



Substance vs. Sideshows in the More Guns, Less Crime Debate: A Comment on Moody, Lott, and Marvell

Abhay Aneja¹, John J. Donohue III², and Alexandria Zhang³

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We are grateful to authors Carlisle Moody, John Lott, and Thomas Marvell (hereafter MLM) for their close attention to our article “The Impact of Right-to-Carry Laws and the NRC Report: Lessons for the Empirical Evaluation of Law and Policy,” which was published in the *American Law and Economics Review* (Aneja, Donohue, and Zhang 2011), and then re-issued as a National Bureau of Economic Research working paper with some substantively unimportant errors corrected (Aneja, Donohue, and Zhang 2012). (Henceforth, we too will use the abbreviation ADZ to refer to our jointly authored work.) We think the attention to this work is warranted because it represents the most comprehensive and exhaustive analysis to date in the scholarly debate over right-to-carry (RTC) laws.

In thirty-three tables and twenty-seven graphs, our 2012 NBER paper showed that estimates of the impact of RTC laws were sensitive to four econometric modeling features: (1) choices of econometric controls (below we show results with variables used in work by Lott and David Mustard versus our own preferred models that include, most importantly, controls for incarceration, as well as models that do or do not control for pre-existing state crime trends); (2) functional form (estimating either an average post-passage effect or a change in the

1. Stanford University, Stanford, CA 94305.

2. Stanford University, Stanford, CA 94305.

3. Johns Hopkins University, Baltimore, MD 21218.

trend in crime); (3) choice of county or state crime data; and (4) computations of the standard errors (which, we showed, must include a cluster adjustment to reflect the lack of independence in state crime observations over time). The importance of these modeling choices is captured in Tables 1 and 2 below, which use data that is both more current and accurate than the data that was available to the National Research Council (NRC) for its 2005 report *Firearms and Violence: A Critical Review*.

The major substantive finding of our work

Our extensive review of the findings and the methodological choices made by the National Research Council in its 2005 chapter on the deterrent effects of RTC laws, coupled with our extensions and improvements in their data and analyses, led us to a number of noteworthy substantive and methodological findings. Importantly, we affirmed the committee's conclusion that there is no evidence in aggregate econometric data that supports the existence of a net crime-reducing effect from RTC legislation.

Our paper also highlighted some potential missteps and issues that were overlooked in the NRC report. Perhaps the most important of these is that the NRC's failure to correct for serial correlation using clustered standard errors led to large underestimates of the standard errors, resulting in Type I error rates of between 40 and 70 percent.⁴ Another important finding with substantive methodological implications is that the estimates of RTC laws' impact are highly sensitive to the inclusion of state-specific crime trends.

Tables 1 and 2 show eight different estimates of the impact on crime of adopting a RTC law for seven different crime categories—a total of 56 estimates. Of these, 23 are negative (suggesting crime decreases), but none of these negative estimates is significant at the .01 level and only one isolated estimate, that for auto theft in Table 2b, is significant at the .05 level. In contrast, 33 of the 56 estimates are positive (suggesting RTC laws *increase* crime) with three being significant at the .01 level and seven significant at the .05 level. There is only one crime for which one could make a case that the different modeling approaches reveal a discernible pattern: seven of the eight estimates for aggravated assault are positive, and four of those eight are significant at the .10 level or above (with two significant at the .01 level and three significant at the .05 level). Our more complete paper demonstrates

4. Type I error refers to obtaining “false positives” in statistical research. In the present context, it refers to mistakenly finding that RTC laws have a statistically significant impact on crime when in truth there is no statistical effect. Standard econometric practice suggests that researchers should find such false “significant” differences no more than 5 or 10% of the time.

in greater detail the extent to which particular estimates are sensitive to various modeling and data permutations beyond those depicted in Tables 1 and 2. But using the most complete data from 1977 to 2006, the most consistent, albeit imperfect, evidence is that RTC laws *increase* aggravated assaults. If one sharpens the focus to look only at gun assaults as we do in Table 3, the same essential pattern emerges.

TABLE 1. Estimated impact of RTC laws, 1977-2006:
Lott-Mustard controls, clustered standard errors, ADZ (2012) updated county data⁵

Table 1a. No controls for pre-existing state crime trends							
	Murder	Rape	Aggravated Assault	Robbery	Auto Theft	Burglary	Larceny
Dummy Variable Model	-4.00 (6.40)	11.60 (12.98)	15.91*** (5.01)	6.77 (4.61)	16.52** (7.19)	10.82** (4.53)	16.82*** (5.07)
Spline Model	-0.04 (0.65)	-1.68 (1.29)	1.16 (0.94)	0.45 (0.72)	-0.44 (0.57)	-0.52 (0.51)	0.10 (0.62)
Table 1b. With controls for pre-existing state crime trends							
	Murder	Rape	Aggravated Assault	Robbery	Auto Theft	Burglary	Larceny
Dummy Variable Model	-1.66 (4.83)	-9.90 (9.77)	9.56** (4.54)	4.36 (5.77)	8.44 (6.39)	3.75 (5.78)	6.80 (6.22)
Spline Model	-0.47 (0.99)	-5.47 (4.65)	1.78 (1.46)	-0.57 (1.84)	-0.95 (1.80)	-1.37 (1.57)	-1.47 (1.68)

Note: Data from 1993 not included.

TABLE 2. Estimated impact of RTC laws, 1977-2006:
ADZ preferred controls, clustered standard errors, ADZ (2012) updated state data

Table 2a. No controls for pre-existing state crime trends							
	Murder	Rape	Aggravated Assault	Robbery	Auto Theft	Burglary	Larceny
Dummy Variable Model	-3.17 (3.87)	0.42 (3.70)	4.88 (3.69)	5.14 (4.27)	6.39 (5.99)	2.33 (2.99)	6.50** (2.94)
Spline Model	0.08 (0.62)	-0.75 (0.58)	1.33 [†] (0.71)	0.15 (0.81)	-0.35 (0.59)	-0.57 (0.44)	-0.15 (0.48)
Table 2b. With controls for pre-existing state crime trends							
	Murder	Rape	Aggravated Assault	Robbery	Auto Theft	Burglary	Larceny
Dummy Variable Model	0.07 (2.71)	-3.38 [†] (1.83)	-2.17 (2.98)	2.20 (3.59)	7.69 [†] (4.10)	1.47 (2.13)	1.94 (1.80)
Spline Model	0.81 (0.86)	0.06 (0.78)	3.22*** (0.79)	0.59 (1.27)	-1.70** (0.83)	-0.22 (0.87)	-0.18 (0.73)

5. Tables 1 to 3 are based on panel data regressions that include year and county fixed effects and are weighted by county population. All figures reported as percentages. Robust standard errors are provided beneath point estimates in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The control variables in Table 1 (adopted from the Lott-Mustard model) include: lagged arrest rate, county population, population density, per capita income measures, and 36 demographic composition measures indicating the percentages of the population belonging to various race-age-gender groups.

TABLE 3. Estimated impact of RTC laws on gun-related aggravated assaults, 1977-2006: ADZ preferred controls, clustered standard errors, ADZ (2012) updated state data

	Pre-existing state crime trends	
	No controls for those trends	With such controls
Dummy Variable Model	14.76 [*] (8.01)	0.43 (7.26)
Spline Model	1.53 (1.26)	5.66 [*] (3.12)

Correcting the record

Apparently, on the substance of our paper, there is little or no disagreement. The current comment by MLM (2013) focuses only on a tangential issue about our initial inability to replicate some regression results that were published in the NRC report using a Lott-Mustard model on county data for the period from 1977-2000.

A recounting of events may help explain why we think that MLM's speculations are off base. We initially sought to replicate the NRC's results based on the committee's own description of the model. When we were unable to do so, we contacted the NRC committee, who gave us the data set that had been used for the report, but we were told the do-files (illustrating the precise specification employed) had been lost. We then undertook a good-faith, but originally unsuccessful, effort to replicate the two published tables from the NRC report. Our inability to do so underscores our point that many modeling choices need to be made in generating panel data estimates of crime impacts, and we had not expected some of the choices that led to the published NRC estimates.

After the publication of our article (ADZ 2011), members of the NRC panel demonstrated to us that the results in question were replicable based on specification decisions that we did not consider, but which were indeed consistent with the NRC's description of the model. Once we fully understood the way in which these NRC estimates were generated, it became clear that the NRC report presented estimates based on county data from 1977-2000 that essentially had three flaws: (1) the specification (adopted from Lott and Mustard 1997) was problematic in a number of dimensions;⁶ (2) the standard errors were incorrect in two ways,

6. Perhaps the most troubling aspect of the published NRC model was that it used a contemporaneous arrest ratio measure as an explanatory variable, apparently following a Lott specification. Consequently, the NRC estimate of the impact of RTC laws on murder was based on a regression of murders in year t on a set of controls that included the ratio of arrests to murders in year t . Having murders in year t on both sides of the regression equation generates a serious problem of ratio bias, which explains in part why we failed to replicate the NRC finding: We had expected that they would have followed the standard practice of at least lagging the arrest ratio one period (even though now we understand they were just trying to follow but not endorse the Lott approach).

both of which made the results appear more significant than they were;⁷ and (3) there were some errors in the data, which had been supplied by Lott, although these data errors did not substantively effect the results. At the same time, a comment by Moody, Lott, Marvell, and Paul Zimmerman (2012) as well as our own independent review revealed that we had also made some coding errors, although again these data errors had no impact on any of the major findings of our published paper.

To ensure that all of our claims and figures are as accurate as possible, we issued a new, corrected version of our paper through the NBER, and in conjunction with two principals from the NRC panel, we also issued an erratum in the *American Law and Economics Review* (Aneja, Donohue, Pepper, Wellford, and Zhang 2012), making clear that we can now replicate the regressions presented in the NRC report, even though those NRC county data regressions for 1977-2000 did contain data problems (including the minor ones mentioned above that were caused by Lott, as well as some errors in the now-withdrawn 1993 county data from the Uniform Crime Reports). At this point, both we and the National Research Council view the replication issue as settled. As stated in ADZ (2011), as well as in the subsequent erratum, we believe this episode shows the value of having publicly available files that allow researchers to replicate results and ferret out any potential errors.

Conclusion

While we are appreciative that Moody, Lott, Marvell, and Zimmerman (2012) helped in the process of perfecting the estimates presented in the tables above (by bringing to our attention some small data errors, which we list in our NBER paper), we think the current comment by MLM (2013) may mislead readers into thinking that there is support for the view that RTC laws reduce crime. This is decidedly not the case if one uses the most complete data and proper econometric methodology.

MLM seem to be trying to suggest that the replication of earlier, now-superseded regression results somehow breathes life into previous studies of the More Guns, Less Crime hypothesis (see Lott 2010) that were based on less complete and less accurate data and unsound econometric approaches. Thus MLM conclude: “we know that the published articles using Lott’s data have not been

7. Although the NRC report (in our view mistakenly) failed to use a cluster adjustment, it was explicit about doing so. Their failure to use robust standard errors, however, was not mentioned in the report and again surprised us (hence the failure to replicate), because that adjustment to correct for heteroscedasticity has long been part of standard econometric practice.

invalidated because of critical data errors” (2013, 27). Given the findings of ADZ (2011), even if it were true that the original data were flawless, it is entirely misleading to state that the original More Guns, Less Crime hypothesis has now been tested many times over the past decade and a half, with a majority “finding some support for the hypothesis that shall-issue laws reduce crime” (MLM 2013, 26).

A more helpfully accurate statement would be that the NRC’s 2005 report concluded that all of the previous articles that appeared to provide support for the More Guns, Less Crime hypothesis in fact did *not* provide credible statistical support for that view. Moreover, our *ALER* paper (and NBER update) identifies some of the precise econometric errors that led those papers astray. MLM also fail to engage in any way with the important methodological questions of proper econometric technique that are raised in our study. For example, ADZ demonstrate that many of the papers that MLM count as supportive of a beneficial impact of RTC laws fail to use clustered standard errors, which is now standard practice in panel data econometrics (Bertrand, Duflo, and Mullainathan 2004). It is not very useful to count studies that are now known to be fatally flawed in assessing the findings of a body of statistical evidence.

The use of clustering is just one example of a substantive issue raised by ADZ but left unanswered by MLM. MLM also fail to engage with central claims about the sensitivity of estimates to changes in the time period of analysis (crime declined rapidly after 1992, and more markedly in non-RTC states than in RTC states), about the different estimates produced using state-level versus county-level data, about the choice of control variables included in the specification, about the wild divergence of estimates when state linear trends are either omitted or included, and about the claim that the strongest statistical support that can be gleaned from the most accurate and complete data is not that RTC laws generate any net benefits, but rather that RTC laws *increase* aggravated assaults (and gun-related assaults in particular). These are the issues that merit scholarly attention, rather than MLM’s focus on the small and now pre-empted side issue of replication of some methodologically suspect and no longer current NRC regression.

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About the Authors



Abhay Aneja is a J.D. candidate at Stanford Law School. He has previously worked as a research fellow at Stanford University and Yale University. His email address is anejaa5@gmail.com.



John J. Donohue III is C. Wendell and Edith M. Carlsmith Professor of Law at Stanford University. He is well known for using empirical analysis to determine the impact of law and public policy in a wide range of areas, including examinations of the impact on crime of the death penalty, incarceration, guns, and the legalization of abortion. He is a member of the American Academy of Arts and Sciences, a Research Associate of the National Bureau of Economic Research, and formerly the empirical editor of the *American Law and Economics Review*, and the president of the American Law and Economics Association. Donohue received his B.A. from Hamilton College, his J.D. from Harvard University, and his Ph.D. in economics from Yale University. His email address is donohue@law.stanford.edu.



Alexandria Zhang is a Ph.D. candidate at Johns Hopkins University and a member of the research staff at the Census Bureau's Center for Economic Studies. Her email address is azhang4@jhu.edu.

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