A Statistical Analysis on Concealed Carry Laws and Their Effect on Violent Crime/Murder Rate

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Abstract:

The debate for the effects of concealed carry laws often has two starkly different opinions with people either taking the side of more guns lead to more crime or guns prevent crime from happening. This paper dives deep into the subject and looks for a statistically sound way to prove once and for all what the effect of guns on violent crime and murder. Multiple regressions are run to determine the effect of the Shall-Carry or "concealed carry" law between the years of 1977 and 1999. To get a complete look on the picture, multiple observed variables are considered, as well as time and state effects that may have unobserved effects on the regression. What is found is the concealed carry law does not seem to have a large impact on the crime or murder rate in states that implement the law vs those who do not enact the law.

Introduction and Question Posed

During the period of 1977 to 1999 various U.S. States enacted laws that allowed any citizen mentally capable and a non convict to acquire conceal carry permits. This law was called the shall-carry law and two schools of thought formed, does the law deter potential criminals or does it increase crime as the opportunities to use a weapon rise? The core purpose of this paper is to analyze the effect conceal carry permits had on violent crime between the years of 1977 and 1999. An extension of the core purpose is made as the paper also analyzes the effect conceal carry permits had on the murder rate. Motivation for this paper came from a paper on guns and crime by Ayres and Donohue (2003). They found previous estimates of the shall-carry law decreasing the amount of crime were wrong and the shall-carry law could be associated with an increase in crime. Ayres and Donohue (2003) state that a more refined regression will get the result that the shall-carry law increases crime. In order to analyze the purpose, a panel data set is used, the panel data contains information on concealed carry, crime, and more for U.S. States. Relevant variables and statistics on the data set are made available in Table 1. In this paper a regression analysis is used to find the impact of the conceal carry law. Equation 1 through 4 are examined to get the effect of the shall-carry law. What is found is that the shall-carry law has very little to no affect on either of the violent crime or murder rate.

Hypotheses and Regression Mechanics

Ayres and Donohue (2003) found in their analysis the shall-carry law results in an increase in crime rate, but in this paper, it will be argued that the shall-carry law is not associated with an increase in violent crime rate. The hypotheses tested in this paper is that the shall-carry law had no impact on the violent crime rate or the murder rate. These hypotheses provide an interesting counterargument to the idea that more guns result in an increase in crime. Are concealed carry laws leading to an increase in crime/murder as more guns are available or are more guns not leading to an increase in crime. The extension is interesting as it checks if the hypothesis extends to the most extreme crime. The hypotheses will be proven using multiple linear regression and the regressions will be on the dependent variables logarithm of violent crime/logarithm of the murder rate. Ayres and Donohue (2003) state that "facially plausible statistical models appear to generate" a conclusion that more guns lead to less crime but a "more refined analyses" will state otherwise. To show Ayres and Donohue are wrong and that the shall-carry law does not lead to an increase in crime a more refined analyses will be used. The model uses panel data, repeated observations of panel data can be exploited to control for certain types of heterogeneity. To control for unobserved effects a combination of state/year fixed effects and clustered standard errors are used. The regressions used in table 2/3 columns (1) and (2) are simple linear regression, while the regressions in columns (3) and (4) are fixed effect regressions. The first regression contains just the shall-law dummy variable whereas 2, 3 and 4 have other variables that may have an effect controlled. The extra variables considered are listed in table 1.

Controlling for the state effects in the fixed effects regression removes any time invariant unobserved variation across states, meaning that any unobserved variation in the states that is the same across all time periods will be wiped out with state fixed effects. An Example of state effect variation could be ease access to guns and firearm types that can be sold, each state will have different laws on how easy it is to get a gun but should be constant across time. Controlling for time effects in fixed effects regression makes sure that any variation in the model that is state invariant that changes across time is removed from the model. An example of a time effect could be national changing attitude toward violent crime, this could be something that varies between years but not states. Clustered standard errors help the regression when fixed effect assumption 6 does not hold. Assumption 6 states there is no serial correlation across time (i.e. the omitted errors are uncorrelated across state). If assumption 6 fails, then standard errors are likely to be wrong and this will affect the statistical significance testing. Wooldridge (2018) states "we should compute standard errors, confidence intervals, and test statistics that are valid in large cross sections under the weakest set of assumptions", by using clustered standard errors the least amount assumptions of the model have to be made and then the standard errors are also robust to heteroskedasticity of any form. Controlling for state effect, time effects and clustered standard errors creates a more statistically refined regression as the regression now controls for differences that could otherwise lead to an incorrect conclusion. Ayres and Donohue (2003) mention, "Florida and Texas – which both showed large crime decreases after adoption – may have an estimated negative impact as they passed the law in response to crime increases and as crime reverted of its own accord to its normal levels, the regression inappropriately attributed the mean reversion to the passage of the law". Attempting to control for factors that could be present in the model is crucial to finding a model that accurately represents concealed carry effects.

Data Set Description

The descriptive statistics of the data are available in Table 1. For example, the logarithm of violent crime rate/logarithm of the murder rate take the logarithm of their respective per 100,000 members of the population values. The spread and the distribution of the variable is important when interpreting the results of the regression, to know the practical effect. The shall-carry law is a dummy variable taking the value 1 if the concealed carry permit law is enacted and 0 if not enacted, therefore estimated effects of concealed carry on violent crime/murder rate is shown as a log change in tables 2 and 3. Other variables such as incarceration rate and average income have larger spreads which could change how you evaluate the economic significance, as a small statistical significance with large spread will hurt economic significance.

Discussion and Reporting of Results

Regressions were completed for both logarithm of violent crime and the logarithm of the murder rate. Refer to Table 2 for the regression on log violent crime and Table 3 for the regression on log murder rate. In Table 2 (1) the simple regression was run on just shall, the coefficient shows concealed carry states had a decrease by 0.443 in log violent crime relative to states without. A decrease by 0.443 in log violent crime is equivalent to a 44.3% decrease in violent crime, the standard error is 0.042 leading to a t-statistic of 10.55. A t-statistic of 10.55 is highly statistically significant, on a statistical level the coefficient is not zero. In (2) a simple regression was run controlling for other observed variables in the regression that are unaccounted for in (1). In (2) the decrease in log violent crime due to shall-carry compared to those without the law is 0.368, a standard error of 0.033 and a t-statistic of 11.15 which is highly statistically significant. In (3), unobserved state effects and clustered standard errors are considered. Comparatively the carry law resulted in a decrease of log 0.046, the se is 0.042, resulting in a t-stat of 1.10 which is not statistically different than zero. For (4) which considers state effect, clustered standard errors and the time effect, the shall variable effect is a log 0.028 decrease with a 0.041 standard error. The resulting t-statistic is 0.68 which is not statistically significant.

In an extension to the violent crime regression a similar analysis was done for the murder rate. In Table 3 (1) the log change in the murder rate is 0.473 for states that implemented the concealed carry law compared to those without. The standard error and t-statistic are 0.046 and 10.28, respectively. For regression (2) where other variables are controlled, the log change of the murder rate given by the shall variable is 0.368, the standard error is 0.034 and the t-statistic is 10.82 which is significantly different than zero. For regression (3) where state effects and clustered errors are considered, the change in log murder rate for states with the shall-carry law is 0.061, the standard error is 0.037 and the t-statistic is 1.64, which implies the shall variable might be zero. In regression (4) the difference in log murder rate is a 0.015 decrease for those with the shall-carry law compared to those without. The standard error for (4) is 0.038 meaning the resulting t-statistic is not significant at 0.039 and the shall variable might be zero

<u>Interpretation of Results</u>

Regression (1) saw in practical terms a 44.3% decrease in violent crime in states with concealed carry compared to those without. The t-statistic (1) is also statistically significant, some may make the incorrect conclusion that concealed carry law decreases crime, but (1) does not paint the entire picture. Those in favor of concealed carry may take a result like (1) out of context, since a decrease in 44.3% would have a very large economic significance, but there are clearly other factors to why violent crime is lower. In (2), there is a small reduction in the effect of concealed carry, but economic/statistical significance remain large. There is a 36.8% decrease due to concealed carry holding all other variables in (2) constant. In regression (3) economic/ statistical significance fall and the change due to concealed carry is only 4.6% (holding other variables constant), significance falls even further in regression (4) with a 2.8%. decrease in violent due to concealed carry (other variables constant). With the most refined regression shall carry leads to a 2.8% decrease in violent crime, economically this is a small change, but the result cannot be concluded to be different than zero. Controlling for time variables and state variables, while utilizing clustered standard errors eliminates almost any difference between the states, drastically lowering significance and creating a more refined regression. Researchers looking to conclude that guns prevent crime may not control for the time and state unobserved variables to reach a conclusion and conclude based off (1) or (2) shall-carry laws decrease crime.

For the regressions completed on the murder rate, there seems to also be large economic and statistical significance for regression (1) as there looks to be a 47.3% lower murder rate in concealed carry states vs non concealed carry. The effect falls as other variables are controlled but is still statistically/economically significant as the estimated effect is 31.3%. For regression (3) the economic significance is almost entirely gone as the estimated change for concealed carry states is only 6.1%. Then when controlling for time, state and clustered errors the change is only 1.5% which has is a small economic significance. Although in all the regressions the murder rate falls in states with concealed carry, it does not seem to be a very large factor as density and average income seem to be larger factor when controlling for all variables

Conclusion

The hypotheses of this paper are that the shall-carry law had no impact on the violent crime rate and that the shall-carry law should have no effect on the murder rate. This is proved true as controlling for other observed variables and variations across state and time almost completely eliminates the effect of the concealed carry law. There is no statistical significance of the shall-law on either the murder or violent crime rate. The economic significance is also small in both cases when observed and unobserved variables such as state and time fixed effects are controlled. With such a small economical significance and zero statistical significance a conclusion that the shall-carry law changed the crime or murder rate cannot be made. In Ayres and Donohue (2003) they conclude "most states shall- issue laws have been associated with more crime" but "there are substantial concerns about model reliability and robustness", as the model in this paper has done its best to eliminate most concerns, the shall-carry law should not be associated with more violent crime. The extension on the murder rate shows that shall-carry laws did not have an effect on even the most violent of crime, with no evident change in murder rate. In both cases, results are purely descriptive and not causal, there is not a conclusive relationship that shall-carry increases or decreases crime/murder just a potential relationship.

Weaknesses and Next Steps

The biggest potential weakness or threat to the validity of the model would be omitted variable bias. Omitted variable bias may be the hurting any potential relationship that could be concluded. In Ayres and Donohue (2003) they mention that "even the best regression results may not be believable –the huge omitted variable problem represented by the upturn in crime following the advent of crack into certain urban areas in the mid to late 1980s". As the crack problem would be varying across both time and state it does not meet the requirement to be controlled by either state/time fixed effects, it would be an omitted variable. If states adopting concealed carry laws did not see any problem with crack introduction into cities and states that did not have concealed carry did have a problem, results may be incorrect. Results could conclude the shall-carry law was reducing violent crime/murder rate comparatively, but the real problem was crack driving up crime in cities. Potential next steps would be to look for any omitted variables such as the crack problem during the late 1980's and finding a way to control for them in the model. If there was a way to account for the omitted variable using a technique such as instrumental variables, this could be the next step toward fitting the best possible model.

References

Ayres, Ian and John J. Donohue III. "Shooting Down the More Guns, Less Crime Hypothesis." 55 Stanford Law Review 1193 (2003).

Wooldridge, J. M. (2018). Chapter 14 Appendix. In *Introductory Econometrics: A Modern Approach* (7th ed., pp. 493-494). Boston, MA: Cengage.

Appendix

Table 1

Variable	Obs	Mean	Std. Dev.	Min	Max
Ln(violent crime)	1173	6.027	.646	3.85	7.98
Ln(murder rate)	1173	1.783	.703	-1.609	4.389
Violent Crime (per 100 000)	1173	503.075	334.277	47	2921.8
Murder Rate (per 100 000)	1173	7.665	7.523	.2	80.6
Shall-carry (1=yes, 0 = no)	1173	.243	.429	0	1
Incarc Rate (per 100 000)	1173	226.58	178.888	19	1913
Density (per sq mi/1000)	1173	.352	1.355	.001	11.102
Avg Income (thousands)	1173	13.725	2.555	8.555	23.647
Population (millions)	1173	4.816	5.252	.403	33.145
% Pop male, ages 10 to 29	1173	5.336	4.886	.248	26.98
% Pop white, ages 10 to 64	1173	62.945	9.762	21.78	76.526
% Pop black, ages 10 to 64	1173	16.081	1.732	12.214	22.353
Year (1977 to 1999)	1173	88	6.636	77	99
State id Number (Alabama =1, Alaska = 2…)	1173	28.961	15.684	1	56

Table 2

	(1) lnvio	(2) lnvio	(3) lnvio	(4) lnvio
shall	-.443***	-.368***	-.046	-.028
	(.042)	(.033)	(.042)	(.041)
Incarc rate		.002***	0	0
		(0)	(0)	(0)
density		.027**	-.172	-.092
		(.013)	(.138)	(.124)
avg Income		.001	-.009	.001
		(.008)	(.013)	(.016)
population		.043***	.012	-.005
		(.003)	(.014)	(.015)
% Pop male, age 10-29		.081***	.104***	.029
		(.017)	(.033)	(.05)
% Pop white, age 10-64		.031***	.041***	.009
		(.008)	(.013)	(.024)
% Pop black, age 10-64		.009	-.05**	.073
		(.011)	(.021)	(.052)
State Fixed Effect	No	No	Yes	Yes
Time Fixed Effect	No	No	No	Yes
Clustered se	No	No	Yes	Yes
F-Statistic	111.08	188.41	34.10	56.86
Observations	1173	1173	1173	1173
R-squared	.087	.564	.218	.418

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table 3

	(1) lnmur	(2) lnmur	(3) lnmur	(4) lnmur
shall	-.473***	-.313***	-.061	-.015
	(.046)	(.034)	(.037)	(.038)
Incarc rate		.002***	0	0
		(0)	(0)	(0)
density		.04***	-.671*	-.544*
		(.014)	(.396)	(.319)
avg income		-.077***	.024	.057***
		(.008)	(.016)	(.017)
population		.042***	-.026	-.032
		(.003)	(.02)	(.021)
% Pop male, age 10-29		.131***	.031	.022
		(.017)	(.078)	(.076)
% Pop white, age 10-64		.047***	.01	0
		(.009)	(.013)	(.02)
% Pop black, age 10-64		.066***	.039*	.069
		(.011)	(.022)	(.042)
State Effect	No	No	Yes	Yes
Time Effect	No	No	No	Yes
Clustered se	No	No	Yes	Yes
F-Statistic	106.51	223.66	156.39	81.49
Observations	1173	1173	1173	1173
R-squared	.083	.606	.153	.291

Standard errors are in parentheses
**** $p<.01$, ** $p<.05$, * $p<.1$*

Equation 1

$ln(violent\ crime)$ = $B_0 + B_1$shall + u

Equation 2

$ln(violent\ crime)$ = $B_0 + B_1$shall + B_2incarc_rate + B_3density + B_4avg_income + B_5population + B_6(% Pop male, age 10-29) + B_7 (% Pop white, age 10-64) + B_8(% Pop black, age 10-64) + u

Equation 3

$ln(murder\ rate)$ = $B_0 + B_1$shall + u

Equation 4

$ln(murder\ rate)$ = $B_0 + B_1$shall + B_2incarc_rate + B_3density + B_4avg_income + B_5population + B_6(% Pop male, age 10-29) + B_7 (% Pop white, age 10-64) + B_8(% Pop black, age 10-64) + u