

NBER WORKING PAPER SERIES

A PANEL-BASED PROXY FOR GUN PREVALENCE IN THE US

Daniel Cerqueira  
Danilo Santa Cruz Coelho  
John J. Donohue  
Marcelo Fernandes  
Jony Arrais Pinto Jr.

Working Paper 25530  
<http://www.nber.org/papers/w25530>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
February 2019

We are grateful to Matheus Donato, Mira Korb, Haksoo Lee and Sidhart Sah for their excellent work as research assistants, and to Stanford Law School for research support. We thank Daniel Jeske for his valuable comments. Danilo Coelho is a current visiting scholar at Stanford Law School. John Donohue has served as an expert witness in litigation involving gun regulation. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2019 by Daniel Cerqueira, Danilo Santa Cruz Coelho, John J. Donohue, Marcelo Fernandes, and Jony Arrais Pinto Jr.. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

A Panel-based Proxy for Gun Prevalence in the US

Daniel Cerqueira, Danilo Santa Cruz Coelho, John J. Donohue, Marcelo Fernandes, and Jony Arrais Pinto Jr.

NBER Working Paper No. 25530

February 2019

JEL No. K14

**ABSTRACT**

There is a consensus that the proportion of suicides committed with a firearm is the best proxy for gun ownership prevalence. Cerqueira et al. (2108) exploit the socioeconomic characteristics of suicide victims in order to develop a new and more refined proxy. It is based on the fixed effects of the victim's place of residence estimated from a discrete choice model for the likelihood of committing suicide with gun. We empirically assess this new indicator using gun ownership data from the Behavioral Risk Factor Surveillance System (BRFSS) and suicide registers of the US National Center for Health Statistics (NCHS) from 1995 through 2004. We demonstrate that this new gun proxy provides significant gains in correlation with the percentage of households with firearms.

Daniel Cerqueira  
Instituto de Pesquisa Econômica Aplicada, IPEA  
Avenida Presidente Antônio Carlos, 51 17th floor  
Centro, Rio de Janeiro, RJ, 20020-010  
Brazil  
Daniel.cerqueira@ipea.gov.br

Marcelo Fernandes  
Sao Paulo School of Economics, FGV  
Rua Itapeva, 474  
São Paulo, SP 01332-000  
Brazil  
marcelo.fernandes@fgv.br

Danilo Santa Cruz Coelho  
Instituto de Pesquisa Econômica Aplicada, IPEA  
Avenida Presidente Antônio Carlos, 51, 17th floor  
Centro, Rio de Janeiro, RJ, 20020-010  
Brazil  
danilo.coelho@ipea.gov.br

Jony Arrais Pinto Jr.  
Universidade Federal Fluminense  
Rua Prof. Marcos Waldemar de Freitas  
s/n - São Domingo, Niterói, RJ, 24.210-201  
Brazil  
jarrais@id.uff.br

John J. Donohue  
Stanford Law School  
Crown Quadrangle  
559 Nathan Abbott Way  
Stanford, CA 94305  
and NBER  
donohue@law.stanford.edu

## 1. Introduction

A number of papers have concluded that the spatial variation of the ratio of suicides committed with guns to total suicides is the best indirect measure of spatial variation of the prevalence of gun ownership. For instance, Kleck (2004), Azrael et al. (2004) and Briggs and Tabarrok (2014) empirically assess an array of measures to determine which has the highest Pearson's linear correlation with survey data on the percentage of households with firearms. They show that the proportion of suicides committed with firearms is the proxy with the highest correlation.

However, this proxy has some shortcomings. First, because suicides are rare events, it is not very precise for low-population localities. Second, it ignores the detailed victim information commonly available in mortality data. To address these limitations, Cerqueira et al. (2018) exploit the socioeconomic characteristics of suicide victims in order to come up with a novel proxy for gun ownership. Specifically, they estimate a discrete choice model for the likelihood of committing suicide with a firearm controlling for the personal characteristics of the victims as well as fixed effects. They derive the conditions under which the fixed effects reflect gun prevalence in the geographic area where the suicides occur. Based on suicide data from the Brazilian Ministry of Health, Cerqueira et al. (2018) estimate this proxy for Brazilian micro regions. However, since there are no comprehensive survey data available with information on gun ownership in Brazil, they were not able to validate their proxy.

In this paper, we use US data to provide external validation by assessing how their proxy performs relative to the proportion of suicides committed with firearms. First, we estimate both indicators across states using mortality data from the US National Center for Health Statistics (NCHS). We then compare their Pearson's linear and Spearman's rank correlations with the percentage of households with at least one firearm based on survey data from the Behavioral Risk Factor Surveillance System (BRFSS) from 1995 to 1998, 2001, 2002, and 2004.

The remainder of this paper is as follows. Section 2 provides the theoretical justification for the fixed-effects proxy. Section 3 describes the data, Section 4 discusses the main results. Section 5 offers some concluding remarks.

## 2. The panel-based proxy

Denote by  $X_{ij}$  the vector of socioeconomic characteristics of the victim of suicide  $i$  in the location  $j$  (state of residence): age, sex, race, marital status and schooling level. Suppose that the individual decision of committing suicide depends on personal characteristics  $X_{ij}$  of the victim and on overall quality of life  $Q_j$  in location  $j$ . Suppose also that the prevalence of firearms in location  $j$ ,  $G_j$ , depends not only on population composition ( $X_j = \sum_i X_{ij}$ ), but also on the quality of life of location  $j$ ,  $Q_j$ , which includes aggregate exposure to violence among other social stressors. These assumptions imply that the individual decision to commit suicide depends both on  $X_{ij}$  and  $Q_j$ :

$$\Pr(S_{ij}, G_j | X_{ij}, Q_j) = \Pr(S_{ij} | X_{ij}, Q_j) \Pr(G_j | X_{ij}, Q_j), \quad (1)$$

where  $S_{ij} = 1$  if individual  $i$  in location  $j$  decides to commit suicide and zero otherwise.

Similarly,  $S_{ij}^G = 1$  if victim  $i$  in location  $j$  commits suicide using a gun, and equals zero otherwise. Suppose that quality of life affects the decision to commit suicide with a weapon only through the decisions of committing suicide and possessing a weapon:

$$\Pr(S_{ij}^G | S_{ij} = 1, X_{ij}, G_j, Q_j) = \Pr(S_{ij}^G | S_{ij} = 1, X_{ij}, G_j), \quad (2)$$

Thus, if we estimate the probability in equation (2) using suicide micro data, we can then obtain  $\widehat{G}_j$  from the location fixed effects - that is, the estimated coefficients of the location dummy variables.

To estimate equation (2), we use a logit specification:

$$\Pr(S_{ij}^G | S_{ij} = 1, X_{ij}, G_j) = \frac{\exp(X_{ij}\beta + \sum_{j=1}^J G_j D_{ij})}{1 + \exp(X_{ij}\beta + \sum_{j=1}^J G_j D_{ij})}, \quad (3)$$

where:  $D_{ij} = 1$  if victim  $i$  belongs to the location  $j$  (with  $j = 1, \dots, J$ ), and equals zero otherwise.

We estimate Equation (3) using a maximum likelihood estimator and the resulting coefficients  $\widehat{G}_j$  are the location fixed effects that will proxy firearm prevalence for each location.

In short, the new proxy are the fixed effects of the victims' place of residence estimated from a discrete model of suicide committed with a gun probability controlling by victim demographic characteristics. For instance, teenagers are less likely than adult male to use gun to commit suicide. A large proportion of teenagers using a gun to commit suicide in a specific location would indicate a wider gun availability in this location. The idea is that this anomaly should be captured by this location fixed effect. This proxy will reflect well the spatial variation of gun prevalence if the decision of using a gun to commit suicide conditional on the decision of committing suicide does not depend on any aggregate factor that varies only across location other than gun prevalence. This means that quality of life may affect the number of suicides with a gun only through the decision of taking his/her own life (and possibly through gun prevalence).

The presence of many locations with insignificant estimated fixed effects may distort the ranking of locations by prevalence of firearms. Thus, we also estimate the location fixed effects in equation (3) using a regularization technique that combines estimation with automatic parameter selection. In particular, we restrict the objective function to a sum of the absolute values of the fixed effects coefficients, as in Tibshirani's (1996) least absolute shrinkage and selection operator (LASSO). This constraint has little impact if the parameter is large enough, but may shrink some coefficient estimates to zero if they do not contribute enough to the goodness-of-fit. By forcing the coefficient estimates towards zero, Lasso selects the most relevant subset of regressors. The objective function reads:

$$l_\lambda(\beta, G) = -l(\beta, G) + \lambda \sum_{j=1}^J w_j |G_j|, \quad (4)$$

where  $l_\lambda(\beta, G)$  is the logit maximum likelihood function.

Note that equation (4) coincides with the objective function of the logit estimator for the case where  $w_j = 0$  for each  $j = 1, \dots, J$ . Standard LASSO regularization works with uniform weights ( $w_j = 1$  para  $j = 1, \dots, J$ ), while the adaptive penalty (adaLASSO) of Zou (2006) adopts  $|\widehat{G}_j|^{-\tau}$  where  $\tau > 0$  and  $\widehat{G}_j$  denotes a consistent estimate of any initial  $G_j$ . We calculate these weights with the standard logit estimator of  $\widehat{G}_j$  and fix  $\tau = 1$  in the same way as Zou (2006). As in Tibshirani (1996) and Zou (2006), we tune the choice of the shrinkage parameter by means of a cross-validation approach that minimizes the mean square error.

In sum, we estimate location fixed effects using: standard logit, LASSO and adaLASSO estimators.

### 3. Data description

We employ data from the US National Center for Health Statistics (NCHS). It provides information about each suicide victim's state of residence, age, gender, ethnicity, marital status, and years of schooling.

The reference measure of gun ownership prevalence is the percentage of households with at least one firearm, is based on the following Behavioral Risk Factor Surveillance System (BRFSS) surveys question: "Are any firearms now kept in or around your home? Include those kept in a garage, outdoor storage area, car, truck, or other motor vehicle". Answers are: "yes", "no", "don't know/not sure" and "refused". In the estimation, we exclude the observations with answer "don't know/not sure," "refused," or missing.

We only use data that are readily available for download. We collect information from the US Centers for Diseases Control and Prevention (CDC) website, which is only available from 1995 to 1998, 2001, 2002 and 2004. Even in these years there are states that do not collect this information or restrict the access to it. Table 1 shows that from 1995 through 1998, there are few states per year in which we can access this information. Thus, we combined the information of these years, giving priority to more recent years. For instance, we only use New Jersey data for 1998, even though we can access this data for 1995 and 1997, as well.

In order to estimate the proxies, we build a database of suicide victims excluding any observation that violates any of these conditions: (a) age below 101 years old; (b) state that reports education of suicide victims<sup>3</sup>; (c) state with accessible information on firearm ownership from the BFRSS (see Table 1).

Table 2 summarizes the number of suicide victims across the US states in our sample. The huge dispersion reflects the immense difference in population size across states. Approximately 53% of the victims committed suicide with a gun. Table 3 describes the distribution of personal characteristics of the suicide victims in our sample. The vast majority of victims are male: about 80% in the overall sample and 87% of suicides using a gun. The average age of suicide victims is 44.4 in the 1995-

---

<sup>3</sup> Only the state of Georgia does not report education of the victims in 2001 and 2002. In 2004, 12 out of 51 states do not report education: Rhode Island, Washington, Wyoming, Oklahoma, New York, New Jersey, New Hampshire, Montana, Michigan, Idaho, California and Georgia.

1998 sample and increases one year if using a gun. In the 2000s, the average age of suicide is 45.7 (total) and 48.3 if committed with a gun. One reason for this difference is that the 1995-1998 sample contains suicide victims from only 21 US states, so they may have a different social demographic composition from the US as a whole. The victims in these 21 states are not only younger, but also more likely to be single and with less than high school education. In all samples, more than 43% are married, and this percentage decreases if using a gun. The fraction of white victims is about 91%, and slightly higher if using a gun. Those who commit suicide using a gun have slightly less years of education.

#### 4. Validation

Tables 4 displays the coefficient estimates of the panel logit model for the probability of using a gun to commit suicide. Apart from state fixed effects, we control for age, age squared, and several dummy variables relating to categorical features: ethnicity, gender, marital status, and years of schooling.

The probability of using a gun to commit suicide decreases with age. Males, blacks, and married victims are more likely to use a gun to commit suicide. The pattern for education is less clear, but it seems that those with high school degrees are more likely to use firearms than those with college degree or less than a high school degree.

Tables 5 to 9 display for the years 1995-1998, 2001, 2002 and 2004, the percentage of households with a firearm ('Reference'), the proportion of suicides committed with a gun ('SG'), and the new proxies based on the standard Logit, LASSO and adaLASSO estimates of state fixed effects. These tables readily confirm that these new indicators rank the states by prevalence of gun ownership better than the prior proxy based on the proportion of suicides committed with a gun. Using the information from Tables 5 to 8, we assess how much we increase the correlation with the reference measure using one of these new proxies instead of the proportion of suicides committed with a gun. Table 9 reports Pearson's linear and Spearman's rank correlations between these proxies with the reference measure.

As expected, the proportion of suicides committed with a gun strongly correlates with the reference measure, but the new proxies are even more correlated in every subsample we consider. Note also that these new proxies all perform equally well, exhibiting very similar correlations with the reference measure. This suggests that neither the presence of insignificant state fixed effects nor the choice of the regularization method greatly affects the correlation with the reference measure.

The average value of the linear correlations with the reference measure is equal to 0.83 for the proportion of suicides with a gun and 0.86 for the proxies based on state fixed effects (Logit, LASSO and adaLASSO). Regarding Spearman's rank correlation, these values are 0.75 and 0.80, respectively. These results demonstrate that conditioning on personal characteristics brings about significant gains in terms of correlation with the benchmark with respect to the best indirect indicator in the literature.

## **5. Conclusion**

We empirically evaluate the new indicator of gun prevalence of Cerqueira et al. (2018) and demonstrate that it correlates with the percentage of households with firearms more than the prevailing proxy based on the proportion of suicides committed with a firearm.

Unlike the proportion of suicides with a gun, the new proxy is a relative measure since it is based on the fixed effects of the victim's place of residence estimated from a discrete model of suicide probability. Thus, any variation of the proxy values between a locality at different time points or from two different localities can only be interpreted as a variation of gun prevalence if jointly estimated.

In future research, we aim to assess the performance of the new proxy in capturing inter-temporal variation of gun ownership. This validity check would be important because there exists no consensus in the literature that the proportion of suicides committed with a gun (or any other proxy) would be a valid indicator of trends in gun levels (see Kleck, 2004 and Azrael et al., 2004). We also aim to evaluate its performance across localities with small numbers of suicides. Our plan is to access restricted data from US General Social Surveys (GSS) and US National Center for Health Statistics (NCHS) in order to build a county panel data for a large span of time.



## References

- Azrael, D., Cook, P. J., Miller, M. (2004) State and local prevalence of firearms ownership: Measurement, structure and trends. *Journal of Quantitative Criminology*, Vol. 20, No. 1, pp. 43-62.
- Briggs, T., Tabarrok, A. (2014) Firearms and suicide in US. *International Review of Law and Economics*, Vol. 37, issue C, pp. 180-188.
- Cerqueira, D., Coelho, D., Fernandes, M., Junior, J. (2018) Guns and suicides. *The American Statistician*, vol. 72, Issue 3, pp. 289-294.
- Cook, P, Ludwig, J. (2002) The effects of gun prevalence on burglary: deterrence vs inducement. NBER Working Paper, No. 8926.
- Cummings, P., Koepsell, T. D, Grossman, D. C., Savarino, J., Thompson, R. S. (1997) The association between the purchase of a handgun and homicide or suicide. *American Journal of Public Health*, Vol. 87, No. 6, pp. 974-978.
- Killias, M. (1993) International correlations between gun ownership and rates of homicide and suicide. *Canadian Medical Association Journal*, Vol. 148, No. 10, pp. 1721–1725.
- Kleck, G. (2004) Measures of gun ownership levels for macro-level crime and violence research. *Journal of Research in Crime and Delinquency*, Vol. 41, No. 1, pp. 3-36.
- Tibshirani, R. (1996) Regression shrinkage and selection via the LASSO. *Journal of the Royal Statistical Society, Series B*, Vol. 58, No. 1, pp. 267-288.
- Zou, H. (2006) The adaptive lasso and its oracle properties. *Journal of the American Statistical Association*, Vol. 101, No. 476, pp. 1418-1429.

**Table 1**  
**US States with BFRSS information on firearm ownership for selected years**

US States that one can download BFRSS microdata from US Centers for Diseases Control and Prevention (CDC) website on firearm ownership.

<b>Year</b>	<b>States</b>
1994	No state.
1995	Arizona, Connecticut, Delaware, Indiana, Kansas, Kentucky, Mississippi, New Jersey, New Mexico, New York and West Virginia.
1996	Alaska, Kentucky, Louisiana, Maryland, New Hampshire, New York and West Virginia.
1997	Colorado, Hawaii, Mississippi, New Hampshire, New Jersey, North Dakota and Ohio.
1998	Louisiana, Montana, New Jersey and Pennsylvania.
1999	No state.
2000	No state.
2001	All states.
2002	All states, except California.
2003	No state.
2004	All states, except Hawaii.

**Table 2**  
**Descriptive statistics for the number of suicides across states and counties**

We report mean, minimum and maximum values for the number of suicides across the states and counties in US as well as their empirical quartiles by year. The data set is from the US Center for Health Statistics (NCHS), years 1995, 1996, 1997, 1998, 2001, 2002 and 2004.

<b>Year</b>		<b>Mean</b>	<b>minimum</b>	<b>first quartile</b>	<b>median</b>	<b>third quartile</b>	<b>Maximum</b>
1995-1998	using a gun	274	40	100	214	351	778
	total	472	80	155	337	596	1343
2001	using a gun	324	18	111	238	425	1442
	total	598	52	195	462	738	2869
2002	using a gun	304	13	97	247	431	1259
	total	561	37	200	448	748	2361
2004	using a gun	329	3	117	262	394	1316
	total	614	37	314	488	792	2419

**Table 3**  
**Personal characteristics of the suicide victims**

We report mean values for age of the victim in years as well as for some personal characteristic indicators that take value one if true, zero otherwise. The data set is from the US Center for Health Statistics (NCHS), years 1995, 1996, 1997, 1998, 2001, 2002 and 2004.

Characteristics of suicides victims		1995-1998		2001		2002		2004	
		using a gun	total	using a gun	total	using a gun	total	using a gun	total
Age		45.80	44.40	48.30	45.70	48.30	45.70	48.30	45.50
Gender	Male	0.880	0.817	0.876	0.806	0.881	0.807	0.865	0.789
	Female	0.120	0.183	0.124	0.194	0.119	0.193	0.135	0.211
Race	White	0.908	0.899	0.918	0.905	0.924	0.913	0.924	0.914
	Black	0.072	0.070	0.063	0.063	0.061	0.061	0.063	0.062
	Others	0.020	0.031	0.019	0.032	0.016	0.026	0.013	0.024
Marital status	Single	0.318	0.345	0.281	0.320	0.274	0.317	0.278	0.319
	Married	0.413	0.389	0.425	0.389	0.428	0.385	0.417	0.377
	Widowed	0.090	0.080	0.091	0.077	0.088	0.076	0.088	0.072
	Divorced	0.177	0.181	0.199	0.207	0.207	0.216	0.213	0.277
	not stated	0.003	0.006	0.005	0.007	0.004	0.006	0.005	0.006
Schooling	less than high school	0.242	0.224	0.217	0.213	0.215	0.211	0.208	0.213
	high school diploma	0.451	0.442	0.430	0.420	0.434	0.426	0.439	0.424
	more than high school	0.260	0.286	0.326	0.335	0.328	0.336	0.332	0.340
	not stated	0.047	0.047	0.028	0.033	0.023	0.027	0.022	0.023

**Table 4****Logit regression with states and counties fixed effects for the probability of using a gun to commit suicide.**

We report standard logit coefficient estimates and their robust standard errors. The \*\*\*, \*\* and \* represent 1%, 2% and 5% significance levels, respectively. The data set is from the US Center for Health Statistics (NCHS), years 1995, 1996, 1997, 1998, 2001, 2002 and 2004.

		1995-1998		2001		2002		2004	
	controls	coeff.	se	coeff.	se	coeff.	se	coeff.	se
gender	female	-1.037 ***	0.057	-1.050 ***	0.032	-1.131 ***	0.034	-1.032 ***	0.035
age		-0.026 ***	0.007	-0.028 ***	0.004	-0.020 ***	0.004	-0.026 ***	0.004
squared age		3.5E-04 ***	6.7E-05	4.5E-04 ***	3.8E-05	3.8E-04 ***	4.0E-05	4.5E-04 ***	4.4E-05
Race	black	0.218 **	0.088	0.135 ***	0.052	0.095	0.055	0.058	0.059
	other than black or white	-0.709 ***	0.140	-0.785 ***	0.076	-0.664 ***	0.089	-0.926 ***	0.102
marital status	married	0.312 ***	0.061	0.281 ***	0.035	0.321 ***	0.037	0.279 ***	0.040
	widowed	0.216 *	0.107	0.139 **	0.061	0.099	0.065	0.148 *	0.072
	divorced	0.108	0.071	0.063	0.040	0.065	0.042	0.014	0.045
	not stated	-0.591	0.315	-0.614 ***	0.163	-0.475 **	0.185	-0.365	0.203
schooling	less than high school	-0.047	0.059	-0.165 ***	0.034	-0.172 ***	0.036	-0.254 ***	0.038
	more than high school	-0.206 ***	0.052	-0.049	0.029	-0.086 ***	0.030	-0.095 ***	0.032
	not stated	-0.154	0.115	-0.240 ***	0.088	-0.437 ***	0.102	-0.289 **	0.117

**Table 5**  
**Gun prevalence across states - 1995-1998.**

We report the percentage of households with firearm ('Reference') by state extracted based on data of Behavioral Risk Factor Surveillance System, years 1995-1998. We proxy for gun prevalence across states using the proportion of suicides committed with a gun ('SG') or the standard LOGIT, LASSO and adaLASSO estimates of the state based on suicide data of US Center for Health Statistics (NCHS), 1995-1998. The numbers beside of each measure refer to the corresponding ranking of gun prevalence.

State	Year of reference measure	Reference	SG	LOGIT	LASSO	adaLASSO
Alaska	1996	0.633 1	0.706 5	1.690 2	1.638 2	1.650 2
Arizona	1995	0.339 13	0.690 6	1.357 6	1.304 6	1.317 6
Colorado	1997	0.379 11	0.589 12	0.873 12	0.820 12	0.832 12
Connecticut	1995	0.182 18	0.465 18	0.297 18	0.244 18	0.256 18
Delaware	1995	0.279 15	0.500 16	0.417 17	0.365 17	0.377 17
Hawaii	1997	0.139 21	0.304 21	0.038 19	-0.018 19	-0.004 19
Indiana	1995	0.409 10	0.655 8	1.061 11	1.009 11	1.021 11
Kansas	1995	0.426 9	0.669 7	1.146 8	1.095 8	1.107 8
Kentucky	1996	0.493 7	0.717 4	1.369 5	1.317 5	1.329 5
Louisiana	1998	0.501 6	0.736 3	1.502 4	1.450 4	1.462 4
Maryland	1996	0.252 17	0.553 15	0.665 15	0.611 15	0.624 15
Mississippi	1997	0.619 3	0.807 1	1.882 1	1.829 1	1.841 1
Montana	1998	0.627 2	0.645 9	1.109 9	1.057 9	1.069 9
New Hampshire	1997	0.337 14	0.496 17	0.554 16	0.500 16	0.513 16
New Jersey	1998	0.148 20	0.388 19	-0.039 21	-0.093 21	-0.081 21
New Mexico	1995	0.441 8	0.635 11	1.081 10	1.029 10	1.041 10
New York	1996	0.165 19	0.382 20	-0.016 20	-0.070 20	-0.058 20
North Dakota	1997	0.542 5	0.642 10	1.172 7	1.119 7	1.131 7
Ohio	1997	0.262 16	0.563 14	0.678 14	0.625 14	0.638 14
Pennsylvania	1998	0.351 12	0.579 13	0.736 13	0.682 13	0.694 13
West Virginia	1996	0.567 4	0.740 2	1.504 3	1.450 3	1.462 3

**Table 6**  
**Gun prevalence across states - 2001.**

We report the percentage of households with firearm ('Reference') by state, based on data of Behavioral Risk Factor Surveillance System, year 2001. We proxy for gun prevalence across states using the proportion of suicides committed with a gun ('SG') or the standard LOGIT, LASSO and adaLASSO estimates of the state based on suicide data of US Center for Health Statistics (NCHS), 2001. The numbers beside of each measure refer to the corresponding ranking of gun prevalence.

<b>State</b>	<b>Reference</b>		<b>SG</b>		<b>LOGIT</b>		<b>LASSO</b>		<b>adaLASSO</b>	
Alabama	0.517	9	0.736	2	1.399	2	1.347	2	1.358	2
Alaska	0.577	2	0.612	15	1.252	6	1.200	6	1.211	6
Arizona	0.311	37	0.608	16	0.853	16	0.800	16	0.811	16
Arkansas	0.553	6	0.708	5	1.279	5	1.226	5	1.238	5
California	0.213	41	0.503	35	0.353	37	0.300	37	0.311	37
Colorado	0.347	32	0.540	28	0.531	26	0.479	26	0.491	26
Connecticut	0.167	45	0.396	44	-0.157	44	-0.210	44	-0.199	44
Delaware	0.255	39	0.482	40	0.309	39	0.256	39	0.267	39
District of Columbia	0.038	50	0.346	46	-0.252	45	-0.306	45	-0.295	45
Florida	0.244	40	0.525	30	0.364	34	0.311	34	0.323	34
Georgia	0.403		NA		NA		NA		NA	
Hawaii	0.087	49	0.211	50	-0.586	48	-0.640	48	-0.628	48
Idaho	0.553	8	0.656	11	1.100	8	1.050	8	1.061	8
Illinois	0.202	43	0.435	42	0.041	43	-0.011	43	0.000	43
Indiana	0.391	26	0.564	20	0.566	22	0.513	22	0.524	22
Iowa	0.428	17	0.510	33	0.323	38	0.271	38	0.282	38
Kansas	0.421	19	0.564	20	0.644	20	0.592	20	0.603	20
Kentucky	0.477	11	0.662	9	1.050	11	0.997	11	1.008	11
Louisiana	0.441	13	0.698	6	1.208	7	1.154	7	1.166	7
Maine	0.405	24	0.521	31	0.367	33	0.316	33	0.327	33
Maryland	0.213	42	0.481	41	0.259	41	0.206	41	0.218	41
Massachusetts	0.126	47	0.245	49	-0.842	50	-0.895	50	-0.884	50
Michigan	0.384	28	0.506	34	0.363	35	0.310	35	0.322	35
Minnesota	0.417	21	0.495	36	0.373	32	0.320	32	0.332	32
Mississippi	0.553	7	0.729	4	1.358	4	1.306	4	1.317	4
Missouri	0.417	22	0.554	24	0.529	27	0.476	27	0.488	27
Montana	0.577	3	0.753	1	1.464	1	1.411	1	1.423	1
Nebraska	0.386	27	0.587	17	0.663	19	0.611	19	0.622	19
Nevada	0.338	34	0.556	23	0.610	21	0.557	21	0.568	21
New Hampshire	0.300	38	0.488	38	0.360	36	0.308	36	0.319	36
New Jersey	0.123	48	0.290	47	-0.632	49	-0.685	49	-0.674	49
New Mexico	0.348	31	0.516	32	0.539	25	0.486	25	0.497	25
New York	0.180	44	0.349	45	-0.324	46	-0.377	46	-0.366	46
North Carolina	0.413	23	0.625	13	0.871	15	0.818	15	0.830	15
North Dakota	0.507	10	0.482	40	0.448	30	0.394	30	0.406	30
Ohio	0.324	36	0.543	25	0.473	29	0.420	29	0.432	29
Oklahoma	0.429	16	0.624	14	0.908	14	0.855	14	0.867	14
Oregon	0.398	25	0.540	28	0.525	28	0.472	28	0.483	28

Pennsylvania	0.347	33	0.533	29	0.446	31	0.393	31	0.404	31
Rhode Island	0.128	46	0.287	48	-0.344	47	-0.396	47	-0.385	47
South Carolina	0.423	18	0.657	10	1.079	10	1.025	10	1.037	10
South Dakota	0.566	4	0.398	43	0.226	42	0.175	42	0.186	42
Tennessee	0.439	14	0.675	8	1.098	9	1.045	9	1.056	9
Texas	0.359	29	0.638	12	0.941	13	0.889	13	0.900	13
Utah	0.439	15	0.562	21	0.664	18	0.612	18	0.623	18
Vermont	0.420	20	0.558	22	0.565	23	0.513	23	0.524	23
Virginia	0.351	30	0.576	18	0.683	17	0.630	17	0.641	17
Washington	0.331	35	0.541	26	0.551	24	0.498	24	0.509	24
West Virginia	0.554	5	0.684	7	1.035	12	0.981	12	0.993	12
Wisconsin	0.444	12	0.489	37	0.282	40	0.229	40	0.241	40
Wyoming	0.597	1	0.732	3	1.374	3	1.321	3	1.332	3

---

**Table 7**  
**Gun prevalence across states - 2002.**

We report the percentage of households with firearm ('Reference') by state, based on data of Behavioral Risk Factor Surveillance System, year 2002. We proxy for gun prevalence across states using the proportion of suicides committed with a gun ('SG') or the standard LOGIT, LASSO and adaLASSO estimates of the state based on suicide data of US Center for Health Statistics (NCHS), 2002. The numbers beside of each measure refer to the corresponding ranking of gun prevalence.

State	Reference		SG		LOGIT		LASSO		adaLASSO	
Alabama	0.579	7	0.711	3	1.090	4	1.030	4	1.048	4
Alaska	0.609	3	0.684	6	1.433	1	1.374	1	1.392	1
Arizona	0.370	30	0.622	14	0.738	15	0.679	15	0.696	15
Arkansas	0.587	5	0.679	8	0.964	5	0.905	5	0.923	5
California	NA		NA		NA		NA		NA	
Colorado	0.347	35	0.516	32	0.287	29	0.227	29	0.245	29
Connecticut	0.164	44	0.328	46	-0.609	46	-0.669	46	-0.652	46
Delaware	0.271	39	0.493	39	0.095	39	0.034	39	0.053	39
District of Columbia	0.053	49	0.351	43	-0.457	44	-0.515	44	-0.499	44
Florida	0.266	40	0.513	33	0.162	36	0.102	36	0.119	36
Georgia	0.414		NA		NA		NA		NA	
Hawaii	0.102	48	0.167	49	-1.065	48	-1.126	48	-1.109	48
Idaho	0.571	8	0.681	7	0.880	9	0.821	9	0.839	9
Illinois	0.212	42	0.399	42	-0.268	43	-0.328	43	-0.311	43
Indiana	0.396	29	0.582	22	0.524	21	0.464	21	0.482	21
Iowa	0.444	21	0.506	36	0.187	35	0.128	35	0.146	35
Kansas	0.442	22	0.583	21	0.442	23	0.383	23	0.401	23
Kentucky	0.486	11	0.662	11	0.874	10	0.814	10	0.832	10
Louisiana	0.463	13	0.665	10	0.870	11	0.811	11	0.828	11
Maine	0.415	25	0.479	40	0.072	40	0.012	40	0.030	40
Maryland	0.225	41	0.497	37	0.149	37	0.089	37	0.107	37
Massachusetts	0.129	46	0.222	48	-1.176	49	-1.236	49	-1.219	49
Michigan	0.407	26	0.516	32	0.231	32	0.172	32	0.189	32
Minnesota	0.450	19	0.463	41	0.019	41	-0.039	41	-0.022	41
Mississippi	0.550	9	0.743	2	1.282	3	1.223	3	1.241	3
Missouri	0.458	14	0.602	18	0.560	20	0.500	20	0.518	20
Montana	0.621	2	0.622	14	0.722	16	0.663	16	0.681	16
Nebraska	0.423	23	0.525	29	0.245	31	0.184	31	0.202	31
Nevada	0.326	36	0.571	23	0.464	22	0.404	22	0.422	22
New Hampshire	0.311	38	0.511	34	0.191	34	0.131	34	0.149	34
New Jersey	0.115	47	0.316	47	-0.731	47	-0.790	47	-0.773	47
New Mexico	0.401	28	0.589	20	0.685	17	0.625	17	0.643	17
New York	0.184	43	0.331	45	-0.551	45	-0.611	45	-0.593	45
North Carolina	0.416	24	0.639	12	0.742	14	0.681	14	0.699	14
North Dakota	0.545	10	0.556	25	0.405	24	0.346	24	0.364	24
Ohio	0.322	37	0.517	30	0.202	33	0.142	33	0.160	33
Oklahoma	0.450	18	0.621	15	0.772	13	0.713	13	0.730	13
Oregon	0.403	27	0.565	24	0.396	25	0.336	25	0.354	25



Pennsylvania	0.367	31	0.526	28	0.250	30	0.190	30	0.208	30
Rhode Island	0.135	45	0.345	44	-0.057	42	-0.116	42	-0.099	42
South Carolina	0.456	16	0.690	4	0.960	6	0.899	6	0.917	6
South Dakota	0.604	4	0.538	26	0.784	12	0.726	12	0.744	12
Tennessee	0.470	12	0.666	9	0.926	8	0.866	8	0.884	8
Texas	0.364	34	0.603	17	0.632	18	0.573	18	0.590	18
Utah	0.455	17	0.509	35	0.330	28	0.272	28	0.289	28
Vermont	0.457	15	0.589	20	0.394	26	0.333	26	0.351	26
Virginia	0.365	33	0.606	16	0.629	19	0.569	19	0.587	19
Washington	0.367	32	0.537	27	0.342	27	0.282	27	0.300	27
West Virginia	0.582	6	0.689	5	0.950	7	0.890	7	0.908	7
Wisconsin	0.445	20	0.493	39	0.128	38	0.069	38	0.086	38
Wyoming	0.631	1	0.757	1	1.365	2	1.307	2	1.325	2

---

**Table 8**  
**Gun prevalence across states - 2004.**

We report the percentage of households with firearm ('Reference') by state, based on data of Behavioral Risk Factor Surveillance System, year 2004. We proxy for gun prevalence across states using the proportion of suicides committed with a gun ('SG') or the standard LOGIT, LASSO and adaLASSO estimates of the state based on suicide data of US Center for Health Statistics (NCHS), 2004. The numbers beside each measure refer to the corresponding ranking of gun prevalence.

State	Reference		SG		LOGIT		LASSO		adaLASSO	
Alabama	0.522	7	0.671	5	1.023	5	0.969	5	0.981	5
Alaska	0.598	2	0.610	9	1.404	1	1.352	1	1.363	1
Arizona	0.323	31	0.578	13	0.688	12	0.634	12	0.646	12
Arkansas	0.588	3	0.622	8	0.781	10	0.726	10	0.739	10
California	0.201		NA		NA		NA		NA	
Colorado	0.346	28	0.501	27	0.361	26	0.307	26	0.319	26
Connecticut	0.181	36	0.348	36	-0.392	36	-0.447	36	-0.435	36
Delaware	0.262	32	0.500	28	0.306	27	0.251	27	0.263	27
District of Columbia	0.042	38	0.081	38	-2.088	38	-2.146	38	-2.133	38
Florida	0.252	33	0.495	30	0.217	31	0.162	31	0.174	31
Georgia	0.403		NA		NA		NA		NA	
Hawaii	NA		NA		NA		NA		NA	
Idaho	0.557		NA		NA		NA		NA	
Illinois	0.207	35	0.377	35	-0.245	35	-0.299	35	-0.287	35
Indiana	0.385	24	0.527	23	0.406	23	0.352	23	0.364	23
Iowa	0.457	10	0.440	34	-0.012	34	-0.065	34	-0.053	34
Kansas	0.428	18	0.548	15	0.530	18	0.476	18	0.488	18
Kentucky	0.477	8	0.663	6	0.995	6	0.940	6	0.953	6
Louisiana	0.450	12	0.690	2	1.165	2	1.110	2	1.122	2
Maine	0.403	20	0.547	16	0.478	19	0.424	19	0.436	19
Maryland	0.217	34	0.487	32	0.207	32	0.151	32	0.164	32
Massachusetts	0.115	37	0.221	37	-1.059	37	-1.114	37	-1.102	37
Michigan	0.408		NA		NA		NA		NA	
Minnesota	0.412	19	0.503	26	0.372	25	0.318	25	0.330	25
Mississippi	0.546	6	0.693	1	1.104	3	1.050	3	1.062	3
Missouri	0.442	14	0.537	20	0.452	21	0.398	21	0.410	21
Montana	0.626		NA		NA		NA		NA	
Nebraska	0.454	11	0.506	25	0.376	24	0.323	24	0.334	24
Nevada	0.340	29	0.540	17	0.437	22	0.382	22	0.394	22
New Hampshire	0.310		NA		NA		NA		NA	
New Jersey	0.114		NA		NA		NA		NA	
New Mexico	0.397	22	0.532	22	0.567	16	0.514	16	0.526	16
New York	0.185		NA		NA		NA		NA	
North Carolina	0.394	23	0.588	11	0.688	13	0.633	13	0.645	13
North Dakota	0.562	5	0.539	18	0.603	14	0.550	14	0.562	14
Ohio	0.340	30	0.495	30	0.272	30	0.218	30	0.230	30

Oklahoma	0.465		NA		NA		NA		NA	
Oregon	0.398	21	0.535	21	0.457	20	0.403	20	0.415	20
Pennsylvania	0.351	27	0.508	24	0.290	28	0.235	29	0.247	29
Rhode Island	0.124		NA		NA		NA		NA	
South Carolina	0.433	16	0.677	3	1.042	4	0.987	4	1.000	4
South Dakota	0.599	1	0.538	19	0.872	9	0.820	9	0.832	9
Tennessee	0.466	9	0.651	7	0.964	8	0.909	8	0.922	8
Texas	0.371	26	0.568	14	0.603	15	0.549	15	0.561	15
Utah	0.448	13	0.487	32	0.289	29	0.236	28	0.248	28
Vermont	0.438	15	0.582	12	0.540	17	0.484	17	0.497	17
Virginia	0.375	25	0.594	10	0.697	11	0.642	11	0.654	11
Washington	0.340		NA		NA		NA		NA	
West Virginia	0.585	4	0.671	5	0.993	7	0.939	7	0.951	7
Wisconsin	0.429	17	0.455	33	0.186	33	0.131	33	0.143	33
Wyoming	0.655		NA		NA		NA		NA	

---

**Table 9****Proxies correlations with the percentage of households with a firearm**

We report Pearson's linear and Spearman's rank correlations between the percentage of households with firearm and four different proxies of gun prevalence. The percentage of households with firearm is based on data of Behavioral Risk Factor Surveillance System, 1995, 1996, 1997, 1998, 2001, 2002 and 2004. We proxy for gun prevalence across states using the proportion of suicides committed with a gun ('SG') or the standard LOGIT, LASSO and adaLASSO estimates of the state based on suicide data of US Center for Health Statistics (NCHS), years 1995, 1996, 1997, 1998, 2001, 2002 and 2004.

proxy	1995-1998	2001	2002	2004	row average
<b>Pearson's linear correlations</b>					
<b>SG</b>	0.878	0.805	0.852	0.779	0.829
<b>LOGIT</b>	0.909	0.841	0.861	0.822	0.858
<b>LASSO</b>	0.909	0.842	0.862	0.822	0.859
<b>ADALASSO</b>	0.909	0.842	0.862	0.822	0.859
<b>Spearman's ranking correlation</b>					
<b>SG</b>	0.868	0.727	0.780	0.629	0.751
<b>LOGIT</b>	0.905	0.752	0.816	0.703	0.794
<b>LASSO</b>	0.905	0.752	0.816	0.706	0.795
<b>ADALASSO</b>	0.905	0.752	0.816	0.706	0.795