to mine closures: the number of mines suffers a permanent decline of just under 10%. Compared to NP designation, the opening of new parks appears more disruptive for the mining industry. Interestingly, employment at the industry level does not show a clear decline corresponding to the reduction in mines. In fact, we find that employment in the average mine rises (Figure A.5 in the Appendix). This is consistent with a story where the remaining mines soak up many of the workers displaced from the mines that shut down. This within-industry heterogeneity can explain the flat employment estimates at the industry level shown on Figure 4.

4.2 Forestry

Next, we investigate the forestry sector. As shown on Figure 5, we find no effect of either NP designation or park opening on forestry income. For NP designation, this could be because logging was already prohibited by the Park Service before a park acquired NP designation, though this would not explain the lack of effect for park opening.

Another possibility is heterogenous impacts within the industry, as demand for forestry management services might increase while logging declines. As discussed in Appendix 3, results on our third treatment, the impact of park expansions, are consistent with such an interpretation.

A third possibility is that the market adjusts to logging restrictions in ways that offsets the negative effects on the logging industry. The potential for such adjustments is suggested

[20]The increase in mining also cannot be explained by the booms and busts of coal mining in the 1970s and 80s documented in Black et al. (2005). Using the mine-level data, we checked which counties had any coal mining (as of 1983, the earliest year available). Only 3 of the treated parks did, and 2 of those acquired NP designation after 1999. The documented cycles in coal mining are therefore not correlated with NP designations.

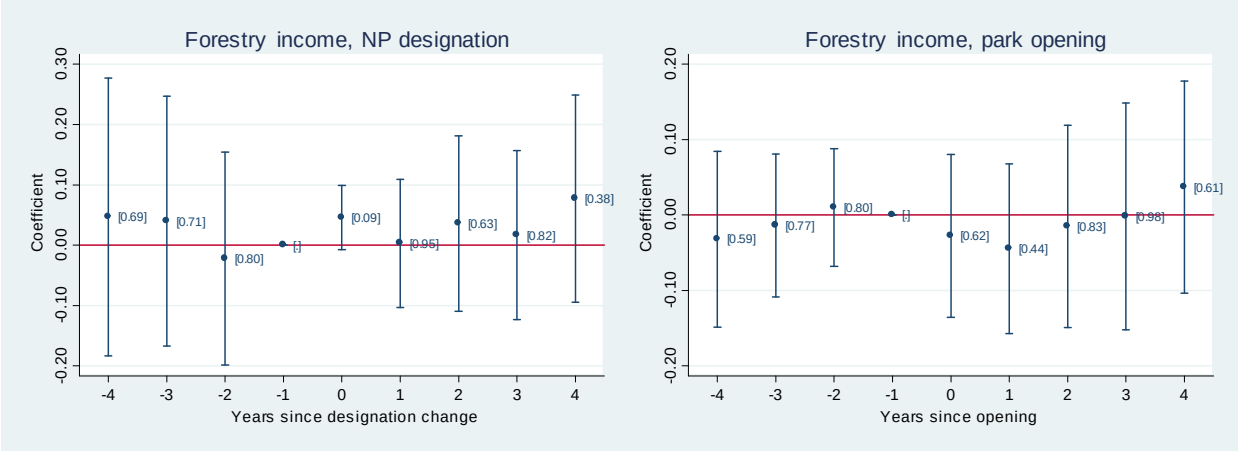

Figure 5: The impact of parks on forestry income

Event study coefficient estimates for the impact of NP designation or park opening. Estimates are relative to the year before the designation change. Standard errors are clustered at the park level. Bars indicate 95 percent confidence intervals, p-values are in brackets. N = 6468, 71819.

by Berck and Bentley (1997), who discuss a rise in the price of redwood timber after the establishment of Redwood NP. Here, we consider a related but different adjustment.

Simple economic logic dictates that mandating the conservation of one resource will create incentives for the increased extraction of resources that are substitutes and, on the margin, relatively less protected.[21] Thus, we ask whether the opening of a park led to increased timber harvesting in adjacent US national forests.

National forests are federal lands managed by the US Forest Service. Unlike the National Park Service, which is part of the Department of the Interior, the Forest Service is part of the Department of Agriculture, and the two systems operate independently. Whereas the Park Service's mandate is focused on conservation, the Forest Service's mandate emphasizes the "management" of natural resources. When a park is included in the NPS, reducing the availability of timber in the area, timber extraction in national forests could increase in response.[22]

To study whether this is the case, we obtain the annual volume of timber cut from each unit ("forest" from now on) managed by the Forest Service. This data is available starting in 1977, and there are 123 forests from which timber is cut at any point. We restrict attention

[21] See Pfaff and Robalino (2017) for a review of the literature on the various spillover effects of conservation programs.

[22] Whether timber in national forests is a good substitute for parks in the NPS depends on a number of factors we have no data on (e.g., the type of trees in each area). This will make it more difficult to detect a substitution effect in our regressions below.

to parks that are adjacent to one or more forests, where we call two areas "adjacent" if they share a county. In our sample, 96 parks in the NPS are adjacent to a national forest, and 13 of these parks were included in the NPS after 1973. For each park, we calculate the total volume of timber cut annually in all adjacent forests (this is measured in 1000 board feet, and we take logs). We also include in the regressions 21 forests that are not adjacent to any park as part of the comparison group.[23]

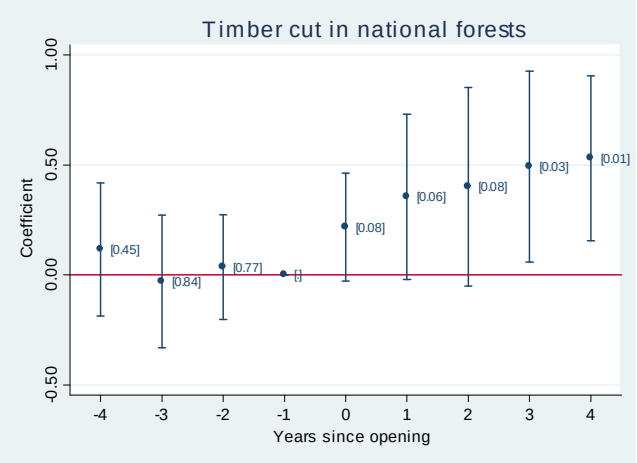

Figure 6: The impact of park opening on timber cut in adjacent national forests

Event study coefficient estimates of park opening. Timber volume is measured in log(1000 board feet). Estimates are relative to the year before opening. Standard errors are clustered at the park level. Bars indicate 95 percent confidence intervals, p-values are in brackets. Years 1977-2017. N = 4522.

Figure 6 shows event study estimates of including a park in the NPS on annual volume of timber cut in adjacent national forests. We find clear positive effects: the volume of timber cut jumps by 20% in the year of opening, and continues to increase for at least the next 5 years. Corresponding estimates for NP designation are also positive but not statistically significant (Figure A.19 in the Appendix).

This finding should not be used to draw strong conclusions regarding the impact of the NPS on conservation. Even putting aside the fact that conservation is difficult to define (Schuurman et al., 2020), the number of trees left standing is at most one component of conservation. Our result does however illustrate that the simple economic logic that limiting resource extraction in the NPS may lead to more resource extraction elsewhere could be a relevant consideration. Such substitution across resources may partially offset some of the

[23]The results are similar with or without these forests. Because we take logs, observations reporting 0 timber cut are excluded. We get almost identical results if we retain these observations by adding 1 before taking logs.

impact of the NPS, and more generally may indicate a weakness of conservation policies that focus only on limited geographic areas and/or specific government agencies.

4.3 Farming

Figure 7 looks at farming income. There is no evidence of clear negative effects - if anything, income shows an increase following NP designation (though most coefficients are not statistically significant). An increase in farm income would be consistent with more tourists creating higher demand for farm products. Some increase might also come from farms selling inventory, e.g., cattle farms reducing their stock as grazing on public land becomes more difficult. Results using the USDA Census of Agriculture do not rule out these explanations: although imprecise, the point estimates show an increase in the sale of farm products along with a reduction in cattle inventories, cattle farms, and the total number of farms (Appendix Figure A.6).

Estimates for farming employment are on Figure A.7, and Figure A.8 estimates further lagged effects for both employment and income. None of these show evidence of large declines for the farming industry as a whole.

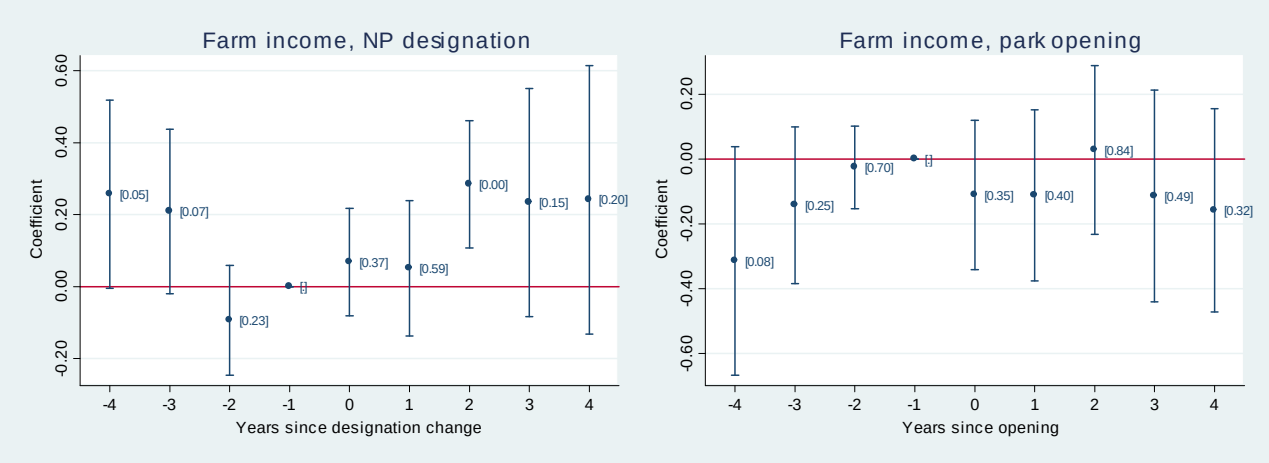

Figure 7: The impact of parks on farm income

Event study coefficient estimates for the impact of NP designation or park opening on log farming income. Estimates are relative to the year before the designation change. Standard errors are clustered at the park level. Bars indicate 95 percent confidence intervals, p-values are in brackets. N = 8297, 116990.

5 Externalities: traffic and air pollution

The above analysis has focused on some of the economic impacts of the NPS. Clearly, conservation efforts such as this will have a variety of additional impacts, both on society and on the natural environment. Over the years observers have expressed concerns regarding externalities such as increased traffic and pollution. These are potentially important effects but we are not aware of any empirical estimates. We use the available data to look at this directly, by studying traffic accidents and pollution due to motor vehicle traffic. Because the time series of these variables begin later, in the main text we focus on park openings to leverage more variation. We present corresponding estimates for NP designation in the Appendix.

A priori, the relationship between parks and vehicle traffic is ambiguous. More tourism means more vehicle traffic, which could increase accidents and pollution. This has been one of the concerns of critics of the NPS mission of increasing public access to natural areas since at least the 1950s. On the other hand, increased tourist traffic could be accompanied by reduced commuter or commercial traffic (e.g., if the park will restrict such traffic on some existing roads). Furthermore, any effects may be attenuated by avoidance behavior - for example, tourist traffic in parks may decrease when pollution is higher (Keiser et al., 2018).

5.1 Traffic accidents

We use data on the log number of motor vehicle accidents involving a fatality, as well as the log number of fatalities. Event study estimates of the impact of park opening are on Figure 8. Estimates following a park opening are mostly positive and some are statistically significant. Accidents and fatalities appear to increase by approximately 10% 3-4 years after the opening of a new park. Given that fatalities are a rare event but the value of a statistical life is large, even relatively imprecise estimates may indicate substantial costs. For the median park about to open, the 90% confidence interval in year 3 is $[0.34, 6.01]$ extra fatalities. We also checked if the effects differ based on parks' proximity to urban areas (Figure A.16). The estimates suggest that parks more than 50 miles from a metropolitan area with a population of at least 1 million create more accidents, while for parks close to urban areas accidents actually show a short-run decline before returning to their pre-treatment levels. The latter may reflect a reduction in commuter traffic in these areas.

Corresponding estimates for the impact of NP designation on accidents yield imprecise results (Figure A.17).

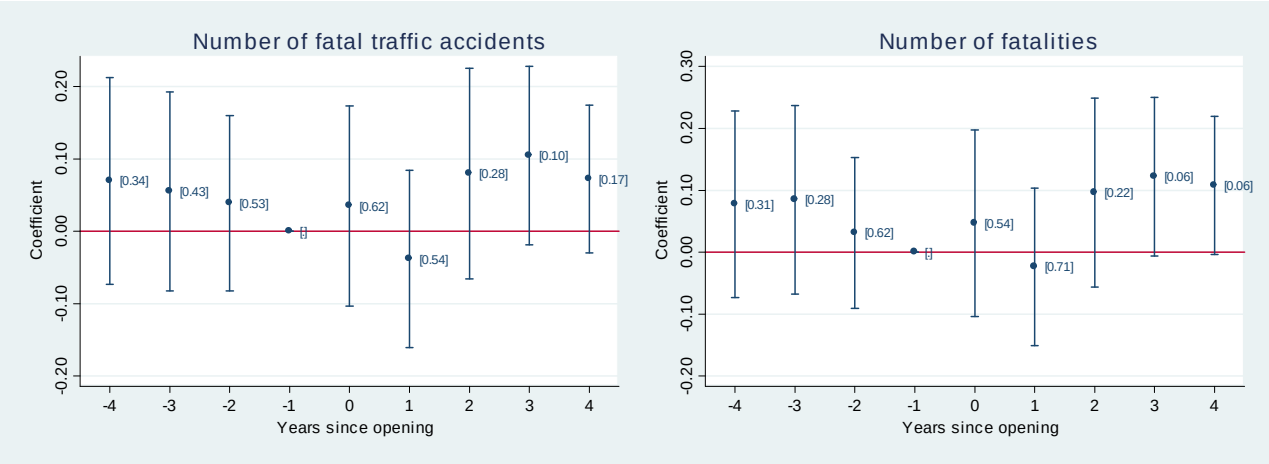

Figure 8: The impact of park opening on traffic fatalities

Event study estimates of park opening on log number of fatal accidents and log number of traffic fatalities. Estimates are relative to the year before opening. Standard errors are clustered at the park level. Bars indicate 95 percent confidence intervals, p-values are in brackets. Years 1975-2017. N = 116,229.

5.2 Air pollution

To measure air pollution, we look at county level nitrogen dioxide (NO_2) and ozone concentration. Of the various compounds linked to pollution from vehicles, these are the most consistently available during our period of study.[24] NO_2 is considered a primary pollutant, while ozone is a secondary pollutant created when the emitted NO_2 is exposed to sunlight (see National Park Service (1999) for a discussion of the importance of these and other pollutants for the National Park System). The EPA publishes data on NO_2 and ozone for the period 1980-2017.

The estimates for park openings are always small and statistically insignificant (Figure 9). For NO_2, the point estimates are often negative, and the upper end of the 95% confidence interval is 6 parts per billion (ppb). By comparison, the mean and median concentration in our sample are both 25 ppb, and the EPA air quality standard is 53 ppb. The conclusions regarding ozone are similar: the point estimates vary in sign and the upper end of the 95% confidence interval is 3ppb. The latter is small both relative to the sample mean or median (both 52 ppb), and relative to the EPA standard (70 ppb). Our findings from the available data suggest no adverse air quality effects from park openings.

[24] We also considered using two additional compounds, carbon monoxide and suspended particles. Unfortunately, there are very few observations for carbon monoxide, and for suspended particles, what is being measured varies over time as air quality standards change. Note that there are also other ways parks could impact air quality, such as through increased forest cover and the resulting sequestration of greenhouse gases.

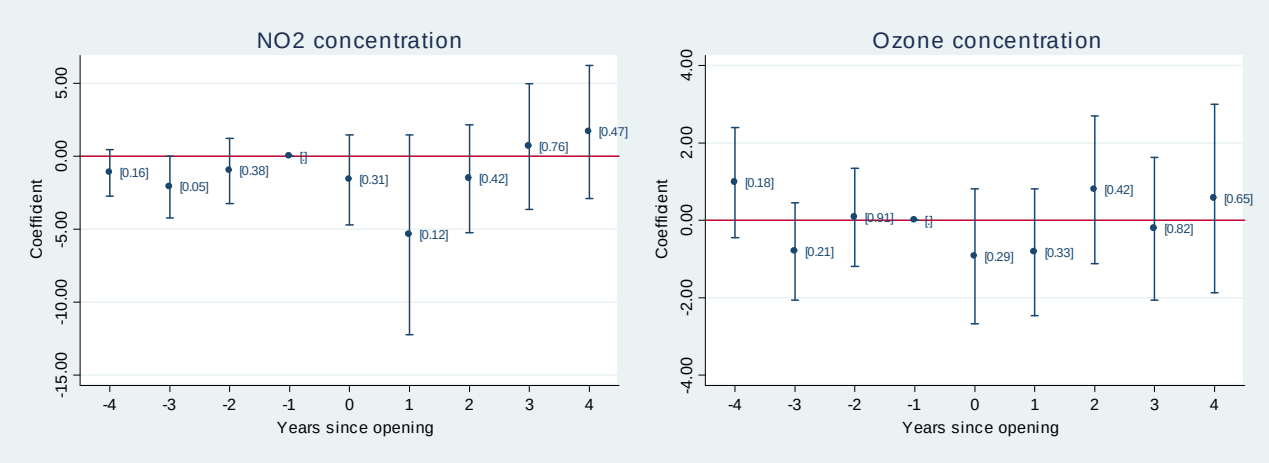

Figure 9: The impact of park opening on air pollution

Event study estimates of park opening on NO2 and O3 concentration. Estimates are relative to the year before park opening. Standard errors are clustered at the park level. Bars indicate 95 percent confidence intervals, p-values are in brackets. Years 1980-2017. N = 7221, 20173.

Estimates for NP designation are consistently negative (an improvement in air quality) (Figure A.18 in the Appendix). These sometimes reach statistical significance, but concentration levels for both NO_2 and ozone are trending downwards prior to the treatment, so it is unclear if the designation change contributes to the improvement in air quality. We again do not find any large negative effects on air quality in this data.

6 On the economic benefits of parks

Szabó and Ujhelyi (2023) find significant positive impacts of parks on local employment and income. In principle, these effects could mask heterogeneity across sectors, with some winners and some losers. The above results do not indicate large negative impacts on the industries most likely to lose from conservation. For completeness, we now investigate which industries benefit from parks.

In Appendix 5, we study three industries: hotels, retail, and construction. Because of increased tourism, the hotel and retail industries are obvious candidates for gains from parks. In addition, since establishments and infrastructure may need to be built or upgraded, we may also see more demand for the construction industry. The hotel estimates are generally positive but noisy. Park openings have a clear positive impact on the retail sector, raising income by 2-4% one year after the treatment. NP designation has a large impact on the construction industry, with a 15-20% rise in income and a 10% rise in employment following

the treatment.[25]

These results are consistent with tourism increasing investment and creating other multiplier effects in the local economy.

7 Conclusion

This paper investigates some of the potential negative impacts of conservation. We study the US National Park System, and estimate its impact on factors that are commonly cited as potential costs of the park system: impacts on the mining, forestry, and farming sectors, as well as on traffic and air pollution in the local economy. To do this, we combine a detailed dataset on the NPS with county-level information from several sources.

We find little evidence that the mining, forestry, or farming sectors *overall* experience large losses from NP designations or new park openings. At the same time, there is evidence of heterogenous effects within some of these sectors, such as some mines benefitting when others close following the opening of new parks. Such substitution effects are also present in the forestry sector: when an area becomes part of the NPS, timber extraction in nearby national forests increases.

Investigating possible negative externalities, parks do not seem to increase pollution related to motor vehicles. However, there is some evidence of increased traffic fatalities following the opening of new parks.

References

[1] Berck, P., and W.R. Benley (1997): "Hotelling's Theory, Enhancement, and the Taking of the Redwood National Park," *American Journal of Agricultural Economics* 79, 287-298.

[2] Black, D., T. McKinnish, and S. Sanders (2005): "The Economic Impact of the Coal Boom and Bust," *The Economic Journal* 115(503), 449-476.

[3] Buono, F., and B. West (1986): *Regulating activity in National Park System units*, Natural Resources Report Series No. 86-2, NPS Energy, Mining and Minerals Division, Denver, CO.

[25] To address concerns of multiple testing, the reader can use the p-values we report to adjust inference for any desired subset of hypotheses. In Appendix Table A.22 we present one possible adjustment that controls for the false discovery rate by treatment, industry group, and year relative to the event.

[4] de Chaisemartin, C., and X. D'Haultfoeuille (2020): "Two-way fixed effects estimators with heterogeneous treatment effects," *American Economic Review* 110(9), 2964-96.

[5] Dilsaver, L.M. (2008): "Not of National Significance: Failed National Park Proposals in California," *California History* 85(2), 4-23.

[6] Goodman-Bacon, A. (2021): "Difference-in-Differences with Variation in Treatment Timing," *Journal of Econometrics* 225(2), 254-277.

[7] Greenstone, M., R. Hornbeck, and E. Moretti (2010): "Identifying Agglomeration Spillovers: Evidence from Winners and Losers of Large Plant Openings," *Journal of Political Economy* 118(3), 536-598.

[8] Haefele, M., J.B. Loomis, and L.J. Blimes (2020): "Total Economic Valuation of the National Park Service Lands and Programs: Results of a Survey of The American Public," *in*: Blimes, L.J., and J.B. Loomis (eds): *Valuing U.S. National Parks and Programs. America's Best Investment,* Routledge, New York, NY.

[9] Keiser, D., G. Lade, and I. Rudik (2018): "Air pollution and visitation at U.S. national parks," *Science Advances* 4(7).

[10] National Park Service (1999): *Air Quality in the National Parks*, 2nd ed., NPS, US Department of the Interior, Washington, D.C.

[11] Pfaff, A., and J. Robalino (2017): "Spillovers from Conservation Programs," *Annual Review of Resource Economics* 9, 299–315.

[12] Rettie, D.F. (1995): *Our National Park System*, University of Illinois Press, Chicago, IL.

[13] Rose, G.R. (2017): ""Reservations of Like Character" - The Origins and Benefits of the National Park System's Classification Hierarchy," *Penn State Law Review*, 121(2), 355-420.

[14] Rothman, H.K., and C. Miller (2013): *Death Valley National Park: A History*, University of Nevada Press, Reno, NV.

[15] Runte, A. (2010): *National Parks - The American Experience*, Taylor Trade Publishing, Lanham, MD.

[16] Schmidheiny, K., and S. Siegloch (2019): "On Event Study Designs and Distributed-Lag Models: Equivalence, Generalization and Practical Implications," IZA Discussion Paper N. 12079.

[17] Schuurman, G. W., C. Hawkins Hoffman, D. N. Cole, D. J. Lawrence, J. M. Morton, D. R. Magness, A. E. Cravens, S. Covington, R. O'Malley, and N. A. Fisichelli (2020): *Resist-accept-direct (RAD) - a framework for the 21st-century natural resource manager,* Natural Resource Report NPS/NRSS/CCRP/NRR 2020/2213. National Park Service, Fort Collins, Colorado.

[18] Sims, K.R.E. (2010): "Conservation and development: Evidence from Thai protected areas," *Journal of Environmental Economics and Management* 60, 94-114.

[19] Sims, K.R.E., J.R. Thompson, S.R. Meyer, C. Nolte, J.S. Plisinski (2019): "Assessing the local economic impacts of land protection," *Conservation Biology* 33(5), 1035–1044.

[20] Szabó, A., and G. Ujhelyi (2023): "National Parks and Economic Development," working paper.

[21] Walls, M., P. Lee, and M. Ashenfarb (2020): "National monuments and economic growth in the American West," *Science Advances* 6(12).