Modeling Membership in the National Rifle Association

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This paper empirically tests several hypotheses offered by political scientists and economists to explain membership in political interest groups by examining the aggregate membership of the National Rifle Association (NRA) from 1921 to 1984. Intervention and transfer function ARIMA analysis is used to model membership on the basis of (1) qualitative changes in the level of material selective benefits offered prospective members, and (2) fluctuations in the number of people being discharged from the military. The NRA has an extensive history of institutional sponsorship. NRA membership increased dramatically with the onset of new selective material benefits in 1979 but did not decline when a reduction in selective material benefits occurred in 1968. Demobilization at the end of World War II had a significant impact on NRA membership and a positive relationship exists between NRA membership and the level of annual discharges from the military.

The National Rifle Association (NRA) is one of the best known single-issue, noneconomic political interest groups in the United States. In the mid-1980s it had close to 3 million members, over 350 staff members, 54 state-level affiliates, over 12,000 local groups, a budget of almost $54 million, a political arm -- the Institute for Legislative Action -- with a budget of $6.5 million, and one of the nation's most generous political action committees. The NRA has been active for many years in the political arena to prevent perceived restrictions on the "right of the people to keep and bear arms."

This research models the equilibrium level of membership in the NRA over time. It sheds new light on several theoretical controversies regarding factors affecting membership in political interest groups. By modeling aggregate annual membership from the 1920s to the 1980s, the effects associated with changes in the level of material selective benefits offered prospective members are identified for a noneconomic political interest group. The paper also investigates the relationship between the "military experience" and annual changes in NRA membership.

Explanations of Group Membership

Building on Bentley (1908), Truman (1951/1971) developed a pluralist explanation of political interest groups that became conventional wisdom for the next twenty years. The concept of interaction among individuals is crucial to Truman's view because it is the "shared attitudes growing out of interaction which constitutes the group" (Salisbury 1975, 189-190). On this basis, it is possible for Truman to utilize the concept of "potential" interest group, by which he means a group whose members share common attitudes that are not yet expressed in their

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interactions and, accordingly, are not yet acted upon in the form of demands upon society (Truman 1971, 34-35). The transformation from "potential" to "actual" can occur when disturbances or "events . . . produce an increased rate of interaction among the affected individuals" (1971, 36-37).[1]

Olson (1965/1971) caused a complete reexamination of the membership decision on the part of individuals and of how organizations interact with their "potential" membership. Using a rational actor paradigm, Olson provides a logical rationale for self-interested individuals not to contribute to collective efforts to provide public goods (as long as others do, one can receive the benefits without absorbing the costs). "Latent groups" can form only if they have the capacity to coerce potential members into participation or if they offer "selective" benefits (1971, 134). For Olson, individuals do not join a group because they favor the group's collective good activities, but because of more personally salient incentives offered by the group that are available only upon joining.

Salisbury (1969) has argued that we can better understand the dynamics of political interest group membership by conceptualizing the relationship between organizers and prospective members as an exchange relationship where organizers offer a variety of benefits in exchange for membership dues. Salisbury's (1969, 16) perspective, which is broader than Olson's and which is derived from Clark and Wilson (1961), suggests a role for three types of benefits: material (economic benefits), solidary (a sense of belonging to a group), and purposive (projecting values).

In a series of publications, Moe (1980a, 1980b, and 1981) has made a significant contribution in both theoretical and empirical terms to understanding the dynamics of group membership. Building on the criticism of Olson by others, he argues the need to consider noneconomic incentives and to allow for imperfect information on the part of individuals in explaining micro-level decisions to join or not join interest groups. Relaxing the assumption of perfect information allows individuals to think that their behavior "can make a difference," i.e., believe that they are efficacious (Moe 1981, 536, and 1980a, 5-6), and for organizational entrepreneurs to manipulate the potential member's perception of marginal costs and benefits flowing from the membership question so that joining is more likely (Moe 1980a, 31-33). Relaxing the assumption of economic self-interest makes it possible for other benefits, i.e., solidary and purposive benefits to motivate individuals to join.

Moe, in effect, develops a middle case between the pluralists and Olson (Moe 1980a, 34). If individuals are of the opinion that their efforts don't matter and if they are motivated by economic considerations, then Olson's analysis fits. This model would seem appropriate for economic groups where individuals are almost by definition motivated by selective economic benefits, and less appropriate for noneconomic groups where other selective benefits can be given greater weight. If, on the other hand, individuals are efficacious and motivated by noneconomic

considerations, then the pluralist description is appropriate (Moe 1981, 537). Relaxing Olson's assumptions leads to analytical situations in which individuals join groups for political and social reasons.

Walker (1983) adds another factor that needs to be taken into account when attempting to explain the existence and development over time of political interest groups. The question is: how do political interest groups get started? If one assumes that there are "start up" costs associated with forming political interest groups, then this becomes an important question to answer. Walker provides an insight into how some groups got started: "the intervention of sympathetic patrons who provide fresh resources and critical assistance for entrepreneurial leaders at critical times" (1983, 27).

Historical Background of the National Rifle Association

The NRA was founded in 1871 by former Army officials who were disappointed with the marksmanship of Northern soldiers during the Civil War. Despite a lackluster early history as a state organization in New York, in 1900 it became a national organization.

In 1903, legislation created the National Board for the Promotion of Rifle Practice (NBPRP), which quickly urged the War Department to organize and support rifle clubs composed of civilians. Trefethen and Serven (1967, 128) understood the importance of creating the NBPRP: "The immediate effect . . . was to approve and lend the support of the federal government to the principles and program of the NRA." Legislation in 1905 authorized the War Department to sell "at cost weapons, ammunition and other military equipment to rifle clubs" formed under the NBPRP, which in turn required that the clubs be sponsored by the NRA (Trefethen & Serven 1967, 130). In 1910, the War Department was authorized to issue free rifles and arms to organized rifle clubs through the NBPRP, which again required NRA affiliation.

As part of the preparedness program for World War I, the Army established and operated rifle ranges, and provided arms and ammunition to NBPRP clubs. After the war, in 1924, legislation named NRA members exclusively to be eligible to purchase arms at cost from the government. The sale of arms at cost and a subsidized shooting program were powerful inducements for individuals to join the NRA (Kennett & Anderson 1975, 205-206; Bakal 1969, 293). The importance of low-cost firearms to members long has been understood by the NRA's leaders, such as C.B. Lister: "It is hardly good sportsmanship to take advantage of a privilege which may be extended by an organization (inexpensive weapons and ammunition), then to quit the organization when the privilege is temporarily withdrawn, and then to go back to the organization when, through the efforts of *other people* the privilege has again been granted" (*American Rifleman* [*AR*] Aug.

1926, 8).

It is estimated that the government sold approximately 200,000 firearms at cost to NRA members in the period between the two World Wars. Many times that number were sold in the post-World War II period.[2] Documentation on the number of weapons sold to NRA members is available after 1958 from the Director of Civilian Marksmanship (DCM).[3] From 1958 to 1984 the DCM sold 702,641 firearms. However, sales were curtailed severely after 1967. In 1968, as part of a cost-saving program, the Defense Department canceled the National Rifle Matches jointly sponsored with the NRA, slashed the NBPRP's budget by 90 percent, and terminated completely the sale of surplus firearms (Kukla 1973, 99-100; *AR* Nov. 1983, 12-14). Subsidized ammunition sales to NBPRP-recognized senior clubs were eliminated, and sales to junior clubs were restricted substantially (Sherrill 1973, 224). Subsequently, DCM sales of surplus firearms were restored at nominal levels; since 1968, a few hundred rifles have been sold annually to buyers chosen by lottery.

In 1979, the constitutionality of the 1924 Act that established membership in the NRA as a requirement for purchasing surplus weapons was challenged (*Gavett v. Alexander*, 497 F. Supp. 1035). The Court ruled that membership in the NRA was not "the means least restrictive" (of the First Amendment) through which the government could develop trained marksmen. Technically, government surplus firearms no longer can be considered selective benefits available only to NRA members. However, there is ample evidence that the public did not notice the change in government policy. For example, in 1978 and 1979, civilian requests to purchase weapons averaged more than 90,000 annually (*AR* May 1980, 14-19). In 1984, the DCM claimed he was "overtaxed with record requests" for rifle sales (*AR* Jan. 1984, 12).

The NRA long has been active in politics. The following chronology indicates when the NRA first engaged in various kinds of activity: organized grass roots lobbying of Congress (1927); reported roll call votes of Congressmen to membership (1928); raised funds to oppose state referenda on gun control and established a legislative division (1934); issued bulletins to membership on state (1939) and federal (1949) legislation and court cases (1958); registered as a lobby organization (1974); contributed PAC funds (1976); rated Members of Congress (1978); funded a national advertising campaign (1982); and rated candidates for state legislative races (1988).

The NRA was slow to develop programs and services to provide selective material benefits to its membership. Early efforts at providing material benefits were half-hearted, ineffectual and soon abandoned. However, since 1979 the NRA has offered an impressive array of selective material benefits to induce and retain members. Introduced within a single year, the NRA now offers members: (1) free firearms insurance, (2) free personal liability insurance against lawsuits resulting from accidents with firearms, (3) free accidental death and dismemberment protection, (4) low cost life insurance, (5) low cost cancer insurance, and (6) low

cost group health insurance. Furthermore, the NRA offers extremely attractive insurance programs to shooting and hunting clubs composed of at least 50 percent NRA members.[4]

The NRA has been very explicit in its view of the benefits it provides members. NRA President Harlon Carter wrote: "With our program, I just can't see how any gun owner can afford to pass up NRA membership" (*AR* Dec. 1979, 48). The NRA even has argued that individuals who don't support its political program or its hunting programs should join to take advantage of the insurance programs.

Analysis of NRA Membership

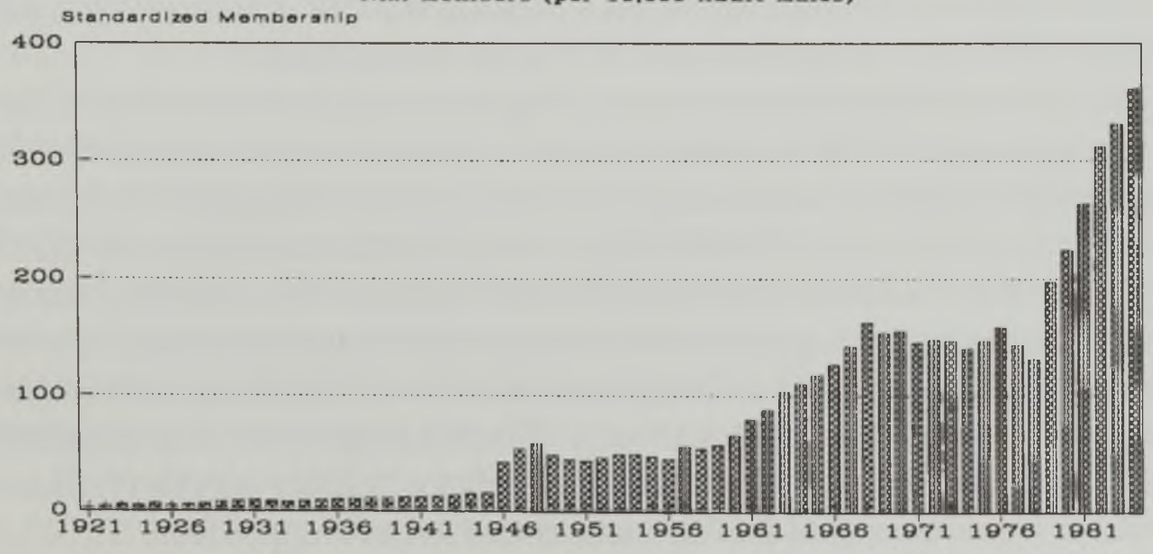
In this section, the annual membership of the National Rifle Association (NRA) from 1921 to 1984 is modeled in two slightly different, but complementary ways. For purposes of presentation, an understanding of autoregressive integrated moving average (ARIMA) models is assumed. Interested readers are directed to the technical note below.

It is hypothesized that aggregate membership will vary generally in terms of (1) selective material benefits offered potential members and (2) the level in society of one kind of "shared experience," i.e., service in the military.[5] Data on the annual membership of the NRA was collected from a search of NRA publications and historical works on the organization. The most important source was the *American Rifleman's* annual report on the NRA's national convention.[6]

The dependent variable is NRA membership standardized over time. This is accomplished by expressing NRA membership not as a simple "head count" but instead as members per 10,000 adult resident males in the country, thereby adjusting for population growth over time and for years when many Americans were overseas.[7]

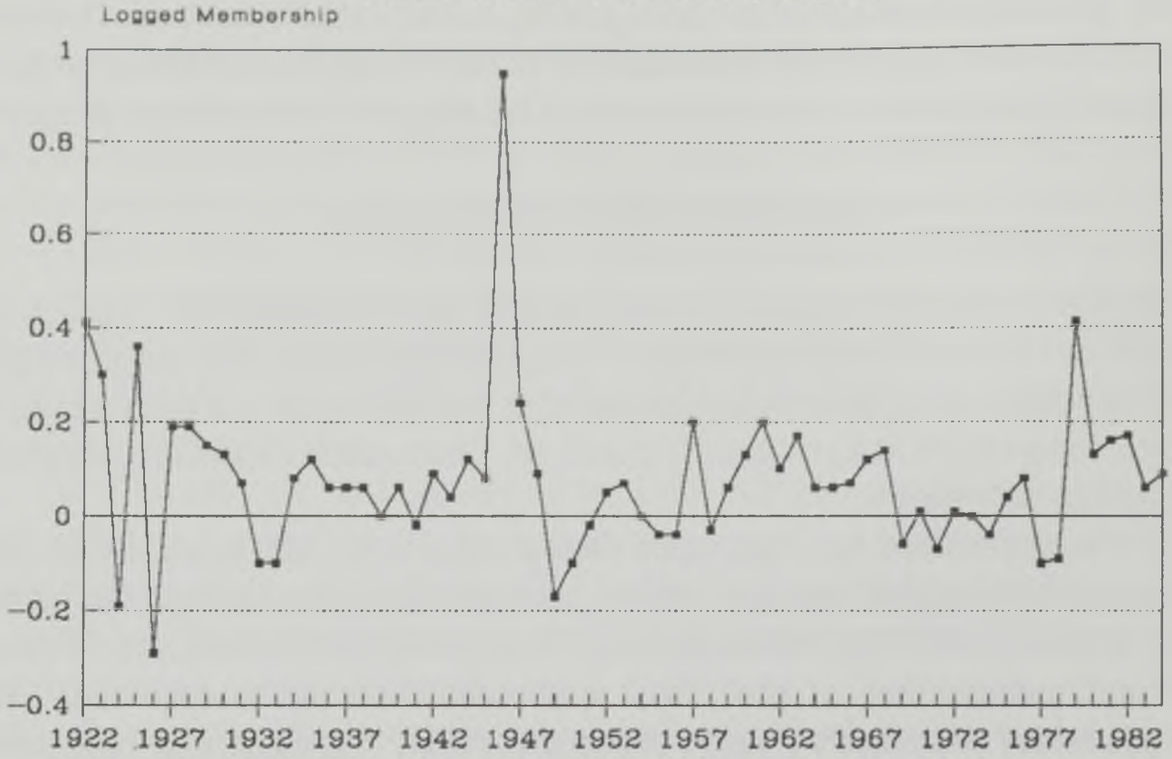
The dependent variable of interest, members per 10,000 adult resident males (MEMB), is shown in Figure 1. MEMB is not stationary in level or variance (requirements of the ARIMA model), so the natural log was taken and the trans-

Figure 1.
NRA Members (per 10,000 Adult Males)



formed variable was first differenced. The plot of this series appears in Figure 2. Inspection of the plot reveals a very large value at 1946 which demands inclusion in the model if other variables are to be tested.[8]

Figure 2.
First Difference of Membership (Logged)



Generally, the time series model under consideration is:

$$(1\text{-}B)LNMEMB_t = f(WAR_t) + f(DCMCUT_t) + f(INSUR_t) + N_t$$

where LNMEMB = the natural log of NRA members per 10,000 adult male residents; f = the form of the intervention function; WAR = the demobilization of U.S. military personnel at the end of World War II (0 before 1946; 1 thereafter); DCMCUT = the reduction or elimination of firearm sales and ammunition subsidy (0 = before 1968; 1 = thereafter); INSUR = expansion of NRA insurance programs (0 = before 1979; 1 = thereafter); and N_t = noise component.[9]

The value at 1946 is the most outstanding feature of the time series. It clearly must be accounted for if a model of membership is to be estimated. It is hypothesized that the value is associated with the demobilization of American armed forces at the end of World War II and that the experience of war had familiarized large numbers of Americans with firearms and convinced many of them of the need for an organization which promoted marksmanship. (A more general test of this hypothesis will be presented below.) This interpretation would square with Truman's disturbance theory. There is support for such an interpretation. Because of the demobilization of American military personnel after the surrender of Japan, the size of the American armed forces dropped from 12,123,455

to 3,031,978 in 1946, a single year reduction of more than nine million men. Kennett and Anderson (1975, 217-218) discuss the effect of demobilization on NRA membership; and the NRA itself noted the opportunity for organizational growth that "the returning G.I." represented (*AR* Aug. 1945, 10-13).

The other outstanding feature of the plots is the dramatic increase in membership beginning in 1979. This increase in membership coincides with the dramatic increase in selective material benefits the NRA offered potential members. Theoretically, the *Gavett v. Alexander* (1979) decision removed one important source of selective material benefits that might mute the estimate of INSUR. However, it is known with considerable confidence, based on subsequent levels of individual requests received by the DCM, that the public remained uninformed and/or confused about the consequences of this case.

Ideally, it would be desirable to have a measure of political benefits supplied by the NRA over time. In terms of the analysis that follows, political activity and its associated benefits is viewed as an unspecified but present background characteristic. Inspection of the time series plots in terms of known dates when political services came on-line and the adequacy of residuals generated by the models tested below can serve as a check against the possibility of specification error. *Visually inspecting the plots fails to reveal any significant changes in the level of membership that coincide with the known dates when political services were expanded.*

Hypotheses regarding the parameters associated with the variables can be made on the basis of theory. First, an expansion of selective material benefits, such as the NRA's insurance programs (INSUR), should boost membership. This is the core relationship in Olson's theory and Moe's synthesis sees selective benefits as "all gravy" that should have the effect of making membership more attractive, thereby boosting organizational membership. Second, a reduction in selective material benefits, such as the DCMCUT, is more problematic. Olson seems to suggest a symmetry of effect -- that is, a reduction in selective material benefits should cause a reduction in membership. Of course, symmetry should not be assumed. Moe's theoretical work attempts to differentiate between economic and noneconomic groups and predicts that selective material benefits will not be crucial for membership in noneconomic groups; selective material benefits can never hurt, but they are not essential for such groups because the members are motivated by other considerations. If we consider the NRA to be a noneconomic group, then Moe's theory would postulate no impact on membership from a reduction in selective material benefits (DCMCUT). Third, it would be vintage Truman to suggest that World War II (WAR) increased the interest of people in marksmanship and firearms, as well as their training with and familiarity with firearms, and that this "disturbance" contributed to increased membership in an interest group that promotes and values the use of firearms.

From the first differenced plot of logged membership in Figure 2 it is

apparent that the intervention at 1946 has an abrupt, but temporary impact on the time series. This can only be modeled as a pulse function, i.e., applying a first-order transfer function to a differenced step function. Interestingly, DCMCUT fails to achieve statistical significance in any model in which WAR takes this specification, and therefore must be interpreted as not having an effect on the series.

The model being discussed was estimated using the conditional likelihood method of SCA (see Table 1). Model I has the form:

$$(1\text{-}B)LNMEMB_t = \theta_0 + ((\Omega)/1\text{-}\delta B)(1\text{-}B)WAR_t + ((\Omega)/1\text{-}\delta B)(1\text{-}B)INSUR_t = + a_t$$

The model passes diagnostic checks of the residuals.

Table 1. ARIMA Models of Annual Changes in NRA Membership, 1921-1984

Independent Variable	Dependent Variable: (1-B)LNMEMB[a] Model I[b]	Model II[c]
(1-B) WAR		
Ω	.90	---
	(7.64)[d]	
δ	.18	---
	(1.42)	
(1-B) INSUR		
Ω	.33	.34
	(2.88)	(2.60)
δ	.49	.62
	(2.00)	(2.91)
NETVET		
Ω	---	.000045
		(4.31)
CONSTANT (θ_0)	.05	.04
	(3.27)	(2.20)
NOISE COMPONENT	a_t	a_t
RSS[e]	.01	1.21
R^2	.99	.99
OBSERVATIONS	63	62
LBQ(12)[f]	11.1	10.7

[a]First difference of the natural log of NRA members per 10,000 adult male residents

[b]$(1\text{-}B)\ LNMEMB_t = \theta_0 + ((\Omega)/1\text{-}\delta B)\ (1\text{-}B)\ WAR_t + ((\Omega)/1\text{-}\delta B)\ (1\text{-}B)\ INSUR_t + a_t$

[c]$(1\text{-}B)\ LNMEMB_t = \theta_0 + (\Omega)\ (1\text{-}B)\ NETVET_t + ((\Omega)/1\text{-}\delta B)\ (1\text{-}B)\ INSUR_t + a_t$

[d]Figures in parentheses are t-statistics

[e]Residual Sum of Squares

[f]Ljung-Box Q-statistic for 12 lags

Interpretation of the model reveals a 199.7 percent change of impact for WAR (i.e., the post-intervention equilibrium level is 199.7 percent greater than the pre-intervention equilibrium level), and a 91.0 percent change of impact for INSUR.[10] The impact of WAR is greater than INSUR, but it also is more short-lived. It is important to keep in mind, when evaluating the numerical impact on membership, that the equilibrium level of the series in 1979 was many times what it was in 1946.

The identification of an impact for WAR raises the interesting question of whether there is a relationship between the number of people "experiencing" the military and the size of NRA membership. If a time series documenting the number of military personnel discharged annually was available, then the hypothesis of a positive relationship between the discharge variable and annual changes in NRA membership could be tested. Unfortunately, the Department of Defense has only published the discharge data for the post-1965 time period. Therefore, to test this hypothesis a surrogate variable is utilized.

The surrogate variable, NETVET, is calculated to represent annual changes (measured in thousands) in the rolls of the Veterans Administration. The logic here is that annual increases in NETVET will be highly correlated with annual discharges from the military. Indeed, we refer to civilians as veterans after they leave the military. Year-to-year fluctuations in the number of veterans are reflective of the number of new veterans, i.e., discharges, enrolled each year minus the number of veterans who die each year. The surrogate, NETVET, is highly correlated with the number of annual discharges from 1965 to 1985 ($r = .65$; $p = .00$) and with the number of persons in the active military for the same time period ($r = .59$; $p = .00$). The time series conforms well to historical expectations in that NETVET growth coincides with periods of increased military manpower, i.e., World War II, Korean War, and the Viet Nam Conflict.

Parameter estimates using the conditional likelihood method of SCA were estimated for a second model (see Table 1). Model II's form is:

$$(1\text{-}B)LNMEMB_t = \theta_0 + (\Omega)(1\text{-}B)NETVET_t + ((\Omega)/1\text{-}\delta B)(1\text{-}B)INSUR_t + a_t$$

Parameters associated with DCMCUT were insignificant in all models estimated and the variable was dropped from the final model. INSUR, again, makes an independent contribution to the model and has parameter estimates that are similar to those identified in the intervention model. Such consistency is a positive sign that the variable is capturing a real world phenomenon. NETVET is statistically significant as a zero-order transfer function. The model produces white noise residuals.

The two models, however, do have slightly different interpretations: Model I suggests that the massive demobilization of the military in 1946 dramatically affected NRA membership, while Model II suggests a more general relationship between the number of people getting out of the military each year and annual

changes in NRA membership. The models are not contradictory and both can contribute to an understanding of the membership question. There clearly was an increase in membership in 1946 and the second model provides supporting proof that the jump can be explained in terms of the number of people experiencing the military. Interpretation of the NETVET parameter is a bit complex. The numbers are clear enough: a one unit change in NETVET (1,000 more veterans) causes a .000045 unit change in (1-B)LNMEMB. Two points need to be kept in mind: (1) the range of the membership series for the sixty-four years under study as plotted in Figure 2 is less than 1.3, and (2) the actual impact in terms of annual changes in membership varies with the level of membership and the magnitude of NETVET. For example, NRA membership today is approximately 360 members per 10,000 adult male residents. If NETVET were to match its historical average (390,000), then NRA membership would increase by 6.39 persons per 10,000 adult males in the U.S.; if NETVET were one million (slightly above NETVET levels at the end of the Korean Conflict), then membership would grow by 16.57 per 10,000 adult males; and if NETVET reached 1946 levels (approximately ten million), then membership would increase by 204.59.

The impact of INSUR in Model II is associated with an asymptotic level change of 44.7 percent. Interestingly, the change in level is only about half of that identified for INSUR in Model I. This change in the parameter estimate is understandable since NETVET is now explaining a portion of the variance. The onset of selective material benefits in the form of insurance services still has a very significant effect on NRA membership.

Discussion

The historical record and statistical evidence allow some conclusions to be reached regarding the membership growth of the NRA. First, the NRA seems to be a classical case of institutional patronage in terms of early and sustained government subsidies and laws that promoted the organization. Although generally not recognized, the NRA is an example *par excellence* of this phenomenon. Second, there is support for Truman's disturbance theory. Governmental responses to World War I boosted NRA membership by means of legislation which promoted marksmanship and supplied the NRA with selective material benefits it could pass on to members. Furthermore, there was a dramatic jump in NRA membership at the conclusion of World War II. The finding of a positive relationship between NETVET and NRA membership levels is additional support for the hypothesis that "shared attitudes growing out of interaction" or common experiences influence membership levels. Third, the data do not corroborate the hypothesis that a reduction in selective material benefits leads to a reduction in membership. The "symmetry" hypothesis did not hold for the NRA, a noneconomic political interest group. This seems contrary to Olson's theory and consistent with

Moe's argument that there is a fundamental difference between economic and noneconomic political interest groups in this regard.[11] Fourth, the increase in selective material benefits offered by the NRA in 1979 in the form of insurance services did coincide with an increase in membership, a finding consistent with theorists who see a role for selective material benefits in motivating membership and organizational growth. In a slight twist of Berry (1978), who investigated whether public interest groups formed as a result of disturbances or entrepreneurial activity, the NRA seems to have benefitted substantially from both. Fifth, it would appear to be a mistake to attribute the sudden increase in membership in 1979 to the political activities of the NRA since those activities were present in one form or another many years prior. It is very clear that some *new and unique stimulus occurred in 1979*; the provision of new selective material benefits to members as the explanation is strongly supported by the evidence. More importantly, there was no contemporaneous political development which might serve as a rival hypothesis. For recent years, it is likely that the NRA's "higher profile" resulting from increased national advertising and the rise of an organized opposition (Animal Rights Movement and handgun control organizations) are factors determining membership levels.

In conclusion, by testing various theories, this work highlights the dynamic nature of group membership at the aggregate level and, by inference, at the individual level. Changes in group membership cannot be understood adequately without taking into account the group involved, the time periods involved, and the motivations of the individuals involved (Moe 1980a; Rothenberg 1988; and Brown 1989). We should not expect simple single-dimensional theories of group membership to be applicable to all groups at all times. The analysis presented demonstrates that a synthesis of the previous theories is necessary to explain membership changes at different points in time. Only a theory that specifies with considerable detail the conditions listed above will be able to capture the dynamic nature of interest group membership.

TECHNICAL NOTE

This section provides a condensed description of nonseasonal autoregressive integrated moving average (ARIMA) models. It heavily utilizes McCleary and Hay (1980); clearly, however, it is not a substitute for reading an introductory text on the subject.

"A time series is a set of N time-ordered observations of a process" (McCleary and Hay 1980, 21). The key feature is that observations have a specific order unlike the set of cases in cross-sectional analysis. ARIMA models are built on the assumption that each realization of a time series has an underlying process that generated the observed data.

It long has been known that estimates generated by the classical linear regression model are unreliable in the presence of autocorrelated disturbances, a feature endemic to longitudinal analysis (Hibbs 1977). Ordinary least squares (OLS) regression in the presence of autocorrelation will yield inefficient estimates of coefficients and biased standard errors that result in inflated t-statistics and R-squares (Pindyck and Rubinfeld

1981, 153). Additionally, OLS parameter estimates are uninterpretable in the presence of trend or seasonality (McCain and McCleary 1979, 232-235), are sensitive to outliers and are heavily influenced by beginning and end observations (McCleary and Hay 1980, 33-34). Furthermore, regression methods are not dynamic, "they do not indicate over what time span the effects of X on Y occur and how that effect is distributed" (Norpoth 1986, 242). ARIMA modeling provides an extremely powerful and flexible means of identifying these problems, correcting them, and then estimating efficient parameters.

Univariate modeling has been the most utilized ARIMA technique; it models a variable "as some function of its own past values (autoregressive), a mean or a trend (integrated), and serially correlated error (moving average)" (Moe 1982, 205). Univariate modeling is the building block by which more complicated ARIMA models are constructed. Interventions can be introduced into the analysis as "dummy" independent variables. Transfer function modeling depends on the correct univariate identification of the variables as a preliminary step before estimating the temporal relationship between time series variables while controlling for their internal dynamics (McCleary and Hay 1980, 250-251).

ARIMA models are built through an iterative process of identification, estimation and diagnostic checking (McCleary and Hay 1980, 91-103). The process should be directed by theory. The identification stage requires a time series that is stationary in variance (i.e., process variance is constant throughout the length of the time series), stationary in level (i.e., in statistical equilibrium around a constant mean), and close attention to patterns of autocorrelation and partial autocorrelation. The estimation stage requires that the parameter estimates be statistically significant and within the mathematical bounds of stationarity and invertibility. Ultimately, the model must generate white noise residuals. Parsimony is a highly valued criterion in the ARIMA model building process. Several models are built and estimated, including "meta-diagnostic" modeling; the most adequate is reported.

Univariate Models. To be modeled, a time series needs to be stationary in variance and level. Frequently, a time series needs to be transformed (for example, natural logarithm) to be stationary in variance. Differencing, subtracting Y_t from Y_{t-1}, is often required to make a time series stationary in level. Differencing can be represented by the backshift operator, such that $(1-B)Y_t = Y_t - Y_{t-1}$. A time series that requires differencing to be modeled is "integrated." The discussion below assumes a time series that is stationary in both senses.

Autoregressive parameters are interpreted as remnants or carry overs from previous observations which contribute to subsequent observations; they are represented as:

$$Y_t - \theta_0 = \emptyset_1 Y_{t-1} + \emptyset_2 Y_{t-2} + \ldots + \emptyset_p Y_{t-p} + a_t$$

where Y_t = the values of an undeviated (the mean of the series has not been subtracted out) time series; θ_0 = mean or level of the series; $\emptyset_p$ = autoregressive parameters; p = time lag counter; and a_t = random error. Moving average parameters are interpreted as random shocks to the system which persist for a finite number of periods; they are represented as:

$$Y_t - \theta_0 = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q}$$

where θ_q = moving average parameters; q = time lag counter; and all other terms remain as previously defined.

ARIMA models can be identified by three structural parameters (p,d,q): p for autoregressive order, d for the difference order, and q for the moving average order. Accordingly, a mixed ARMA model, already integrated, contains both autoregressive and

moving average parameters. Such a model is represented as:

$$Y_t - \theta_0 = \emptyset_1 Y_{t-1} + \emptyset_2 Y_{t-2} + \ldots + \emptyset_p Y_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q}$$

Identification of the structural parameters (p,d,q) is done by means of examining the autocorrelation and partial autocorrelation functions of the time series (McCleary and Hay 1980, 66-79). For parameters to be included in a model they must be statistically different than zero as determined by t-statistics during the estimation process and they must satisfy stationarity-invertibility conditions (McCleary and Hay 1980, 97-98).

Intervention Models. These models allow for the modeling of variables, usually events, that are difficult to quantify (Campbell 1963; Campbell & Stanley 1966). These "interventions" are introduced into the analysis as dummy variables which take on binary (0 or 1) values after the univariate identification of the time series has taken place and may be modeled as a step (abrupt, permanent) function, a pulse function (abrupt, temporary), a gradual, permanent asymptotic change, or a gradual, temporary change (McCleary and Hay 1980, 168-172; Norpoth 1987). Because they describe a dynamic response they also are referred to as transfer function models. Individually, in the order mentioned, the four functions can be represented as:

$$Y_t - \theta_0 = \Omega_0 I_t + N_t$$
$$Y_t - \theta_0 = (\Omega_0/(1-B))(1-\delta B) I_t + N_t$$
$$Y_t - \theta_0 = (\Omega_0/(1-\delta B)) I_t + N_t$$
$$Y_t - \theta_0 = ((\Omega_0 + \Omega_1 B + \Omega_2 B^2)/(1-\delta B))(1-B) I_t + N_t$$

where I_t = a binary intervention time series coded to reflect the onset of a condition; Ω_0 = an impact parameter, i.e., the effect of X on Y; δ = a rate parameter; N_t = the noise term which includes the univariate ARMA modeling components; and other terms remain as defined earlier.

Transfer Function Models. If the dependent variable (Y_t) is to be accounted for by one or more interval-level independent variables (X_ts), then a multivariate transfer function ARIMA model is appropriate. Because of the great flexibility allowed by this model in describing when an effect occurs and for how long, it is difficult to express succinctly a model in equation form as was done above. It is best to proceed by illustration. For example, various effects take the following forms: a contemporaneous effect ($Y_t = \Omega_0 X_t$); a two time-period delayed effect ($Y_t = \Omega_0 X_{t-2}$); a two time-period delayed effect of two time-periods in duration ($Y_t = \Omega_0 X_{t-2} + \Omega_1 X_{t-3}$); and an abrupt, temporary effect delayed two time-periods ($Y_t = ((1-\delta B)\, \Omega_0 X_{t-2})$). Although the illustrations are bivariate, the methodology allows for multiple independent variables each with their own functional form.

The lag structure between the stationary independent variable and each stationary dependent variable is identified by the cross correlation function (CCF). (The CCF is analogous to a correlation between Y and X for any number of specified time lags.) The correlation of two non-stationary time series clearly will be spurious. Likewise, the CCF of two autocorrelated time series will provide a misleading picture of the true relationship. Accordingly, ARIMA modeling requires the "prewhitening" of the variables (McCleary and Hay 1980, 243-257). This approach requires prewhitening by the presumed cause, i.e., the univariate stochastic model of the input series is used as a filter to convert it to a random series, and the same filter applied to the output series will convert it to a new series that is not normally random. "This transformation not only wrings out nonstationarity, but also removes autoregressive and moving-average components to the extent that they are present" (Norpoth 1986, 253). The CCF of the prewhitened input series and the filtered

output series at various lags identifies the temporal relationship between the two variables. The process is repeated for each non-binary independent variable in the model. After prewhitening, the full model is estimated (including the identification of ARMA components for the noise term) and diagnostic checks of residuals produced are conducted.

ARIMA modeling has profound implication for establishing the criteria by which the causality between time series variables can be inferred. The great utility of ARIMA models is that they allow for and control for the independent behavior of variables (trends, drifts, and stochastic behavior) before testing for and identifying the dynamic effect of an independent variable on the dependent variable. Controlling for the endogenous behavior of variables makes it harder to "find" relationships, but more confidence can be placed in those that are found.

NOTES

[1]The catalogue of macro-level forces that can give rise to political interest groups is theoretically unlimited. Discussions of the kinds of events that qualify as disturbances can be found in Truman (1971, 53-65), Salisbury (1975, 190), and Berry (1984, 68-69).

[2]The relationship between the government and the NRA in this regard was "hand in glove." In 1927 the DCM requested that individuals purchasing arms enclose their NRA membership card with their orders (*AR* Jan. 1927, 34). The lure of DCM/NRA rifle sales was strong. An announced sale in 1948 flooded the DCM with orders, including a record 21,000 requests in one day (*AR* Oct. 1947, 41; *AR* Nov. 1948, 14). A similar announcement in 1957 resulted in such a tremendous response that staff shortages forced the DCM to have the NRA process the requests (*AR* Jan. 1957, 18).

[3]The following quantities of weapons were sold to NRA members under the DCM Sales Program from 1958 to 1984: 1958 (932); 1959 (6,080); 1960 (106,936); 1961 (121,158); 1962 (122,585); 1963 (146,938); 1964 (55,361); 1965 (51,538); 1966 (39,345); 1967 (26,061); 1968 (0); 1969 (300); 1970 (300); 1971 (300); 1972 (300); 1973 (300); 1974 (300); 1975 (0); 1976 (600); 1977 (0); 1978 (1,200); 1979 (600); 1980 (600); 1981 (2,600); 1982 (2,600); 1983 (3,745) and 1984 (11,962).

[4]This potentially creates a kind of "mini-free rider" dilemma for the membership since only a portion have to absorb the cost of providing the service to all. Insurance as a selective material benefit is interesting in that it is a recurring, year-to-year need. Insurance is not a one-time benefit, but provides a permanent incentive for membership and, as a result, provides some stability for the organization offering it.

[5]Questions of individual motivation in joining and remaining in interest groups can only be answered conclusively with individual-level data. Such research (Cook 1984; Rothenberg 1988) is rare because of the difficulty in collecting such data. The aggregate-level analysis reported in this manuscript follows the tradition of Tontz (1964), Hansen (1985), and Brown (1989); it can be used for hypothesis testing and can be suggestive of individual relationships.

[6] A complete set of the *American Rifleman* for the time period from 1923 to 1985 was examined in conjunction with other historical sources to permit double-checking. The few discrepancies that exist were resolved in favor of the *AR* reports. In light of the fact that the time series' source is the official "in-house" publication of the NRA, the data can be

deemed "official" and accurate.

[7] Women never have been a significant proportion of total NRA membership, although there has been growth recently. In 1989, NRA female members reached 100,000 for the first time (a 20 percent increase over 1988), or about 3 percent of total NRA membership.

[8] See McCleary and Hay (1980, 131) for a discussion of "outlier influence" in ARIMA modeling.

[9] The equation contains the backshift operator, B, which is used to indicate differencing such that $(1-B)Y_t = Y_t - Y_{t-1}$.

[10] The numerator "omega" is an impact term and the denominator "sigma" is a rate of change term. The "rate" parameter associated with WAR is accepted because it has the expected sign and meets a one-tail, .10 test of significance (t-critical = 1.30). The larger omega is, the greater the impact of the intervention. The closer sigma is to 0 the quicker the series reaches a new asymptotic level; the closer sigma is to 1 the slower the series reaches the new level. The asymptotic percent change in the level of the series is calculated by taking the natural antilogarithm of the transfer function ratio, subtracting that value from 1 and multiplying the new value by 100. McCleary and Hay (1980) provide an extensive and easily understood discussion of how to interpret these parameters.

[11] NRA membership did decline slightly during this time period but not by a large enough magnitude to be statistically significant even by a one-tail test. The historical situation cuts different ways. The escalation of the Viet Nam War and the flowering of the anti-war movement, the assassinations of Robert Kennedy and Martin Luther King, and the social upheaval in the cities undoubtedly affected the purposive benefits of gun ownership in different ways for different people. Other possible explanations can be offered as to why DCMCUT did not have an independent effect on the time series: (1) the expansion of benefits in 1979 came too soon on the heels of the DCM reductions for them to take effect -- indeed, the expansion of insurance benefits may have been an organizational response by the NRA to the situation it found itself in at the time; and (2) the relevant public, as suggested above, seems not to have been aware of the changes in DCM policy that eliminated, in effect, the selective material benefits that used to go along with membership in the NRA. In any event, the NRA survived these years relatively unscathed.

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