

Federal Funding and State Wildlife Conservation

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Abstract. Federal aid programs subsidize local governments in sectors ranging from healthcare to transportation but there is little empirical study of their effects on local provision. We examine the effects of America's oldest program in the area of environmental conservation, which was created by the 1937 Pittman-Robertson Act to direct federal tax revenue from guns and hunting equipment to state wildlife agencies on the condition that receiving states not divert license revenues to purposes unrelated to wildlife conservation. Our theoretical model explains why the program could have increased or decreased revenue from license sales leading to ambiguous effects on agency budgets and wildlife conservation. Panel data for 1925-2018 suggests the program increased license sales and revenue leading to positive effects on long-run conservation.

Appendix materials can be accessed online at:
<https://uwpress.wisc.edu/journals/pdfs/LE-98-3-Lueck-app.pdf>

1. INTRODUCTION

The interaction of federal and state governments in the US is an important feature of governance in a wide range of sectors from healthcare to transportation. It is notably important in environmental and natural resource governance, including matters ranging from air and water quality to wildlife conservation. One important federal-state interaction arises from programs that grant revenue from federal excise taxes to states for earmarked purposes, conditional on a state using (or not using) the federal funding in specific ways. Excise taxes on alcohol, firearms, gasoline, and tobacco are the most prominent and all generate important revenues for state programs (Congressional Research Service 2013). This paper examines this federal-state interaction in wildlife conservation where such relationships began.

State wildlife departments are among the oldest conservation agencies in the United States, created in the wake of severe wildlife depletion and some cases of extinction. In the late 19th century, state intervention evolved from season closures and other limitations on access to a system of hunting and fishing licenses managed by newly created wildlife agencies (Lueck and Parker 2020). This system was significantly modified in 1937 with the passage of the Federal Aid in Wildlife Restoration Act¹ (known as the Pittman Robertson Act for its legislative sponsors). It directed revenues from federal excises taxes on long guns (rifles and shotguns) and other hunting equipment to state wildlife agencies on the condition that those agencies did not divert license funds to non-wildlife avenues.² This system was modified again in 1950 with the Federal Aid in Sport Fish Restoration Act³ (known as the Dingell-Johnson Act for its legislative sponsors) which similarly directed revenues from taxes on fishing boating equipment and motorboat fuels to the states. These programs remain in place today, now known collectively as

the Wildlife and Sport Fish Restoration Program (WSFRP) and, along with license revenues, are the major source of funding for wildlife agencies.

In this paper we examine the causes and consequences of this federal participation in state wildlife management. Prior to federal involvement - from the late 19th century until 1937 - wildlife agencies relied almost exclusively on hunting and fishing licenses for revenue and most agencies were autonomous in this regard, essentially being funded by wildlife “users.”⁴ At the same time, in many states, license revenues were diverted from wildlife agencies to other government programs, such as highway maintenance, schools, and forest fire prevention. During this period wildlife populations remained depleted. During the 1930s state wildlife agencies became organized and joined sportsmen in lobbying for the passage of the Pittman Robertson Act and later, in the late 1940s, for the Dingell Johnson Act. Wildlife management history shows a strong correlation between 20th century wildlife restoration-recovery and federal involvement in state agency funding but the economic mechanisms are not well understood.⁵ More generally, there is little economic analysis of state-federal coordination on natural resource management and the linkage with federal tax policy.⁶ This study illuminates these issues by developing models of state behavior with and without federal intervention and by testing the implications against panel data on agency budgets from 1925 to 2018.

Our analysis focuses on two features of federal wildlife restoration tax programs. First, the Acts stipulate that a state spend all license revenue on the administration of the fish and wildlife agency as a condition for receiving federal funds. We explain how this stipulation stabilized and increased state budgets for wildlife management because it stopped the widespread practice of diverting funds to non-wildlife purposes. We also explain how the no-diversion

stipulation may have prevented diversions of state support towards other public projects that might have indirectly benefitted wildlife populations (e.g., forests and parks).

The second feature of federal wildlife tax programs is the formula used to determine how the earmarked federal tax revenue is distributed to states. The formula is based, in part, on the number of hunting and fishing licenses sold in each state. We explain how this formula incentivized states to keep average license prices lower than they might otherwise be, for example by creating lower priced license products, compared to a regime without this federal intervention. This incentive structure could have in theory undermined the federal legislative goals of increasing long-run investments in wildlife conservation by decreasing revenue; however, empirical analysis indicates otherwise. We find that the federal payments not only increased overall budgets for wildlife conservation, but they also increased revenue from license sales.

The paper proceeds as follows. Section 2 provides an overview of the history of wildlife agency funding. Walls (this issue) also discusses the current status of wildlife funding. Section 3 develops an economic framework for analyzing agency budgets and behavior before and after Pittman Robertson. Sections 4 and 5 describe the data on agencies and tests the implications derived in Section 3. Section 6 summarizes the study and points to potential lessons for the design of programs seeking to create earmarked taxes for conservation purposes.

2. HISTORY OF WILDLIFE AGENCIES

Wildlife management by state agencies evolved in major stages as summarized in Table

1. The first stage was the enactment of laws (mostly state though some local) to restrict access to

hunt or ‘take’ wild populations. These included season closures and bag limits and were enacted throughout the 19th century and some during the colonial period. Though these laws were often challenged as unconstitutional state action, the 1896 US Supreme Court upheld state authority to regulate resident game and fish, in the case of *Geer v. Connecticut*.⁷

Table 1

The second stage was the creation of game commissions and specialized administrative agencies to enforce wildlife laws. These agencies, created during the period of 1879 to 1932, initially focused on enforcement by hiring specialized police officers called ‘game wardens,’ a term borrowed from English law (Lueck 1989).

Table 2

The third stage was the implementation of hunting and fishing licenses to generate revenue to support the enforcement and, later, the management efforts of the state agencies. License systems augmented revenue from fines on violations of wildlife laws and emerged in the late 19th century. License systems eventually came to discriminate between residents and non-residents with non-resident prices always higher, often by an order of magnitude. Once licenses were implemented the typical organization was an autonomous self-funded state agency. The fourth, and current stage, is the addition of federal action, through regulation, taxation, and coordination that began early in the 20th century. This regime has been modified since 1937 as summarized in Table 2.

Federal intervention into wildlife management began with the Lacey Act of 1900 which prohibited the trade of fish and game taken illegally but did not raise funds for the protection or restoration of wildlife. The Migratory Bird Treaty Act of 1918 implemented the 1916 Migratory Bird Treaty and made it illegal to take migratory birds without a federal permit.⁸ In the years

that followed, the federal government developed a system of licenses and permits to regulate taking in cooperation with state agencies. The Migratory Bird Hunting and Conservation Stamp Act of 1934 required all waterfowl hunters in the US to buy a federal hunting stamp. The stamps are known as “duck stamps” and the act is commonly referred to as the Duck Stamp Act of 1934.⁹ Revenues from the sale of duck stamps are deposited in the Migratory Bird Conservation Fund and cannot be appropriated for uses other than management and habitat for migratory waterfowl.¹⁰

In 1937 the Pittman Robertson Act became law and created what is now called the Wildlife and Sport Fish Restoration Program (WSFR) administered by the US Fish and Wildlife Service (FWS).¹¹ At its inception, Pittman Robertson authorized the distribution of revenues from a federal excise tax on firearms to state wildlife agencies for the purpose of wildlife restoration.¹² These federal funds were made available to state agencies on the condition that states dedicate all the hunting and fishing license revenues for the administration of state fish and wildlife agencies.¹³ At the time more than a dozen states were diverting license funds to other government priorities such as transportation infrastructure and education (Connery 1935).

The initial program implemented by Pittman Robertson included the following features. The federal funds were derived only from the taxes on rifles, shotguns and related ammunition (funds from taxes on handguns and handgun ammunition were later included) and the funds were allocated to the states based on a formula that depended on the size of the state (in area) and the number of licensed hunters. The formula was soon adjusted so each state would get at least 0.5% of the aggregate funds but no more than 5%. The law also required that states use the funds for specific wildlife restoration projects and that federal dollars could fund up to 75% of project-specific costs. States were also required to begin restoration projects with their own funds before

being reimbursed with the federal funds. In 1950 the Dingell Johnson Act expanded federal involvement to include tax revenues from fishing equipment and added revenues from a 10% tax on select fishing tackle and distributed funds back to the states on a 75-25 percent basis following Pittman Robertson. The WSFR program went into effect in 1939, just two years after Pittman Robertson, and in that year distributed \$890,000 (\$16.1 million in 2018 \$s) to the states (FWS 2012). In 2018 over \$1 billion were distributed to states under all the WSFR programs and over \$20 billion has been cumulatively granted to states since 1939.¹⁴

There have been many changes since 1950 when the WSFR program simply directed grants to states for wildlife and sport fish restoration.¹⁵ Today WSFR includes programs for hunter safety and education, boat access and boat infrastructure, clean vessels, and aquatic resource education. Taxes on handguns and handgun ammunition (10% of sales price), archery equipment (11% of sales price), boat imports, and boat fuel have been added to the original taxes on firearms-ammunition for hunting and sport fish gear.¹⁶

Data from the FWS show how WSFR funds have changed over time and how the components of state agency funding have changed as well. We present these data in Figures 1 through 3 which show various time series. Figure 1 shows per capita appropriations to states from 1938 to 2018, in 2018 dollars. Per capita PR appropriations exceeded DJ appropriations until the Wallop-Breaux amendment in 1984 caused a dramatic increase in fishery funding through the addition of motorboat fuel taxes. However, per capita PR funding again surpassed per capita DJ funding from 2009-2018. PR funding nearly doubled from 2012 to 2016, due to a dramatic increase in firearm sales during this period.

Fig 1

Figure 2 shows the number of hunters and anglers as a proportion of the population from 1952 to 2016. For hunters, this proportion has declined from 0.09 to 0.05 while anglers peaked at 0.13 and has since fallen to around 0.09. Prior to 1952, the FWS data reported the number of licenses sold rather than the number of individual hunting and fishing license holders.¹⁷ The number of licenses sold exceeds the number of license holders because many states issue a variety of licenses that distinguish between species and seasons (e.g., big game vs. upland birds and warm water fish vs. trout).¹⁸ The number of hunting and fishing licenses sold (and likely the number of hunters and fishers) increased rapidly after World War II. The differences suggest that, particularly for hunting, states are increasingly offering a suite of lower priced hunting license products.

Figure 2

Figure 3 shows the ratio of federal appropriations to license revenue over time. Federal payments have become increasingly important to state budgets especially as the number of hunters and anglers decline. As of 2018, states received almost as much revenue from PR as they did from hunting license sales and, in some states, PR funding exceeds license revenues. On a per-hunter basis, PR payments ranged from \$40 to \$60 in recent years. On a per-angler basis, DJ payments were about \$10 in recent years.

Figure 3

3. ECONOMIC FRAMEWORK

In this section we develop a framework to examine the behavior of agencies before and after the federal funding intervention. The first part examines the causes of license revenue diversion prior to the Pittman Robertson Act (PR). The second part examines the effects of PR on the incentives, behavior, and output of state wildlife agencies.

A. *Diversion of License Revenues Prior to Pitman Robertson*

We begin by considering two state agencies: a wildlife agency that generates revenues from user fees (hunting and fishing licenses) and a non-wildlife agency that provides public goods and does not generate its own funds. We consider a state's policy choice to be the proportion of wildlife license revenue to divert (d) to the other agency, where $0 \leq d \leq 1$. Let $V_w(B_w)$ and $V_{nw}(B_{nw})$ be the value functions (perceived by state policy makers) for the budgets (B) granted to wildlife (w) and non-wildlife (nw) agencies, respectively, with declining marginal values such that $V'_w > 0$ and $V'_{nw} > 0$ but $V''_w < 0$ and $V''_{nw} < 0$.¹⁹ In the simplest case when there is only a wildlife agency, optimal diversion from the perspective of state policy makers is zero; that is, $V_{nw} = 0$ and $d^* = 0$.²⁰ Further let $B_w = (1-d)pL$ and $B_{nw} = dpL + T$ where T is a lump sum source of funds from general state tax revenues, L is the number of hunting licenses sold, and p is the price per license. If the policy makers maximize $V_w + V_{nw}$ by choosing d the first order necessary condition is $V'_w = V'_{nw}$ which implies $d^* = d(T)$. It can be shown that increases in general tax funding to non-wildlife agencies will reduce the diversion of license revenues from wildlife agencies.²¹ The corollary is that, holding constant T and pL , the addition of more non-wildlife agencies increases wildlife revenue diversion such that $\partial d^* / \partial N > 0$ where N is the number of other agencies providing public goods (for which user fees are not an option).²²

This analysis makes two simplifying assumptions. First, it assumes the non-wildlife agency produces goods that have no effect on wildlife (e.g., schools). If, however, the non-wildlife agency provides roads, parks, or forest fire protection, then allocations to the non-wildlife agency could either harm or benefit wildlife. The existence of such complementarities would affect the preferred allocations of state policy makers. Second, we assume the agency

sells a single license at the same price to all buyers. Below we discuss the limits of this assumption and its implications for empirical analysis.

B. Effects of Diversions on Wildlife License Sales

Prior to the PR Act, an agency's budget was less than or equal to revenue because license revenues were often diverted as discussed above and because the wildlife agencies had no other sources of funds. Letting B be the budget of the wildlife agency (referred to as “B_w” above) and R be the revenue from license sales, this implies $B \leq R$.

As noted above, we assume there is a single homogenous license that is sold at price, p , so that the annual revenue is $R = pL(p, W)$. The number of licenses, L , is negatively related to price (i.e., hunting or fishing license demand is downward sloping) and positively related to W , the stock of wildlife in the state.²³ Recalling that d indicates the proportion of the license revenue diverted to another agency, the wildlife agency budget is given by

$$(1) \ B = (1 - d) R = (1 - d) pL(p, W).$$

We also assume a per unit cost c for administering and enforcing a hunting or fishing license. Assuming the agency's personnel is rewarded for a greater surplus, or net revenue, the agency solves the following optimization problem:

$$(2) \ \underset{L}{\text{Max}} \ S = (1 - d) pL(p, W) - cL,$$

which implies a chosen number of licenses $L^*(d, W)$ and price p^* and a corresponding agency revenue R^* . The following comparative static results emerge from this model: $\partial L^*/\partial d < 0$; $\partial p^*/\partial d > 0$; and $\partial L^*/\partial W > 0$. Moreover, $\partial R^*/\partial d < 0$ (and by implication $\partial B^*/\partial d < 0$) if we assume the wildlife agency is behaving like a single-price monopoly and operating in the elastic portion of the demand curve. This is true as long as the agency is maximizing objective (2) and has exclusive control over hunting license rights.

The bottom line is that the diversions lower the price, and this reduces license sales and revenue relative to a pricing structure that would maximize net revenue absent the federal program. In other words, diversions are like an *ad valorem* tax on wildlife agency output. The increase in p , or $\partial p^*/\partial d$, is the incidence of diversions on hunters.

The model is simple but here we comment on possible extensions. First, if we allow the stock of wildlife (W) to be endogenous to wildlife budgets, past and present, then persistent revenue diversions could reduce the quality and quantity of wildlife stocks by reducing the funds available for habitat improvements, stocking, and wildlife law enforcement. Thus, increases in d would indirectly reduce license revenues by reducing W , and this could shift the demand for licenses down. This is similar to the positive feedback effect that can occur when the decrease in the provision of a public good (such as W) can decrease private demand for a complementary good (such as hunting).²⁴ If increases in d eventually impair W , then this effect would reinforce the prediction that $\partial L^*/\partial d < 0$ but would make the prediction $\partial p^*/\partial d > 0$ ambiguous.

Second, we are assuming that wildlife agencies take d as given and respond accordingly. However, there was unavoidable uncertainty about the annual size of d from the perspective of wildlife agencies. Moreover, states may have considered potential revenue losses when setting the value of d if they anticipated how d would change agency behavior. For example, states may have set d at higher values only when hunting demand was inelastic. Third, we assume that agencies have autonomy in setting license prices but in practice state legislatures have final price setting authority while also considering input from wildlife agencies.

C. *Effects of Pittman Robertson*

Pittman Robertson prohibited states from diverting license revenues so that $d = 0$ for all states. Moreover, after PR wildlife agencies began to receive appropriations from a pool of

federal tax revenue comprised of τG , where G is the sale of guns and ammunition (and later fishing equipment and both fuel) and τ is the federal tax rate (e.g., 10% or 11%). The wildlife agency in each state receives a share, α_s , of τG each year. The share is based on a state's land area, A , and the number of hunting license sold, L . A state's share during the first decade of PR funding was defined by the following expression that links to the Pittman Robertson fund allocation formula described in section 2: ²⁵

$$(3) \alpha_s = \frac{A_s}{2 \sum_{s=1}^{48} A_s} + \frac{L_s}{2 \sum_{s=1}^{48} L_s}$$

Equation (3) indicates that α_s is a weighted share of a state's land area (A_s) as a proportion of total U.S. land area and of a state's hunting licenses (L_s) as a proportion of all hunting licenses sold in the U.S. Under this formula, Rhode Island received the lowest share at about 0.0008 and a few large states with many hunters – Michigan, New York, Pennsylvania, and Texas - received between 0.05 and 0.06.²⁶ Starting in 1948, PR appropriations were bounded at a minimum of 0.005 (1/2 % of τG) and a maximum of 0.05 (5% of τG). If the calculated share is less than 0.005 (e.g., Rhode Island and Hawaii once it became a state in 1959), then $\alpha_s = 0.005$. If the calculated share is greater than 0.05 (e.g., Texas and Alaska, once it became a state in 1959), then $\alpha_s = 0.05$.²⁷ With PR in place, the state wildlife agency's budget can be written as

$$(4) B = pL(p, W) - cL + \alpha(A, L(p, W))\tau G .$$

The first and second terms on the right-hand side are revenue from license sales and costs as before, but with the $d = 0$ constraint. The third term says the state's share of federal appropriations, α , is a function of area, which the agency cannot affect, and the number of license holders, which state policy can affect through pricing or by “gaming” the program by

offering a larger suite of lower-priced products (e.g., big game vs. upland birds and warm water fish vs. trout).²⁸ This share is multiplied by national PR tax revenue.

Equation (4) illustrates an incentive introduced by Pittman-Robertson for wildlife agencies trying to convince state legislature to price in ways that maximize net revenue for agencies. By lowering prices, or offering a larger suite of license products, the state can increase the share of money from PR because $\partial\alpha/\partial p \leq 0$.²⁹ The incentive is sharp in years where τG is high because the benefits from selling more licenses increase. The inequality sign is weak because states with $\alpha = \bar{\alpha}$, at either $\bar{\alpha} = 0.005$ or $\bar{\alpha} = 0.05$, do not face a tradeoff in their pricing decisions. Agencies in these states receive what is effectively a lump sum transfer through PR. Because each state receives at most 0.05 of τG , the framework treats national gun sales as exogenous to the decisions of any individual state wildlife agency.³⁰

D. Testable Implications

The framework just described delivers three implications that we examine in the empirical section to follow.

1. States with more agencies to fund (e.g., forests, roads, parks, water quality) were more likely to divert license revenue from wildlife agencies during the early 20th century, prior to PR.
2. States that diverted license revenue to non-wildlife agencies prior to PR are expected to sell fewer hunting licenses and generate lower license revenue prior to PR when controlling for other factors. The effect of diversions on license prices is ambiguous. The short run effect of diversions raised license prices but, if the long-run consequence was an impaired wildlife stock, then license prices could have been reduced due to lower quality wildlife management.
3. The introduction of PR, and any further exogenous increases in τG , is expected to increase the number of licenses sold and total agency budgets. The effect would be smallest for states near the boundaries of $\alpha = 0.005$ or $\alpha = 0.05$. The effects of PR on license prices and license revenues are ambiguous. The short run effect would be to lower prices and license revenues but long-run improvements in W could have led to higher prices and license revenues.

The model has two additional implications, or theoretical mechanisms, that we are unable to test due to data limitation. First, during the pre-PR period states that consistently diverted license revenue to non-wildlife agencies prior to PR would reduce wildlife habitat and wildlife populations at a rate faster than other states when controlling for other factors. Second, PR would be expected to increase wildlife habitat and wildlife populations in the long run. The effect is expected to be largest in states that had $d > 0$ prior to PR when controlling for other factors.

4. EMPIRICAL ANALYSIS: REVENUE DIVERSION PRIOR TO PITTMAN ROBERTSON

To examine the potential causes and effects of license revenue diversion prior to Pittman Robertson, we exploit data contained in Connery's (1935) political science dissertation on *Governmental Problems in Wildlife Management*. Connery gave a list of 25 states with legislation that explicitly protected license revenue from being diverted,³¹ and a list of 16 states that explicitly authorized the diversion of license revenue to other purposes.³² From Connery, we create two indicator variables, *Revenue Diversion* and *Revenue Protection*, that provide measures of d from our model. We treat each variable as time invariant for our historical analysis of 1927 to 1937 outcomes, which is the 10-year window preceding Pittman Robertson for which data are available.³³

Our theoretical framework suggests three historical factors were important for determining whether states would divert license revenue. These are 1) the number of non-wildlife state agencies that existed in the 1920s and 1930s; 2) the degree to which the non-wildlife agencies had other dedicated funding sources (e.g., user fees); and 3) the amount of general tax revenue accrued by a state.

Data on the number of non-wildlife agencies come from Lueck and Parker (2020) and are summarized in Table 3. By 1920, most states had wildlife, inland fish, agriculture, and health agencies. However, several states had yet to establish forestry or parks agencies, and none had agencies devoted to water quality protection. By 1940, most states had natural resource agencies and six states had water quality agencies.

Table 3

We focus on resource and environmental administration because these agencies were most likely to receive funding diverted from hunting licenses prior to Pittman Robertson (Connery 1935). We code the information in Table 3 in two ways to facilitate empirical tests of the prediction that state with more agencies to fund were more likely to divert license revenue from wildlife agencies prior to PR. First, we include a count of the number of non-wildlife agencies in each state prior to PR. Second, we use indicator variables to show the presence or absence of forest, parks, water quality, and saltwater (marine) agencies.

Our model implies that states with more agencies to fund (e.g., forests, parks, water quality) were more likely to divert license revenue from wildlife agencies prior to PR. Of potential importance, the non-wildlife agencies differ in the degree to which they were self-financed by user fees. State parks, for example, did and continue to raise revenue from entrance fees. State forest fire management, on the other hand, was not self-financed. We predict that states with agencies lacking user funding, such as forestry, were more likely to divert hunting and fishing license revenues.

Table 4 shows results from linear probability model (LPM) regressions in which we pool all 48 states over 1927 to 1937 and cluster the standard errors by state. The LPM estimates show that the number of non-wildlife agencies, which is time variant over 1927 to 1937, is positively

related to revenue diversion and negatively related to revenue protection as implied by the theoretical framework. The signs of the relationships are robust to the inclusion of regional fixed effects based on 1930 Census definitions of the regions, although only the negative relationships with revenue protection are statistically significant.³⁴ The coefficients in Columns 4 and 5 imply that the addition of a non-wildlife agency was associated with a 17.3 to 22.6 decrease in the probability that a state had a statute protecting license revenue from diversion to other agencies. For perspective, the mean number of agencies was 5.14 with a standard deviation of 0.88 and a range of 3 to 7.

Table 4

In Columns 3 and 6 we include indicator variables for whether a state has a forestry, parks, water quality, or marine fishery (saltwater) administrative agency. The results indicate the existence of a forestry agency is positively associated with revenue diversion and negatively associated with revenue protection. This is interesting because, as Connery (1935) notes, many states diverted hunting license revenue for forest fire protection, which did not have an independent revenue source. This may have created a strong incentive for states to divert revenue from hunter and anglers, who benefit from spending on forest management only if it improved habitat for fish and wildlife. To summarize, the estimates indicate that revenue protection was strongly associated with state administrative capacity as the theoretical model suggests. Unfortunately, we lack the data to test how the amount state general tax revenue during 1927-1937 influenced revenue diversion.

To evaluate the potential effects of license revenue diversions prior to Pittman-Robertson we combine historical data on hunting licenses with the Connery data on revenue diversions prior to 1938. The license data were sent to us as files from the US Fish and Wildlife Service and

are not available on the agency's website, which provides license data for 1952-2018.³⁵ The historical data indicate the number of hunting licenses sold per state, separated by residency status, along with total license revenue.

The pre-1938 license data are annual and span 1925 to 1937. Beginning in 1934, the coverage is for all 48 states (Alaska and Hawaii were not states until 1958). Prior to 1934, the data span a range of 29 to 47 states, with the peak coverage of 47 states occurring in 1927. Many states sporadically provided data prior to 1934 and one state, Mississippi, did not have a resident hunting license system until the 1930s. Table 5 shows summary statistics for 1927, 1937, and changes from 1927 to 1937. The statistics exclude Mississippi, Alaska, and Hawaii. Hunting licenses per capita measure the quantity of licenses sold.

Table 5

We assess the potential effect of *Revenue Diversion* and *Revenue Protection* by studying how each relates to state-level changes in outcomes over 1927 to 1937. We focus on changes, rather than levels, for two reasons. First, the outcomes in any particular year will be affected by many state-level factors that would be difficult to fully control for in cross-sectional analysis (e.g., state land cover, wildlife habitat, and demographic composition). Focusing on changes over time reduces some of the omitted variable problems that confound interpretation. Second, it is likely that revenue diversion, or revenue protection, will have effects on wildlife management that accumulate over time. Focusing on the decadal period of change preceding Pittman Robertson highlights trends that may be attributable to longer-run patterns of revenue diversion and protection.

Table 6 compares changes in outcomes over 1927 to 1937 in a univariate regression. The dependent variables are summarized in Column 3 of Table 5. Column 1 indicates that states

explicitly allowing revenue diversion experienced, on average, a decrease in license sales per capita relative to states that did not allow revenue diversion. The revenue diversion coefficient of -1.84 is large relative to the sample mean of -0.22 (see Table 5). The estimates in Column 2 indicate that the share of non-resident licenses also fell in states that diverted license revenue, relative to states that did not. The coefficient of -0.96 means that revenue diversion was associated with a one percentage point decrease, which is large relative to the sample average of -0.27 percentage points. These results indicate that the number of licenses sold fell with revenue diversion, even though the average price also decreased, albeit with a statistically imprecise estimate (see Column 3). This pattern suggests that revenue diversions may have caused inward shifts in demand, presumably from a decrease in the quality or quantity of wildlife (W in the theory) resulting from fewer resources available for wildlife management.

Table 6

A comparison between Columns 1-3 vs. Columns 4-6 in Table 6 show that statutes permitting revenue diversion are more precisely correlated with hunting license outcomes when compared to statutes protecting revenues. Column 6, however, shows that states protecting revenue from diversion experienced an increase in average license prices relative to states that did not.

The correlations in Table 6 are generally consistent with the theoretical framework. In states where revenue was susceptible to diversion, the number of hunting licenses were falling prior to Pittman Robertson. This supports our intuition that long-run wildlife management will decay when license revenue is persistently diverted to other purposes.

5. EMPIRICAL ANALYSIS: EFFECTS OF PITTMAN ROBERTSON

Our theoretical framing suggests that PR creates a tradeoff for a state wanting to increase budgets for wildlife conservation when it chooses license policy. On one hand, higher hunting and fishing license prices may increase license revenue if demand is inelastic. On the other hand, higher license prices may decrease appropriations from PR by reducing the number of licenses sold, which are a key part of the PR allocation formula. Qualitative evidence indicates that states are aware of the tradeoff and try to increase their PR and DJ appropriations. Consider, for example, the website of Mississippi's Department of Wildlife, Fish, and Parks which states:

“Hunters have always been the primary supporters of wildlife conservation in Mississippi, but someone who purchases a license to hunt in Mississippi is valuable as a financial supporter of wildlife conservation for two additional reasons. First, the revenue from license sales goes exclusively to administering MDWFP's wildlife and fisheries programs. Second, the number of individual hunting license holders increases our state's share of the total P-R apportionment. Mississippi's apportionment is directly related to the number of hunters we have. Thus, if the number of license holders in Mississippi declines, other states may receive our share of funding.”³⁶

This tradeoff implies that PR has an ambiguous theoretical effect on license revenue because the annual amount of PR funding to individual states has an endogenous component (which is α_s) that states may adjust their license policies to increase PR. To identify causal effects of PR on state agency choices, we employ two complementary approaches. Equation 5 shows our first approach for testing the hypotheses that PR increased license sales, and for evaluating its effects on average license prices and hunting license revenue.

$$(5) y_{st} = \beta_1 PR1_t + \beta_2 PR1_t \times 1(\text{if } \alpha_{st} = \bar{\alpha}_s) + \pi_1 PR2_t + \pi_2 PR2_t \times 1(\text{if } \alpha_{st} = \bar{\alpha}_s) + \lambda \ln pop_{st} + \rho \ln pci_{st} + \omega_s t_s + \varepsilon_{st}.$$

The outcome variables, y_{st} , include hunting licenses sold, the number of individual hunters, the average license price, and annual hunting license revenues. The key variables are $PR1$ and $PR2$. $PR1$ is an indicator for the years for which Pittman Robertson was in effect, which

began in 1939. *PR2* is an indicator for 1972 and later, which are the years for which the second wave of PR funding was authorized through amendments that added a handgun tax to the legislation as discussed above. The model controls for state population and per capita income, both logged.

We interact *PR1* and *PR2* with the “fixed share” indicator 1 (if $\alpha_{st} = \bar{\alpha}_s$) to allow the effects of Pittman Robertson funding to differ for states with limited ability to affect their own share of federal funding. Though no state received a fixed share over the entire period, Delaware, Hawaii, New Hampshire, Rhode Island, and Vermont received close to the minimum share during most of the sample period.³⁷ The indicator variable for “fixed share” is equal to one for these five states and zero for all others.

The approach in equation (5) relies on the fact that the timing of the Pittman Robertson legislation was exogenous to the behavior of any individual state. To account for the possibility that outcomes across states may have been on different trajectories prior to PR and its handgun amendment, we include state-specific linear time trends ($\omega_s t_s$). Because the sample period begins in 1925, the coefficient on *PR1* (β_1) is the difference in outcomes after 1938 relative to 1925-1938, subject to time trends. The coefficient on *PR2* (π_1) is the difference in outcomes after the 1970 amendment was implemented, conditional on time trends.

Table 7 shows the estimates of (5) using data summarized in Appendix Table A1. As Column 1 shows, license sales increased by about 63 percent³⁸ after the initial PR legislation and by an additional nine percent after the handgun amendment. These findings are consistent with the theoretical framework which implies that PR would increase license sales. While we cannot fully decompose the channels through which PR influenced revenue, the finding that the positive effect of the PR legislation exceeded the positive effect of the handgun legislation is consistent

with *PR1* being more important because the initial act eliminated revenue diversion in addition to providing federal funds.

The other results in Table 7 suggest that PR had large and persistent effects on other outcomes. Columns 2 and 3 suggest the handgun amendment increased the number of license holders and decreased the average price of hunting licenses. These results are consistent with the prediction that individual states will respond to a larger PR aggregate funding pool by lowering license prices – at least relative to the long run trend of rising prices - to increase the number of license holders. This could be accomplished by offering more low-priced hunting licenses, for example. Column 4 suggests the net effect of PR was to increase long-run revenue from hunting license sales. Across all columns, there is no evidence that outcomes were differentially affected in states with fixed shares of funding. Below we discuss the role of fixed shares in more detail.

Table 7

Finally, it is worth noting what the estimates in Columns 1 and 3 imply about hunting license demand elasticities. Using the coefficients on both PR1 and PR2, the price elasticity is approximated by:

$$(6) \quad \epsilon_D = \left| \frac{0.5378+0.0881}{-0.0643-0.1366} \right| = 3.1.$$

The terms in the numerator show the estimated quantity response to PR1 and PR2 from Column 1. The terms in the denominator show the estimated price response to PR1 and PR2 from Column 2. This large elasticity, -3.1, can be interpreted as an upper bound, valid as a point estimate only if the quantity and quality of the wildlife stock (W in the theory) is constant over time. If PR caused W to increase, then the elasticity estimate is the net effect of movements along the demand curve with outward shifts in demand for hunting licenses. This provides context to the finding that quantity effects on license sales are large in Column 1, but negative price effects

are small in Column 3. Either hunting license demand is very elastic or, perhaps more likely, hunting license demand shifted out with Pittman-Robertson funding.

Our second approach for evaluating the effects of PR focuses on how states responded over time to annual changes in the size of the national pool of federal tax revenue, which is τG_t in the model. We estimate the following equation

$$(7) \quad \ln y_{st} = \beta_1(\ln PRmoney_{t-1}) + \beta_2(\ln PRmoney_{t-1}) \times 1(\text{if } \alpha_{st} = \bar{\alpha}_s) + \lambda \ln pop_{st} + \rho \ln pci_{st} + \omega_s t_s + \varepsilon_{st}.$$

The notation ($PRmoney_{t-1}$) denotes the amount of national funding through PR, lagged one year. As above, we control for state population and income per capita, and we include state-specific linear time trends ($\omega_s t_s$).

Unlike the model from Equation 5, this model (Equation 7) accounts for temporal changes in the precise amount of PR funds rather than simply controlling for the legislation with indicator variables. The main disadvantage of the approach in Equation (7) is that it implicitly assumes that wildlife agencies can quickly respond to increased PR shares when aggregate funding rises on an annual basis.³⁹ A second disadvantage is that some omitted time-variant variable might be causing changes in both $PRmoney$ and license sales at the state level. For example, an unobservable increase in hunting demand could cause an increase in both national gun sales and state license sales. For this reason, we include state-specific time trends to control for different time patterns across states. We also include the lag of $PRmoney$, rather than the contemporaneous amount, to account for possible reverse causation.⁴⁰

Table 8 shows the estimates of (7) using data beginning in 1940 (because PR funding began in 1939 and we are focused on lagged funding) and summarized in Appendix Table A1. The even numbered columns in Table 8 include state-specific linear trends and the odd columns

do not. The results show that PR funding is positively related to the number of licenses sold and is not strongly related to the average price of a hunting license. The Column 1 and 2 coefficients suggest a 10% increase in PR money is associated with a 2.4% and 2.1% increase in license sales. Consistent with our expectations, the effect of *PR money* on license sales is lower for states who receive a “fixed share” of PR funds. There is also evidence, in Column 4, that states receiving a fixed share of PR money raised hunting license prices (relative to the other states) in response to higher national tax revenue as our theory suggests.

Columns 5 and 6 show the estimated effects of PR funds on hunting license revenue. The evidence suggests that state wildlife agencies increased license revenue in years with larger national tax revenue. There are two potential explanations. First, states responded to larger PR allocations by more aggressively marketing hunting licenses, and this effort was successful at increasing licenses sold without the need to decrease license prices. Second, states responded to larger PR allocations by increasing the menu of license types for sale, and this enabled them to sell more licenses and also raise further revenue.⁴¹

Table 8

6. CONCLUSION

We have examined the origins and effects of a major federal conditional grant program that directs federal excise taxes to state agencies for fish and wildlife management. The program created a dedicated funding source for wildlife conservation in which funding is linked, by design, to national demand for hunting and fishing. This intervention has been hailed by wildlife managers and conservationist constituents as crucial to the rebuilding of decimated

populations. Despite this proclaimed success, there has been little systematic research to understand how it has in fact affected wildlife agency budgets and behavior.

Our analysis focuses on features of the federal program design that have often been overlooked. Because federal tax monies are given only to those states who agreed to not divert hunting and fishing license revenues, the program created a double-stimulus for wildlife agencies in states that were otherwise seeing their revenue diverted away from wildlife conservation: it stopped diversions and it added federal revenue. Using theoretical and empirical analysis, we find evidence suggesting that revenue diversion weakened revenue generation from hunting licenses, and that Pittman-Robertson restored and even enhanced license revenue.

Our analysis suggests that PR secured increased license revenue not only because it ended revenue diversion, but also because it incentivized states to increase the number of licensed hunters. States were incentivized to do so because half of the federal allocations to states depends on the number of license holders. Though this feature gave individual states incentives to lower license prices to more aggressively game the federal funding system, it also gave them incentives to more aggressively market hunting opportunities and to improve habitat. Our empirical results suggest the latter effect dominated the former. In the end, the federal wildlife tax programs have succeeded in increasing aggregate funding for long-run wildlife conservation.

This study has examined one program that conditionally grants federal excise taxes to states. Our findings show that individual states can be expected to adjust to the allocation formulas, but other questions remain. For example, how has the federal government, since 1937, been able to credibly commit to not raiding tax revenues dedicated to wildlife restoration? It seems the federal government has, in this case, created a dedicated fund for and from stakeholders with a unique amount of stability by conditioning funding on no diversion to other

purposes, and by linking the tax revenue funding quite directly to user demand. We infer that the stability of federal funding in other settings would also depend on these program attributes.

Acknowledgements

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Table 1: Evolution of State Wildlife Management, 1700-2000

Year	Game Laws Adopted	Specialized Wildlife Law Enforcement Position	Agency Organization	Resident Licenses	Non-resident Licenses	Funding
1700	3 (25% of colonies)	Local authorities responsible for enforcement of game laws	State laws with weak local enforcement	0	0	None
1750	10 (76.9% of colonies)	Local authorities (Massachusetts creates local deer wardens in 1739)	System changes little until after 1850	0	0	None
1800	13 (81.3% of states)	Local authorities		0	0	None
1850	18 (58.15% of states)	Primarily local authorities (2 more states create local wardens --NH fish wardens 1809, ME moose wardens 1852)		0	0	None (some wardens kept fines (Warren 1997))
1900	48 (98% of states and territories)	31 states (63% of total) develop warden positions at local and/or state level (compensation varies across states between salaries and piece-rate)	State legislatures oversee appointed state wardens who are responsible for local wardens	5 (10%) Michigan and North Dakota were the first in 1895	9 (18.4%) New Jersey was the first in 1873	Limited (states allocated meager funds from general budget as they began to collect license fees)
1950	50 (100% of states and territories)	50 (100%) have game wardens	State legislatures control commissions who oversee agencies headed by paid administrator	44 (89.8%)	50 (100%)	Pittman-Robertson Act of 1937 forces states to give full license fee to wildlife agencies
2000	50 (100% of states)		State commissions are largely independent policy-making bodies which oversee bureaucratic agencies	50 (100%)	50 (100%)	Modern agencies funded by license fees, federal monies, tax checkoffs, dedicated taxes, and other special programs

Source: (Lueck and Parker 2020, Tober 1981)

Table 2 – Summary of Federal Policies towards Wildlife Restoration

Year	Event	Details
1896	<i>Geer v Connecticut</i> 161 U.S. 519	Supreme Court upholds state authority to regulate wildlife. and creates the ‘state ownership doctrine.’
1900	Lacey Act	Federal law prohibiting the trade in illegally taken wildlife. (Amended in 2008.)
1902	Association of Fish and Wildlife Agencies established.	Organization of agencies from US and Canada to coordinate and promote wildlife conservation.
1918	Migratory Bird Treaty Act	Act to establish the 1916 treaty with Canada (UK) to manage migratory waterfowl established federal authority to establish seasons and regulations to hunt migratory waterfowl.
1920	<i>Missouri v Holland</i> 252 U.S. 416	Supreme Court upholds federal jurisdiction over wildlife in the case of migratory waterfowl.
1919	Federal Firearms and Ammunition Tax Act	Imposes excise taxes of 10% on firearms and 11% on ammunition.
1934	Migratory Bird Hunting and Conservation Stamp Act (Duck Stamp Act).	Requires hunters to purchase “duck stamp” for waterfowl hunting.
1937	Pittman Robertson Act	Directs federal firearms taxes to states for wildlife restoration purposes.
1939	Fish and Wildlife Service established in Department of Interior	Combined the Bureau of Fisheries and the Biological Survey.
1950	Dingell Johnson Act	Directs federal taxes on sport fishing equipment to states for sport fish restoration purposes.
1970	Dingell Hart Act	Included 10% tax on handguns and ammunition in WSFR revenue source for hunter safety programs.
1972	Public Law 92-558	Implemented 10% tax on archery equipment.
1973	Endangered Species Act of 1973	Expanded federal authority over species listed as threatened and endangered.
1976	<i>Hughes v Oklahoma</i> 441 U.S. 322	Expressly overturned the state ownership doctrine in <i>Geer</i>
1984	Wallop Breaux Amendments to Dingell Johnson.	Expanded the list of fishing items taxed at 10%. Allowed funds to be used for boat infrastructure and created the Aquatic Resources Trust Fund.
2000	Wildlife and Sport Fishing Restoration Improvement Act	Additional funding for hunting education and safety programs.
2005	Sportfishing and Recreational Boating Amendments Act (Public Law 109-74)	Increases appropriations from Highway Trust Fund to Coast Guard for recreational boating safety.

Sources: (FWS 2012).

Table 3: Number of States with Natural Resource Agencies, 1860-1940

	1860	1880	1900	1920	1940
Wildlife (includes warden)	0	4	30	46	48
Inland fish	0	31	41	46	48
Saltwater fish	1	14	18	19	20
Forests	0	1	13	37	46
Parks	0	0	4	19	44
Agriculture	5	23	40	47	47
Health	1	24	42	48	48
Water Quality	0	0	0	0	6

Source: Lueck and Parker (2020). Note that Alaska and Hawaii were not yet states.
Note also that the number of saltwater fish agencies is limited by the number of coastal states.

Table 4: LPM Estimates of Administrative Capacity and Revenue Diversion

	Y= Revenue Diversion			Y= Revenue Protection		
	(1)	(2)	(3)	(4)	(5)	(6)
Number of Agencies	0.064 (0.319)	0.075 (0.303)		-0.226*** (0.001)	-0.173** (0.025)	
Forest			0.275**			-0.313***
Parks			0.125			-0.131
Water Quality			-0.093			-0.316
Marine			-0.044			-0.227
Constant	1.685***	1.025**	1.035***	-0.038	-0.449	-0.033
Region FE		x			x	
Observations	528	528	528	528	528	528
R ²	0.015	0.073	0.037	0.158	0.246	0.144

Notes: Standard errors are clustered by state. P-values are in parentheses. The sample includes the 48 continental states from 1927 to 1937, prior to Pittman Robertson. The region fixed effects cover six regions defined in the 1930 U.S. Census. The estimation employs a linear probability model.

Table 5: Summary Statistics on License Sales Prior to 1938

	1927	1937	Δ 1937-1927
<i>Hunting Licenses Per 100 People</i>			
Minimum	0.98 (DE)	1.25 (RI)	-10.64 (SD)
Mean	6.73	6.51	-0.22
Maximum	17.24 (ID)	20.46 (MT)	6.54 (MT)
<i>% Licenses Held by Non-Residents</i>			
Minimum	0.03 (OH)	0.04 (OH)	-13.87 (DE)
Mean	1.59	1.32	-0.27
Maximum	14.86 (DE)	5.55 (NM)	2.20 (SC)
<i>Average Price of License (2018 \$s)</i>			
Minimum	11.42 (IN)	13.13 (KY)	-10.72 (DE)
Mean	21.15	29.67	8.52
Maximum	56.58 (NM)	92.82 (WY)	59.05 (WY)

Notes: N = 47 for all statistics. Mississippi, Alaska, and Hawaii are not included. Two-letter abbreviations (in parentheses) indicate states having minimum and maximum observations.

Table 6: OLS Estimates of Changes in License Sales and Prices from 1927 to 1937

	Y= Licenses PC (1)	Y = % Non- Res (2)	Y= Ave. Price (3)	Y= Licenses PC (4)	Y = % Non- Res (5)	Y= Ave. Price (6)
Revenue Diversion	-1.843** (0.023)	-0.962** (0.028)	-1.486 (0.223)			
Revenue Protection				0.594 (0.241)	0.510 (0.233)	4.791* (0.056)
Constant	0.325	-0.560	8.966	-0.527	-0.534	6.077
N	47	47	47	47	47	47
R ₂	0.089	0.039	0.004	0.011	0.013	0.053

Notes: All estimates exclude Mississippi, Alaska, and Hawaii. Robust p values in parentheses. The dependent variables in each OLS estimate are defined in Column 3 of Table 5.

Table 7: Regression Estimates of Effects of PR Legislation

	Y= ln(hunting licenses)	Y = ln(hunting lic. holders)	Y = ln(avg. hunting lic. price)	Y = ln(hunting lic. revenue)
	(1)	(2)	(3)	(4)
PR1	0.5378*** (0.000)		-0.0643 (0.210)	0.4766*** (0.000)
PR1 x fixed share Ind.	-0.1470 (0.597)		0.0388 (0.876)	-0.1102 (0.685)
PR2	0.0881** (0.034)	0.1315*** (0.000)	-0.1366*** (0.000)	-0.0496 (0.175)
PR2 x fixed share Ind.	-0.2096* (0.058)	0.0239 (0.628)	-0.0423 (0.597)	-0.2523 (0.126)
ln(population)	1.5351*** (0.000)	0.7852* (0.058)	0.2165 (0.263)	1.7382*** (0.000)
State FE	yes	yes	yes	yes
State Linear Trends	yes	yes	yes	yes
Observations	3475	2692	3475	3571
Adjusted R ²	0.799	0.577	0.312	0.797

Notes: p-values in parentheses based on standard errors that are clustered by state. * p<0.1, ** p<0.05, *** p<0.01. The data span 1925-2008 with a few years of missing data for columns 1,3 and 4. The data for Column 2 spans 1952-2008 with a few years of missing data. All dollar values are inflation adjusted to 2018 \$. We do not control for state income per capita because it is not available for the early years in the sample.

Table 8: Regression Estimates of Effects of PR Legislation on Wildlife Agency Outcomes

	Y = ln(hunting licenses)		Y = ln(average lic. price)		Y = ln(hunting lic. revenue)	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(PR \$s) _{t-1}	0.239** (0.000)	0.215** (0.000)	0.012 (0.680)	-0.021 (0.476)	0.250** (0.000)	0.193** (0.000)
ln(national PR\$ _s) _{t-1} X fixed share Ind.	-0.139* (0.011)	-0.192* (0.024)	-0.038 (0.659)	0.217* (0.026)	-0.178* (0.041)	0.026 (0.821)
ln(population)	0.291** (0.007)	0.735* (0.017)	-0.181* (0.073)	0.297 (0.204)	0.101 (0.426)	1.037** (0.000)
ln(per capita income)	0.458** (0.000)	0.322** (0.006)	0.063 (0.496)	-0.057 (0.526)	0.528** (0.000)	0.270* (0.022)
State FE	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
State Linear Trends		yes		yes		yes
Observations	3119	3119	3119	3119	3215	3215
Adjusted R ²	0.680	0.787	0.016	0.352	0.642	0.781

Notes: p-values in parentheses based on standard errors that are clustered by state. * p<0.1, * p<0.05, ** p<0.01. The data span 1939-2008 with a few years of missing data for some outcomes. All dollar values are inflation adjusted to 2018 \$s.

Figure Titles

Figure 1: Per Capita Federal Appropriations to States, 1938-2018

Figure 2: Proportion of the Population that are Hunters and Anglers vs. Proportion with Hunting and Fishing Licenses, 1934-2016

Figure 3: Ratio of Federal Appropriations to License Revenue, 1938-2016

FOOTNOTES

¹ Federal Aid in Wildlife Restoration Act (16 U.S.C. 669-669i; 50 Stat. 917).

² The Pittman Robertson Act stipulates that all states eligible for the federal funds must prohibit the diversion of license fees paid by hunters for any purpose other than the administration of the state's wildlife department.

³ Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777k, 64 Stat. 430).

⁴ General funds were used in some states but were a small portion of agency funds.

⁵ Kallman (1987) provides a good history.

⁶ Chan and Kotchen (this issue), Lupi, von Haefen and Ching (this issue), Walls (this issue), and Ji et al. (this issue) are recent studies that examine other issues associated with taxation and natural resource conservation policy. Dye and McGuire (1992) examine the more general issue of earmarked tax revenues.

⁷ 161 U.S. 519. The case involved a game dealer who was selling wild birds in violation of Connecticut law.

⁸ The Act depended on a treaty with Canada (Great Britain) and later an extension of the treaty with Mexico in 1936. States contested federal authority to regulate wildlife but in 1918 the Supreme Court overturned *Geer* and granted federal jurisdiction in *Missouri v Holland* and later explicitly rejected the idea of state ownership of wildlife in *Hughes v Oklahoma* (Lueck 1989). The 1916 Treaty has since been amended to include agreements with Mexico and Russia.

⁹ The National Firearms Act was also enacted in 1934 and was the first federal law to mandate registration of certain weapons (e.g., machine guns). It has been argued that this law stimulated lobbying by the firearms industry to support Pittman Robertson and related legislation (FWS 2012, Kalman 1987, p.9).

¹⁰ These funds, which are allocated directly to state agencies, are used to acquire and protect wetland habitat for waterfowl. See <https://www.fws.gov/birds/get-involved/duck-stamp.php>.

¹¹ Details can be found at <https://wsfrprograms.fws.gov/subpages/AboutUs/AboutUs1.htm>. The FWS states that “The U.S. Fish & Wildlife Service, Wildlife and Sport Fish Restoration Program (WSFR) works with states, insular areas and the District of Columbia to conserve, protect, and enhance fish, wildlife, their habitats, and the hunting, sport fishing and recreational boating opportunities they provide.” See also Kallman (1987) and Lund (1980).

¹² The federal tax on firearms was implemented in 1919 just after World War I. The tax is 10% on handguns and 11% on rifles, shotguns and ammunition. See

<https://www.atf.gov/firearms/firearms-guides-importation-verification-firearms-ammunition-and-implements-war-firearms> and <https://www.ttb.gov/resources/faqs/firearms-excise-tax>

¹³ In practice this means the revenue becomes part of the budget for state wildlife agencies.

¹⁴ See Interior Secretary Zinke’s press release <https://www.doi.gov/pressreleases/secretary-zinke-announces-more-than-11-billion-sportsmen-conservation>.

¹⁵ Today WSFR also includes the Clean Vessel Act Grant Program, the Boating Infrastructure Grant Program, the National Coastal Wetlands Conservation Grant Program, the State Wildlife Grant Program, the Multistate Grant Program, the Landowner Incentive Grant Program, the Tribal Wildlife Grant Program, and the Tribal Landowner Incentive Grant Program. See <https://fawiki.fws.gov/display/TRNG/WSFR+Quick+Reference+Guides>. In 1980 a “Nongame Act” was passed to direct funds for nongame species conservation, but Congress has never authorized funding. Territories such as American Samoa, Guam and Puerto Rico also receive small amounts of WSRF funds.

¹⁶ The 1970 handgun amendments increased the minimum states share from 0.05% to closer to 0.06% after accounting for programs specifically dedicated to gun safety. For tax details see <https://wsfrprograms.fws.gov/Subpages/AboutUs/ItemsTaxedJan2018.pdf>. Also, note a study by Southwick Associates estimates just 22.5% of firearm tax revenue is for hunting purposes. <https://www.southwickassociates.com/breaking-down-excise-taxes-on-firearms-and-ammunition/>.

¹⁷ The correlation between the number of hunters and hunting licenses sold over 1952 to 2016 is 0.74. The correlation between the number of fishers and fishing licenses sold over 1952 to 2016 is 0.95.

¹⁸ In practice a license will typically be a paper or plastic document and may include stamps for specific species and tags to attach to harvested animals (especially for larger game).

¹⁹ The framework does not assume the policy makers maximize a social welfare function and instead embeds political economy factors into the value functions. If non-wildlife lobbyists are more potent than wildlife lobbyists, for example, this would tilt d towards one.

²⁰ The outcome $d^* = 0$ might also emerge if the state has other sources of revenue for public good funding (e.g., state property taxes, excise taxes).

²¹ To see this, start from an equilibrium condition, which, assuming an internal solution, is $V'_w[(1 - d^*)pL] \equiv V'_{nw}(d^*pL + T)$. The comparative static solution finds the change in d that maintains the identity when T changes. Using the notation Δ for changes, and totally differentiating, we have

$$-V''_w pL \Delta d^* = V''_{nw} pL \Delta d^* + V''_{nw} \Delta T. \text{ Re-arranging leads to } \frac{\Delta d^*}{\Delta T} = -\frac{V''_{nw}}{pL(V''_w + V''_{nw})} < 0.$$

²² This result assumes the marginal value functions of each new agency have the same general characteristics, in which case the funding would be optimally split among the different $i=1, \dots, n$ state agencies.

²³ This stock depends on the habitat characteristics of the state and the past efforts of the agency to manage wildlife stocks through enforcement, stocking, and habitat manipulation.

²⁴ See Banzhaf and Smith (this issue) and Chan and Kotchen (this issue).

²⁵ This formula is for wildlife restoration and it is different for hunter education.

²⁶ An equal share would be $1/50^{\text{th}}$ or 2%.

²⁷ Later amendments to PR and DJ added US territories to the system.

²⁸ The state might also be able to increase license sales by aggressively marketing hunting or by improving habitat and access.

²⁹ An alternative approach might have given states a fixed share of federal tax revenues which would not have created an incentive to lower license prices.

³⁰ Also, as the WSFR programs changed and added handguns and boat fuel to the taxable items the connection to agency choice became further removed.

³¹ According to Connery (1935): “The conservationists, in attempting to divorce the department from politics, at an early date urged that a separate fund be established in the state treasury made up of license fees and that this fund be appropriated for the sole use of the conservation department. It was argued that sportsmen paid these fees and therefore they should be used solely for the benefit of sportsmen in increasing the stock of wild game and fish.”

³² According to Connery (1935): “At the opposite side of the picture come some sixteen states which expect the receipts from hunting and fishing licenses not only to pay for the upkeep of the

department but to yield a revenue to be used for other purposes more or less closely related to wild-life conservation.

³³ Connery's study was conducted in the early 1930s and did not provide time series data on revenue diversion or revenue protection laws.

³⁴ As noted above, Revenue Diversion = 1 if the state's statute explicitly allowed revenue to be diverted whereas Revenue Protection = 1 if the state's statute explicitly prohibited revenue diversion.

³⁵ The agency posts hunting license data spanning 1958 to 2018 on its website at <https://wsfrprograms.fws.gov/Subpages/LicenseInfo/Hunting.htm>.

³⁶ The quote is taken from www.mdwfp.com/conservation/who-pays-for-it/pittman-robertson-act.aspx, visited on October 23, 2019.

³⁷ Alaska, which is not in our sample, has always been at the maximum because of its extremely large size.

³⁸ The calculation is $e^{0.5378} - 1 = 0.63$

³⁹ In reality, states may be constrained in how quickly they respond, and the appropriate lag might be longer than one year.

⁴⁰ The estimates are similar with a two-year lag.

⁴¹ We thank an anonymous reviewer for emphasizing this possibility.

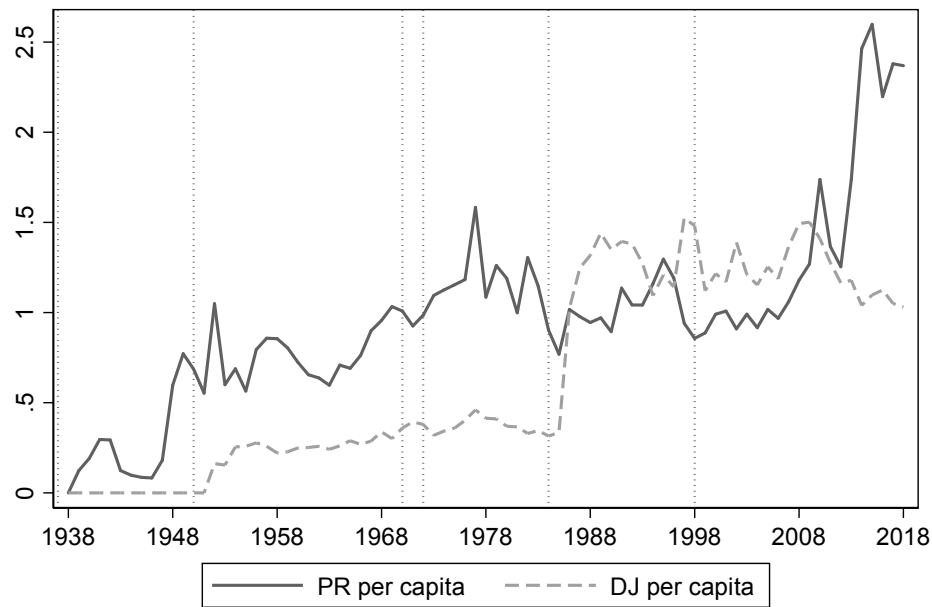


Figure 1: Per Capita Federal Appropriations to States, 1938-2018

Notes: The vertical axis shows federal appropriations through Pittman Robertson (PR) and Dingell Johnson (DJ) in 2018 dollars, divided by population. The dotted vertical lines indicate the passage dates of major amendments to the legislation as summarized in Table 2. Data come from USFWS (2020) and U.S. Census population data.

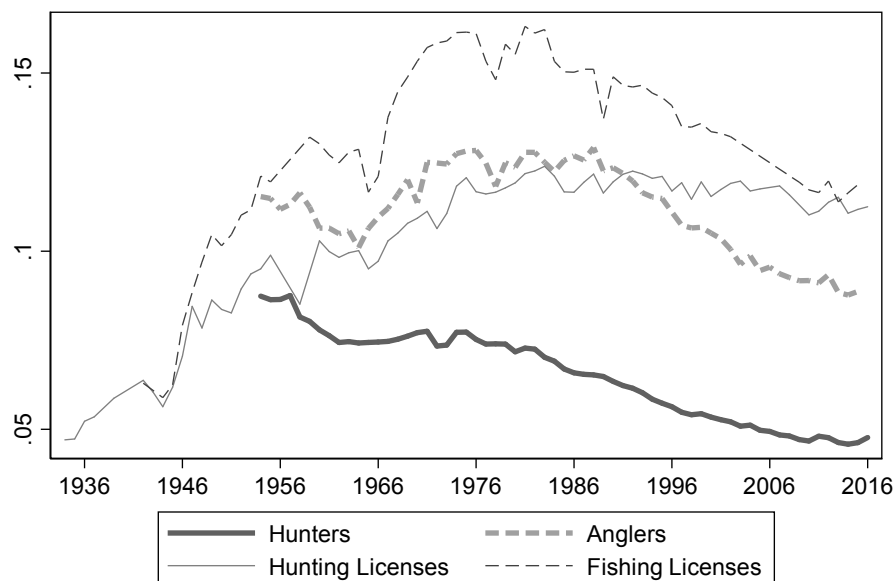


Figure 2: Proportion of the Population that are Hunters and Anglers vs. Proportion with Hunting and Fishing Licenses, 1934-2016

Notes: The vertical axis shows the proportion of the population that purchased licenses. The thick lines show the number of individual hunters and anglers, and the thin lines show the number of licenses sold (e.g., licenses, stamps, etc.). Prior to 1952 we do not know the number of individual hunters and anglers. Data for licenses for 1952-2016 come from the U.S. Department of Interior (2020). License data from 1934-1951 come from files shared with us from the USFWS via personal communication. The population data come from the US Census Bureau.

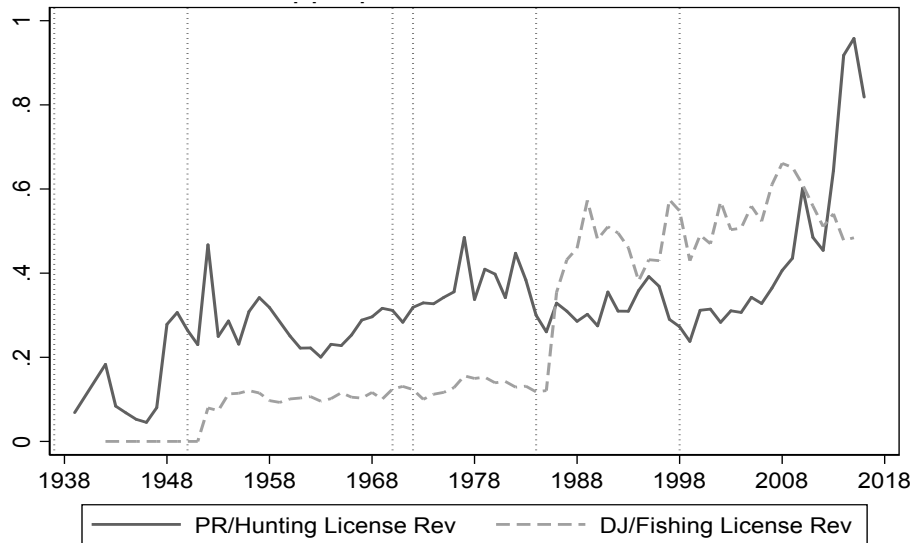


Figure 3: Ratio of Federal Appropriations to License Revenue, 1938-2016

Notes: The vertical axis shows the amount of revenue from federal appropriations divided by the revenue from hunting and fishing license sales. The dotted vertical lines indicate the passage dates of major amendments to the legislation as summarized in Table 2. The solid line shows the ratio of PR payments to hunting license sales and dashed line shows the ratio of DJ payments to fishing license sales. Data for 1952-2016 come from the U.S. Department of Interior (2020). Data for 1934-1951 come from files shared with us from the USFWS via personal communication.