Guns and Crime

James LeDoux, Carly Munnelly & Jack Grella

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Introduction

The debate of whether or not guns cause or prevent more crime has been a hot topic in recent years in the United States. One side of the debate argues that increased gun ownership leads to an increase in the absolute number of criminals, or the number of current criminals becoming active, by making it easier to commit crimes. They encourage criminals who are inclined to commit crimes to do so and further, and in a violent manner. However, others argue that increased gun ownership leads to decreased crime because it deters criminals from engaging in criminal activity due to the fear that the intended target could use a gun to defend themselves.

A good example of the ambiguity of the direction of the relationship is effect of gun ownership on homicide rates. It has been found that 70% of homicides involve gun activity, however the direction of causation is unclear in this relationship. If we assume that guns increase the likelihood of causing conflict, then we would find that increases in gun ownership lead to increases in homicide. Alternately, if criminals find that the target of their crime is likely to own a gun they may be less likely to commit that crime based on their fear for their own safety, therefore making the relationship negative (Duggan 2001).

The empirical research on this topic are mixed. This contradiction in results is likely due to a lack of credible and accessible data on gun ownership in the United States. Many researchers are using different sources and different proxies for gun ownership because the true data does not exist. The General Social Survey, suicide rates by firearm (Moody and Marvell), and the circulation of gun magazines (Duggan 2001) have all been used as attempted proxies for gun ownership, but it is difficult to say how well these truly estimate the amount of guns in the US.

More research is needed to make definitive statements about the effects of gun ownership on crime rates. This information is important for policy makers, so the government can produce educated legislation that results in the betterment of the American society as a whole. Everybody agrees that crime is bad for society, however the question raised is whether restricting gun ownership is an effective way to reduce this.

Moody & Marvell, *Guns and Crime* (2005)

Carlisle Moody and Thomas Marvell conducted a study to address the question does gun ownership increase or decrease crime rates? They used data from across the United States from 1977 to 1998 from various sources that measure crime and gun ownership.

In Moody & Marvell's study, they measured crime and arrest rates through the FBI Uniform Crime Reports and focus on major violent crimes, which are defined as murder, rape, robbery, assault, and burglary. Prison population, unemployment, age and income are all from the U.S. census data. The percentage of suicide by firearm is another proxy the authors used to estimate gun ownership. This is also measured through the General Social Survey's questions on gun ownership. Although this survey does not ask about gun ownership each year, it is among the best data available on gun ownership in the United States. Previous studies have used magazine circulation data as a proxy for gun ownership and the authors of this study show that this data is not as highly correlated with the GSS data, as is the percentage of gun suicide. This is the reason why the Moody and Marvell estimate the missing values of gun ownership through percentage of suicide by firearm rather than the circulation of "American Rifleman", "American Hunter", "American Handgunner" and "Guns & Ammo", which are used in previous studies that found contradictory results (Duggan 2001).

The results from the regressions show that the coefficients on guns in all the crime equations are very small and most are insignificant at a 10% significance level. They make the conclusion that the net effect of crime is zero in the long run. The only exception to this is rape, where there is a small but positive and significant effect. The authors conclude that the direction of causality in this relationship is ambiguous; is increased gun ownership causing more people to become rapists or are people who are raped more likely to afterward own a gun? This is impossible to know from the data. They also have an interesting finding that prison incarceration rates are significantly negative in all crime equations except for assault. They assume that prison rates would have a negative relationship with crime; the more criminals in jail, the fewer criminals out in the public to commit crimes. Moody and Marvell also test the hypothesis that crime causes gun ownership by running Granger causality test, they doing that there are no significant effect of handguns on crime besides a small negative effect on assault. The authors

hypothesize the reason they found handguns have no significant effect on crime may be due to an equilibrium between the amount of people who use guns for crime and the amount of people who use guns for defense.

Our Data

We used the publicly available Uniform Crime Report (FBI) for crime rates, General Social Survey (National Opinion Research Center) for polling data on gun ownership rates, the CDC Wonder mortality database for suicide statistics, and the "statecrime" data set from the BCUSE directory for data on prison populations and US African American population**.** Additionally, we used the Census Bureau, Bureau of Justice Statistics, World Bank, and Office of Personnel Management to control for military employment, population age distribution, income, unemployment, and other population factors. Sometimes this entailed updating older data sets with new values, and other times it meant creating new columns in our data altogether. For model improvements, we used a measurement of domestic gun production minus gun exports as a proxy for US gun sales, which was available from the Bureau of Alcohol, Tobacco, Firearms and Explosives from 1986 to present. We also attempted to use Gallup polling data on US gun ownership, but this information did not prove to be significant when used alongside the GSS data.

The UCR and GSS data were collapsed to give nation-wide data by year. These data sets gave consistent data from the mid 1970s onward, but the CDC's suicide data was not available before 1980, so that is where our data set begins. After normalizing all values by population and, for monetary values, by interest rate, we had nation-level data that was comparable across years.

We were unable to replicate Marvell & Moody's use of magazine circulation data for the period they test, since the body providing this data, the Alliance for Audited Media, does not provide this information prior to 2004 without paying a significant fee. We did obtain what was available online, however, getting circulation for three of the study's four magazines from 1999-2014. While this did not allow us to use these variables during the replication of the study with pre-1999 data, we do not believe that it will diminish the quality of our results, since the study we are replicating only includes these variables in order to show that they are poor proxies for gun ownership, which we were still able to show with the 1999-2014 data.

There were also difficulties in perfectly replicating the values of some of our study's control variables. For many of the Moody study's population control variables, the authors do not discuss how they defined their variables or in which ways they scaled them. For these variables, such as military employment, urban population percentage, and real per capita income, we took it upon ourselves to find the data from credible sources and define them as we saw fit. We are not concerned with these differences, first because we are confident that our data is correct, and second because the Marvell & Moody study is a favorite coefficient model that is only concerned with the effects of gun ownership and prison populations on crime rates, meaning that the differing coefficients of the population control variables are not essential to the analysis.

We improve upon the original Marvell & Moody data set by gathering significantly more data, extending the original 21 year study to now cover a 33 year period. We also include data on domestic gun production and additional gun ownership polling data from the sources previously discussed, with hopes of these serving as strong proxies for gun ownership.

Table 1. Correlation of Proxy Variables to General Social Survey Responses

Proxies	Definition	*N*	GSSHG	GSSGUN
PGS	Percentage gun suicide	1050	0.576	0.618
AMRMMS	*American Rifleman* circulation	950	0.144	0.181
AMHMS	*American Hunter* circulation	950	0.196	0.331
AMHGS	*American Handgunner* circulation	1100	0.169	0.134
GUNSAMM	*Guns & Ammo* circulation	1150	0.258	0.288
PHG	Imputed HG	1050	0.772	
PGUN	Imputed GUN	1050		0.795

GSSHG is the proportion of households reporting a handgun, GSSGUN is the proportion of households reporting a gun, including handguns, rifles, or shotguns. Magazine circulations are per capita. The reported correlation is the simple correlation across time and states over the entire sample. All variables are measured in their natural units. Definitions and means are given in Table 3.

Table 1 from "Guns and Crime" shows the correlation of the potential proxy variables for the missing data in gun ownership. It is clear that the correlation between percentage gun suicide is higher with both GSS handgun ownership data and GSS total gun ownership data relative to all of the other magazine data. Imputed gun and handgun data are highly correlated with the actual data, as is expected. This is why Moody and Marvell decide to use percentage gun suicide and imputed gun ownership rates as proxies for gun ownership rather than magazine circulation

data. Further, these correlation results challenge the accuracy of Duggan's (2001) findings who uses this data and concludes that an increase in gun ownership leads to an increase in crime.

Table 2. Regressions of GSSHG and GSSGUN on Percentage Gun Suicide

Dependent Variable	Coefficient	*t* Ratio	R^2	*N*
GSSHG				
Intercept	−15.617	5.73	0.33	488
PGS	0.679	15.49		
GSSGUN				
Intercept	−7.145	2.21	0.38	486
PGS	0.896	17.28		

Variables are measured in their natural units.

	(1) gun	(2) hg
pgs	107.0***	28.33*
	(4.75)	(2.88)
_cons	-21.54	5.827
	(-1.67)	(1.04)
N	18	18
R-sq	0.585	0.341

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 2 shows the regression of the GSS handgun data and GSS total gun data on percentage gun suicide. The t value from these regressions are very large, which shows that it is largely statistically significant. We replicated these regressions with our data in table to the left, our results show coefficients with the same sign and are statistically significant at the 5% significance level. The magnitudes of our coefficients differ because Moody and Marvell used logs of their variables in these regressions.

Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
hg	12	22.6884	1.677748	19.61415	25.36443
phg	19	23.71904	2.910708	19.61415	31.32
gun	12	42.46342	3.436052	34.88746	47.5862
pgun	19	44.57058	6.567006	34.88746	61.51
pgs	19	.5911144	.0108126	.5698773	.6110464
majorcrime	19	3560.47	297.7261	2856.288	4084.885
murder	19	71.00268	9.401076	49.20665	82.06527
rape	19	119.4963	15.51166	86.57603	138.6235
robbery	19	541.0841	60.39263	392.4765	631.6323
assault	19	1380.042	260.653	988.3822	1778.115
burglary	19	1448.844	301.2531	905.8124	1937.712
prison	19	2515.815	843.9406	1262.872	3894.616
metpct	19	.7538584	.0139979	.7373769	.7817549
ampct	19	.1216259	.0036911	.1169504	.1273914
military	19	7.920651	1.540335	5.206329	9.267693
employ	19	.4250633	.0235968	.386197	.4667898
unrate	19	6.642105	1.420217	4.5	9.7
rpci	19	24643	2395.349	21160	29206
p1524	19	16.17234	1.562157	14.79819	19.34262
p2544	19	31.201	1.429807	28.24698	32.99559
p4564	19	19.73846	.9482306	18.88541	21.8
pop	19	247879.6	13639.33	226549	270248

The table above reports the summary statistics of data we gathered for variables in the years pre-1999. We made this table pre-1999 to compare our data to Moody & Marvell's, whose summary statistics are posted in the table at the end of this section. Our summary statistics from 1980-2013 will be posted in section 5. Our statistics for GSS handgun prevalence, imputed handgun prevalence, GSS gun prevalence, imputed guns, and percentage gun suicide percentage (PGS) all agreed with Moody & Marvell's (scale PGS two decimal points). In the paper, they said that handguns are more likely to be used in crimes, or to defend against crimes. In our results, we agreed, and found "handgun prevalence" to be much more significant and accurate with crime rates than "all gun prevalence."

Our summary statistics of the major crime rates for all major crimes (murder, rape, robbery, assault) are different than Moody & Marvell's because their paper measured and scaled the number of major crimes using different methods that we did. We know the crime rates that

we used are the same because Moody & Marvell used the FBI Uniform Crime Report. When we measured the FBI's Uniform Crime Rate measures against the "bcuse statecrime" crime rates, we saw that the crime rates we gathered independently matched almost perfectly with the crime rates of the bcuse data. This confirms that although our crime rate means are different than seen in the Moody & Marvell study, we are still likely measuring the same underlying rates (See exhibit **1**).

To fix the gun ownership data to make numbers more consistent in our study, we dropped one improbable outlier from 2008 (See exhibit **2**).

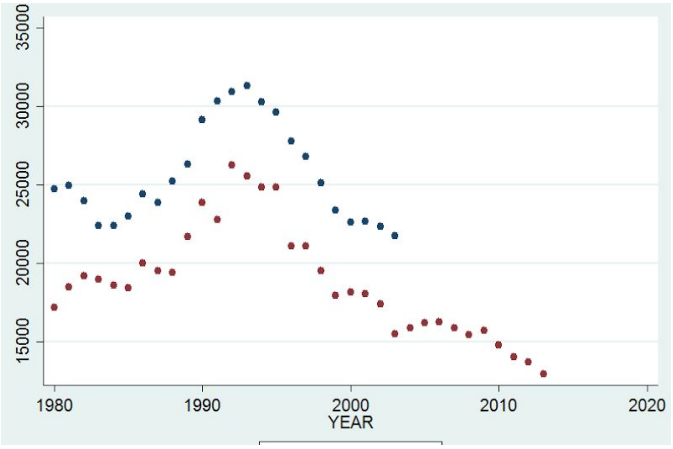

Exhibit 1

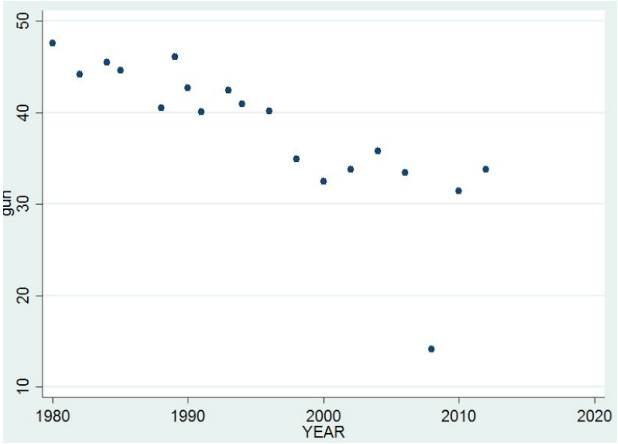

Exhibit 2

Our statistics for the variables Prison population and Unemployment Rate were very similar to the results given by Moody & Marvell. We had the same sources to get our data for those variables. For the military data, Moody & Marvel did not state a source for acquiring their data, so we used a ratio of military personnel per a population from the Office of Personnel Management. The Employment variable's figures look different because we took data from the Bureau of Labor Statistics on total payroll employment in the US in their Current Employment Statistics survey, which is a percentage of total population. Moody & Marvel don't tell us where they got their employment information, or what it means. Our Real Per Capita Income variable is a direct number taken from the United States Census, while Marvell & Moody did not specify the meaning or source of this control variable. Our mean percentage for the urban population in America is 75%, and was taken from the World Bank. For the African American percentage variable, we used the bcuse data and updated all the missing years with data from the US Census and got a mean of 12%. Both these percentages didn't have sources in Moody & Marvell's study.

For Percentage Population Statistics, our group got our data from the US Census and divided age group populations, and then age population percentages, into three separate variables instead of six. These three variables were ages 15-24, 25-44, and 45-64. After acquiring this data and uploading it to our data set, we compared it to the data Moody & Marvel had on their age groups. If you add the means of their age group percentages [(15-19 + 20-24) ; (25-34 + 35-44) ; (45-54 + 55-64)], you will get the same mean statistics that we were able to find on age group percentages of population. Population mean for our studies before 1999 were identical.

Additionally, one reason why our variables could be slightly skewed is because Moody & Marvel's study started three years before ours.

Table 3. Variable Names, Definitions, and Means

Variable	Label	Mean
HG	GSS handgun prevalence (%)	25.922
PHG	Imputed handgun prevalence (%)	25.481
GUN	GSS gun prevalence (%)	48.588
PGUN	Imputed guns (%)	47.351
PGS	Percentage gun suicide	60.491
GUNSAMM	*Guns & Ammo* circulation	2429.830
AMHGS	*American Handgunner* circulation	597.240
AMHMS	*American Hunter* circulation	6572.120
AMRMMS	*American Rifleman* circulation	6659.130
CRMAJ	Major crime per million population	15,936.020
CRMUR	Murder per million population	68.359
CRRAP	Rape per million population	354.064
CRROB	Robbery per million population	1452.410
CRASS	Assault per million population	2923.820
CRBUR	Burglary per million population	11,137.360
PRISON	Prison population per capita	2272.840
AOMAJ	Arrest rate, major crime	20.202
AOMUR	Arrest rate, murder	87.344
AORAP	Arrest rate, rape	36.591
AOROB	Arrest rate, robbery	29.408
AOASS	Arrest rate, assault	43.196
AOBUR	Arrest rate, burglary	12.984
METPCT	Percentage urban	63.795
AMPCT	Percentage African-American	9.570
MILITARY	Military employment	5.089
EMPLOY	Total employment	27.080
UNRATE	Unemployment rate	6.192
RPCPI	Real per capita personal income	13.184
RPCIM	Real per capita income maintenance	0.170
RPCUI	Real p.c. unemployment insurance	0.067
RPCRPO	Real p.c. retirement payments	0.483
P1517	Percentage population 15–17	4.649
P1824	Percentage population 18–24	11.218
P2534	Percentage population 25–34	16.152
P3544	Percentage population 35–44	14.247
P4554	Percentage population 45–54	10.567
P5564	Percentage population 55–64	8.684
POP	Population	5012.130

Regression Results

Moody & Marvell's regression results are reported in table 4 and 4 extended. The statistically significant variables are bolded, however they did not specify at what level these variables are being tested for significance. The most important finding reported in the regression results is that the coefficient on guns is numerically very small, fluctuates between positive and negative depending on the crime and generally is not statistically significant. They use this finding to strengthen their conclusion that gun ownership has no effect on crime rates. Guns only have a statistically significant positive effect on rape, but the coefficient is very small and they conclude it may be due to reverse causation.

They found that the prison coefficient was negative and significant except for in the regression on assault. The logic behind the negative relationship is that as prison population increases, less criminals are on the streets and therefore less crimes are committed.

The other interesting finding in their regression output is that unemployment does not have a consistent statistically significant positive relationship with all crime measures. The logical hypothesis for this relationship is that higher unemployment means that more people are desperate for money, stressed or anxious, and therefore more likely to commit a crime. Moody & Marvell's results contradict this hypothesis. Income had a strong negative and statistically significant relationship with crime rates, as income increases, crime rates decrease. This can be explained through the same logic used for the relationship between unemployment and crime: as income increases, people are less desperate, less stressed and worried about their stability and means of survival and therefore are less likely to commit crimes.

Table 4. Long-Run Models[a]

	Major Crime				Murder				Rape			
	GSSHG		PHG		GSSHG		PHG		GSSHG		PHG	
Variable	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio
Guns	0.00019	0.48	0.00005	0.15	−0.00014	0.23	−0.00033	0.56	0.00078	1.55	**0.00078**	**1.73**
Prison	**−0.07993**	**6.48**	**−0.07778**	**9.71**	**−0.12239**	**6.26**	**−0.11970**	**8.80**	**−0.07248**	**4.57**	**−0.05911**	**5.64**
Arrests	**−0.00244**	**2.78**	**−0.00275**	**4.23**	**−0.00069**	**2.66**	**−0.00046**	**2.88**	−0.00097	1.51	**−0.00098**	**2.30**
METPCT	−0.00205	0.29	0.00645	1.96	−0.00678	0.60	0.00202	0.36	−0.01085	1.18	0.00382	0.89
AMPCT	**−0.06784**	**5.88**	**−0.06484**	**8.28**	**0.07147**	**3.91**	**0.06160**	**4.63**	**−0.06649**	**4.44**	**−0.07091**	**6.91**
EMPLOY	**−0.03532**	**3.64**	**−0.02884**	**4.09**	0.02196	1.46	0.00101	0.09	**−0.07749**	**6.18**	**−0.09746**	**10.58**
UNRATE	0.00013	0.02	−0.00082	0.22	**−0.02626**	**3.91**	**−0.03392**	**5.53**	**−0.01692**	**2.49**	**−0.01213**	**2.54**
P1517	**13.16622**	**3.60**	**3.85463**	**1.80**	0.41840	0.07	−4.78869	1.32	5.03504	1.07	**7.11067**	**2.55**
P1824	1.04390	0.66	**1.89184**	**2.05**	−0.38562	0.16	1.60937	1.04	−1.80779	0.90	1.42613	1.19
P2534	**13.10214**	**8.97**	**10.32273**	**11.93**	**5.15925**	**2.24**	**5.77788**	**3.96**	0.94669	0.50	**4.02570**	**3.56**
P3544	−0.37994	0.24	**−2.48008**	**2.40**	2.87686	1.14	0.57067	0.33	**11.34025**	**5.55**	**12.06604**	**8.94**
P4554	**−4.86070**	**2.15**	**−4.50682**	**3.15**	−0.22909	0.06	−0.63158	0.26	**−12.31786**	**4.23**	**−9.37906**	**5.00**
P5564	**11.52524**	**5.28**	**11.39638**	**8.12**	5.24728	1.51	0.64319	0.27	**19.96232**	**7.10**	**14.34768**	**7.82**
RPCPI	**−0.04204**	**3.47**	**−0.04781**	**6.26**	−0.01173	0.61	**−0.04121**	**3.17**	**0.02571**	**1.65**	0.00817	0.82
RPCIM	0.05278	0.22	0.01164	0.07	0.17799	0.46	0.02433	0.08	−0.22450	0.72	**−0.44973**	**2.02**
RPCUI	0.26027	1.08	0.17891	1.09	0.02020	0.05	0.22678	0.84	−0.22022	0.71	**−0.38067**	**1.77**
RPCRPO	−0.07090	1.43	**−0.05066**	**1.78**	**−0.28817**	**3.66**	**−0.33674**	**6.99**	−0.01854	0.29	−0.01015	0.27
Intercept	**8.81553**	**11.09**	**9.31631**	**19.81**	**2.51757**	**2.02**	**3.22840**	**4.11**	**6.09541**	**6.06**	**4.55357**	**7.53**

Table 4. Extended

Robbery				Assault				Burglary			
GSSHG		PHG		GSSHG		PHG		GSSHG		PHG	
Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio	Coeff	*t* Ratio
0.00007	0.11	−0.00005	0.08	−0.00001	0.01	0.00013	0.26	0.00018	0.43	0.00000	0.01
−0.12785	**6.32**	**−0.12775**	**9.34**	−0.02153	1.31	**−0.02908**	**2.50**	**−0.09891**	**7.28**	**−0.09195**	**10.45**
−0.00038	0.88	−0.00062	1.63	**−0.00094**	**1.86**	**−0.00199**	**5.28**	**−0.00914**	**4.34**	**−0.00575**	**4.10**
0.03157	**2.69**	**0.01547**	**2.76**	0.00738	0.77	0.00223	0.47	−0.00001	0.00	**0.00816**	**2.27**
−0.08330	**4.36**	**−0.08425**	**6.30**	**−0.03488**	**2.28**	**−0.03564**	**3.14**	**−0.07890**	**6.20**	**−0.08133**	**9.46**
0.01195	0.77	0.00969	0.82	0.01696	1.33	**0.03092**	**3.06**	**−0.05160**	**4.76**	**−0.05185**	**6.64**
0.00839	0.98	−0.00244	0.40	**−0.01447**	**2.09**	**−0.00906**	**1.72**	0.00154	0.27	0.00044	0.11
13.38347	**2.24**	−1.62086	0.45	−3.26775	0.67	0.31076	0.10	**15.91996**	**3.97**	**5.55330**	**2.37**
2.74952	1.07	**5.47112**	**3.51**	**6.69634**	**3.21**	**2.59420**	**1.95**	−1.09811	0.64	1.05279	1.04
14.34496	**6.07**	**13.58148**	**9.29**	**6.11655**	**3.17**	**5.18275**	**4.16**	**12.65495**	**7.89**	**10.40270**	**10.97**
2.48301	0.95	−0.51036	0.29	**4.00709**	**1.90**	2.16343	1.44	−1.36918	0.78	**−3.01415**	**2.66**
−10.61787	**2.88**	**−7.70906**	**3.17**	−4.47110	1.49	**−7.87229**	**3.80**	**−5.31759**	**2.15**	**−3.77590**	**2.42**
16.95328	**4.74**	**17.46334**	**7.31**	**7.55551**	**2.61**	**10.02619**	**4.93**	**13.34774**	**5.56**	**12.91734**	**8.41**
0.00331	0.17	**−0.02432**	**1.86**	**−0.02904**	**1.81**	−0.00620	0.56	**−0.04440**	**3.32**	**−0.05650**	**6.73**
−0.67761	**1.71**	−0.16346	0.57	**0.59022**	**1.84**	0.27171	1.10	0.00308	0.01	−0.01560	0.08
−0.45967	1.19	−0.05838	0.21	0.48428	1.55	0.14678	0.63	**0.53048**	**2.05**	**0.39974**	**2.28**
−0.13098	1.61	**−0.17035**	**3.52**	−0.02873	0.44	−0.03183	0.77	−0.06457	1.19	−0.02930	0.94
3.29471	**2.56**	**5.24079**	**6.63**	**6.39846**	**6.05**	**7.41994**	**10.89**	**8.94598**	**10.41**	**9.28541**	**18.23**

Tables 4.1 and 4.2 are our regression results, they were generally consistent with Moody & Marvell, however they did diverge for a few variables. We regressed all of the variables on each of the crime variables through two separate models, one with the regular handgun data and the other with imputed handgun data, this is the way Moody & Marvel ran their regressions as well. Generally, our regression results produced coefficients with the same sign and were consistent with significance levels.

The coefficient for handgun is still not statistically significant for most of the data, although our regression does show that it is significant at the 10% significance level on burglary. This finding may be different because Moody & Marvell do not explicitly state the significance level they are testing at and thus, it may be lower than the 10% that we used. Generally, gun ownership does not have an effect on crime rates.

Tables 4.1 and 4.2:

	(1) majorcr~e	(2) majorcr~e	(3) mc_noas~t	(4) mc_noas~t	(5) murder	(6) murder
hg	116.7		75.03		1.697	
	(0.95)		(3.41)		(0.36)	
prison	2.343	3.667***	0.268	1.628***	0.0905	0.0962**
	(0.42)	(2.66)	(0.27)	(2.39)	(0.43)	(1.88)
metpct	32440.0	-95127.0	69173.3	-56443.0	-3416.5	-3035.9
	(0.06)	(-0.72)	(0.74)	(-0.83)	(-0.17)	(-0.66)
ampct	-48820.7	-5805.4	-68342.5	-1456.1	4979.8	2349.4
	(-0.12)	(-0.04)	(-0.91)	(-0.02)	(0.31)	(0.43)
employ	-10967.3	-12402.6	5426.6	-1911.3	-815.2	-633.3
	(-0.28)	(-0.62)	(0.77)	(-0.17)	(-0.55)	(-0.87)
unrate	-54.63	-127.0	86.40	-11.22	-3.964	-5.002
	(-0.17)	(-0.88)	(1.53)	(-0.12)	(-0.33)	(-0.94)
p1524	-1009.8	-68.08	-441.7	-152.2	-71.89	-16.30
	(-0.37)	(-0.06)	(-0.89)	(-0.27)	(-0.69)	(-0.38)
p2544	-1551.5	-665.1	-688.8	-490.4	-87.51	-32.32
	(-0.49)	(-0.54)	(-1.21)	(-0.82)	(-0.72)	(-0.74)
p4564	-1902.9	-867.6*	-1067.5	-474.6**	-62.63	-33.15**
	(-1.29)	(-1.79)	(-4.05)	(-1.98)	(-1.12)	(-1.90)
rpci	-0.286	-0.240***	-0.188	-0.122*	-0.00301	-0.00485
	(-0.72)	(-2.46)	(-2.64)	(-1.85)	(-0.20)	(-1.33)
phg		53.41***		26.33***		0.624
		(4.05)		(4.94)		(1.40)
_cons	90804.0	116495.3	7394.6	71211.0	7349.9	4165.3
	(0.20)	(0.82)	(0.09)	(1.03)	(0.42)	(0.84)
N	12	19	12	19	12	19
R-sq	0.980	0.950	1.000	0.987	0.972	0.933
adj. R-sq	0.778	0.887	0.995	0.970	0.689	0.849

t statistics in parentheses
* p<0.15, ** p<0.10, *** p<0.05

	(1) rape	(2) rape	(3) robbery	(4) robbery	(5) assault	(6) assault	(7) burglary	(8) burglary
hg	10.43		12.98		41.67		49.92**	
	(3.47)		(1.03)		(0.41)		(6.46)	
prison	-0.266	0.0131	0.768	0.711***	2.075	2.039***	-0.324	0.808**
	(-1.97)	(0.18)	(1.35)	(2.71)	(0.46)	(2.49)	(-0.94)	(2.24)
metpct	39797.8	6450.3	-30261.4	-25503.4	-36733.2	-38684.2	63053.3	-34353.9
	(3.12)	(1.32)	(-0.56)	(-1.10)	(-0.09)	(-0.55)	(1.92)	(-0.86)
ampct	-33507.5	-8174.0	28123.1	11486.2	19521.7	-4349.0	-67937.8	-7117.9
	(-3.27)	(-1.44)	(0.65)	(0.43)	(0.06)	(-0.05)	(-2.58)	(-0.14)
employ	-875.1	-2203.6***	-3448.6	-1816.3	-16393.9	-10491.3	10565.4*	2741.9
	(-0.91)	(-2.68)	(-0.86)	(-0.50)	(-0.51)	(-0.96)	(4.29)	(0.36)
unrate	-3.943	-14.33***	-27.84	-20.95	-141.0	-115.8	122.2*	29.06
	(-0.51)	(-2.44)	(-0.86)	(-0.78)	(-0.55)	(-1.51)	(6.18)	(0.44)
p1524	63.30	-9.743	-432.6	-49.59	-568.0	84.13	-0.562	-76.58
	(0.94)	(-0.24)	(-1.52)	(-0.23)	(-0.25)	(0.12)	(-0.00)	(-0.27)
p2544	74.39	-7.586	-546.9	-155.3	-862.7	-174.7	-128.8	-295.2
	(0.95)	(-0.18)	(-1.67)	(-0.70)	(-0.33)	(-0.25)	(-0.64)	(-0.94)
p4564	-147.7	-50.18*	-352.6	-140.4**	-835.4	-393.0	-504.6*	-250.9
	(-4.10)	(-1.69)	(-2.33)	(-1.90)	(-0.69)	(-1.18)	(-5.45)	(-1.56)
rpci	-0.0299	-0.00586	-0.0522	-0.0496***	-0.0978	-0.118***	-0.103	-0.0616
	(-3.08)	(-1.51)	(-1.28)	(-2.63)	(-0.30)	(-2.43)	(-4.11)	(-1.33)
phg		1.159		7.262***		27.08***		17.28***
		(1.50)		(3.37)		(2.83)		(5.77)
_cons	-24668.9	-1248.4	51651.8	26962.7	83409.3	45284.6	-26937.9	41331.1
	(-2.19)	(-0.24)	(1.09)	(1.06)	(0.22)	(0.58)	(-0.93)	(1.13)
N	12	19	12	19	12	19	12	19
R-sq	0.996	0.928	0.995	0.958	0.981	0.977	1.000	0.991
adj. R-sq	0.952	0.839	0.945	0.905	0.786	0.949	0.999	0.980

t statistics in parentheses
* p<0.15, ** p<0.10, *** p<0.05

Our coefficient on prison is only negative in the regression on rape without the imputed handgun data in the model, in all other models the prison coefficient is positive. However, unlike the regression results produced by Moody & Marvell the coefficient on prison is not always statistically significant; in fact, it is only statistically significant when in the model with imputed handgun rather than handgun. We are not surprised by this outcome because imputing the handgun variable nearly doubled our number of observations. We found that the prison coefficients that were statistically significant were positive, which disagrees with Moody & Marvell's statistically significant negative coefficients on prison. Their data also differs in that the coefficient on prison is statistically significant in both models, not only the model with the imputed handgun data. We theorize that our findings from the prison variable could be due to a reverse causation; when there are more crimes, criminals are more likely to get sent to prison and thus prison populations will rise.

Analysis Improvement

Our first and most significant improvement to the study was that we added more years worth of data. The Moody study spans a 21 year period, from 1977 to 1998, and we were able to collect the same information from 1980 to 2013, which is 12 years longer. The summary statistics for this larger period are as follows:

Variable	Obs	Mean	Std. Dev.	Min	Max
hg	18	21.98146	1.817954	19.54211	25.36443
phg	34	22.03952	3.326157	14.11649	31.32
gun	18	39.45497	5.239202	31.3982	47.5862
pgun	34	38.79881	9.115436	16.97	61.51
pgs	34	.5614011	.0378963	.5015319	.6110464
gunsamm	15	466437.9	71868.12	378380	607971
amhms	15	1006393	94815.7	913361	1203639
amrmms	15	1568245	259355.9	1244714	2201042
majorcrime	34	3033.334	652.4287	1941.318	4084.885
murder	34	55.25775	19.56728	27.10269	82.06527
rape	34	95.24037	30.80049	48.88784	138.6235
robbery	34	440.0945	125.3833	251.1943	631.6323
assault	34	1288.403	232.4096	963.8104	1778.115
burglary	34	1154.339	404.2253	650.3223	1937.712
prison	34	3187.431	993.7982	1262.872	4232.373
metpct	34	.7743909	.026215	.7373769	.81
ampct	34	.1234065	.0036672	.1169504	.129
military	34	6.619693	1.874357	4.731749	9.267693
employ	34	.4347168	.023482	.386197	.4739434
unrate	34	6.464706	1.646094	4	9.7
rpci	34	26996.47	3247.484	21160	30943
p1524	34	15.06219	1.889766	12.16	19.34262
p2544	34	28.78248	4.041572	20	32.99559
p4564	34	22.05091	2.936961	18.88541	26.76
pop	34	270009.5	28490.13	226549	316500

Comparing these summary statistics with those from the earlier period, a few trends are worth noting. First, the percent of households owning guns has trended down since 1998, with the average imputed gun value dropping from 44.5 to 38.7%. Second, while crime rates fell in all categories from 1998 to 2013, the prison population grew substantially, reflecting an interesting and counterintuitive trend in both crime and US law enforcement. One more trend worth noting is that the population continued to age in the recent years that were added, with the middle age group shrinking in proportion and the older one growing.

With this new data included, here are the new results of the previously run regressions:
Table 1 is the regression for 1980-2013, Non-Imputed data
Table 2 is the regression for 1980-2013, Imputed data

Table 1:

	(1) majorcr~e	(2) mc_noas~t	(3) murder	(4) rape	(5) robbery	(6) assault	(7) burglary
hg	65.08***	28.22*	0.900	-0.0466	8.533	36.87***	18.83*
	(3.04)	(1.65)	(1.06)	(-0.04)	(1.32)	(3.67)	(1.71)
prison	1.486***	0.735***	0.0296**	0.0272*	0.372***	0.752***	0.306
	(4.21)	(2.40)	(2.07)	(1.62)	(3.59)	(4.12)	(1.44)
metpct	-38737.7***	-28813.7***	-591.1	-490.6	-8081.3**	-9923.9*	-19650.7***
	(-3.24)	(-2.58)	(-1.20)	(-0.83)	(-2.16)	(-1.69)	(-2.39)
ampct	-75794.9***	-50438.9***	-992.2	-866.2	-17348.0***	-25355.9*	-31232.5***
	(-2.91)	(-2.75)	(-1.15)	(-0.39)	(-3.36)	(-1.81)	(-2.43)
employ	-5128.3	-4168.9	-591.5	-1651.4**	-2628.9	-959.5	702.9
	(-0.29)	(-0.35)	(-0.95)	(-2.13)	(-0.68)	(-0.10)	(0.09)
unrate	40.73	9.678	-1.070	-6.533	-12.15	31.05	29.43
	(0.56)	(0.12)	(-0.35)	(-1.58)	(-0.58)	(0.78)	(0.49)
p1524	51.80	43.09	0.145	-2.692	7.776	8.710	37.86*
	(1.19)	(1.39)	(0.09)	(-0.77)	(0.68)	(0.37)	(1.83)
p2544	18.94	-3.229	0.749	2.665**	-0.665	22.17	-5.979
	(1.13)	(-0.19)	(1.34)	(2.04)	(-0.17)	(1.55)	(-0.39)
p4564	-3.214	42.90	-4.458	-8.658	-5.134	-46.12	61.15
	(-0.03)	(0.53)	(-1.09)	(-1.50)	(-0.21)	(-0.66)	(1.07)
rpci	-0.149	-0.0991	-0.00147	0.00312	-0.0447	-0.0503	-0.0561
	(-0.96)	(-1.21)	(-0.31)	(0.41)	(-1.58)	(-0.58)	(-1.13)
_cons	40960.4***	30234.2***	899.2**	1326.7***	9905.9***	10726.2***	18102.3***
	(3.67)	(2.98)	(1.92)	(3.34)	(2.87)	(2.49)	(2.58)
N	18	18	18	18	18	18	18
R-sq	0.982	0.991	0.977	0.975	0.977	0.957	0.993
adj. R-sq	0.956	0.979	0.944	0.939	0.945	0.896	0.982

t statistics in parentheses
* p<0.15, ** p<0.10, *** p<0.05

Table 2

	(1) majorcr~e	(2) mc_noas~t	(3) murder	(4) rape	(5) robbery	(6) assault	(7) burglary
phg	40.21***	18.71***	0.306	0.362	5.723***	21.50***	12.32***
	(5.78)	(3.59)	(1.13)	(0.80)	(2.79)	(5.56)	(3.58)
prison	1.362***	0.584***	0.0249***	0.0221***	0.310***	0.778***	0.226***
	(6.13)	(3.94)	(3.23)	(2.08)	(5.70)	(4.85)	(2.36)
metpct	-33368.2***	-26362.7***	-411.3	-753.0**	-7380.4***	-7005.5	-17818.0***
	(-3.99)	(-4.40)	(-1.36)	(-1.74)	(-3.57)	(-1.23)	(-4.22)
ampct	-65231.3***	-38485.8***	-905.6**	-851.3*	-13108.4***	-26745.5***	-23620.5***
	(-5.60)	(-4.78)	(-1.99)	(-1.53)	(-3.42)	(-2.58)	(-3.88)
employ	-3557.5	-2216.8	-421.6	-1102.1***	-1450.3	-1340.7	757.2
	(-0.39)	(-0.36)	(-1.29)	(-3.11)	(-0.76)	(-0.25)	(0.17)
unrate	-25.31	-9.806	-2.468	-3.242	-12.79	-15.50	8.695
	(-0.50)	(-0.24)	(-1.36)	(-1.36)	(-1.15)	(-0.40)	(0.27)
p1524	28.77	32.17**	-0.702	-2.733*	4.501	-3.399	31.10***
	(1.14)	(1.79)	(-0.85)	(-1.71)	(0.63)	(-0.25)	(2.88)
p2544	13.83	-3.098	0.710*	2.575***	-2.168	16.93	-4.214
	(1.00)	(-0.33)	(1.52)	(4.28)	(-0.68)	(1.43)	(-0.62)
p4564	8.592	61.47*	-3.333**	-5.922***	-1.455	-52.88	72.18***
	(0.16)	(1.50)	(-1.78)	(-2.46)	(-0.12)	(-1.30)	(2.34)
rpci	-0.214***	-0.121***	-0.00416***	0.00222	-0.0475***	-0.0933***	-0.0714***
	(-3.86)	(-3.50)	(-2.12)	(1.16)	(-3.74)	(-2.71)	(-3.03)
_cons	38164.8***	27173.0***	774.7***	1242.6***	8678.8***	10991.8***	16476.8***
	(6.21)	(6.66)	(3.49)	(4.13)	(5.77)	(2.73)	(6.19)
N	34	34	34	34	34	34	34
R-sq	0.981	0.991	0.975	0.983	0.974	0.945	0.992
adj. R-sq	0.973	0.987	0.964	0.976	0.963	0.921	0.988

t statistics in parentheses
* p<0.15, ** p<0.10, *** p<0.05

One can immediately notice that many more variables became significant with the addition of this new data. The number of observations for the non-imputed data rises from 12 to 18, and for the imputed data they rise from 19 to 34. Most interesting of these is the effect of gun ownership on crime, which became significant and positive at the 5% level for the non-imputed measurement of all major crimes, as well as for assault and major crime without assault. Previously, the non-imputed coefficient was only significant in the model measuring burglary rates, and now it is significant in this and three other models. The coefficient of guns on rape rates became negative in this new model as well, but since it is not statistically significant, it is difficult to say if this truly means anything about an change in true effects.

Another interesting change is that prison coefficients became significant and positive for all models except in the non-imputed model of burglary rates, where previously it was only significant in non-imputed models. Additionally, we saw increased significance in the expectedly negative effects of real per capita income on crime, and also saw increased significance in the positive effects of african american and city populations on crime.

TABLE 3 is the Coefficients of the Magazine Variables when Added to the Full Imputed Model:

gunsamm	-0.00444	-0.000797	-0.0000618	0.0000434	-0.0000676	-0.00364	-0.000711
	(-0.25)	(-0.10)	(-0.13)	(0.16)	(-0.03)	(-0.39)	(-0.13)
amhms	0.000311	-0.000525	-0.0000160	-0.0000406	-0.0000929	0.000836	-0.00037
	(0.06)	(-0.20)	(-0.11)	(-0.49)	(-0.14)	(0.29)	(-0.22)
amrmms	0.000780	-0.0000429	0.00000429	-0.0000115	0.0000351	0.000823	-0.00007

As mentioned earlier, we were only able to collect data on magazine circulation from 1999 to present. Here, we added these variables to the model to see their levels of significance in the regressions on crime. As Marvell & Moody concluded, there is absolutely no effect of gun magazine circulation on crime, with the p-values of these variables being greater than 99% and near-zero magnitudes. This suggests that our omission of these variables in the earlier-period analysis was non-impactful.

Table 4 is regressions for full period with Gun Manufacturing Introduced:

Table 4:

	(1) majorcr~e	(2) mc_noas~t	(3) murder	(4) rape	(5) robbery	(6) assault	(7) burglary
phg	32.76***	15.82***	0.124	0.495	4.588**	16.94***	10.62***
	(3.45)	(2.68)	(0.33)	(1.18)	(1.93)	(3.71)	(3.26)
gunprod	0.0000411**	-0.00000589	0.00000111	0.000000781	0.00000731	0.0000470***	-0.0000151*
	(1.86)	(-0.40)	(1.14)	(0.85)	(1.09)	(3.05)	(-1.69)
prison	1.749***	0.726***	0.0359***	0.0264***	0.391***	1.023***	0.272***
	(7.04)	(4.30)	(3.55)	(2.26)	(6.43)	(8.02)	(2.83)
metpct	-44562.7***	-28303.4***	-740.4***	-1180.1***	-9967.0***	-16259.3***	-16415.8***
	(-5.59)	(-4.32)	(-2.36)	(-3.57)	(-3.77)	(-3.68)	(-4.37)
ampct	-82182.1***	-35779.5***	-1319.8**	-1345.6**	-16082.4***	-46402.6***	-17031.7***
	(-4.91)	(-3.21)	(-2.09)	(-2.01)	(-3.61)	(-3.99)	(-2.21)
employ	-18214.2**	-12904.8***	-920.8***	-665.7*	-4796.7**	-5309.5	-6521.5**
	(-1.95)	(-2.21)	(-2.55)	(-1.63)	(-2.07)	(-0.97)	(-1.83)
unrate	-33.06	-50.15	-3.102*	0.788	-15.15	17.08	-32.68
	(-0.66)	(-1.12)	(-1.53)	(0.44)	(-0.83)	(0.50)	(-1.19)
p1524	30.89	4.307	-1.647	1.562	-0.933	26.58	5.325
	(0.62)	(0.13)	(-0.85)	(0.55)	(-0.06)	(0.99)	(0.29)
p2544	51.28***	1.080	1.916***	2.554***	6.040	50.20***	-9.430
	(2.63)	(0.07)	(2.54)	(3.38)	(0.96)	(4.83)	(-1.02)
p4564	-0.146	8.562	-4.112**	-1.557	-5.628	-8.707	19.86
	(-0.00)	(0.19)	(-1.96)	(-0.90)	(-0.27)	(-0.21)	(0.79)
rpci	-0.112**	-0.0550	-0.000436	0.000635	-0.0212	-0.0570	-0.0340
	(-1.79)	(-1.46)	(-0.21)	(0.28)	(-1.35)	(-1.31)	(-1.49)
_cons	50415.6***	32548.9***	1161.1***	1283.5***	11474.8***	17866.6***	18629.6***
	(7.42)	(7.34)	(4.41)	(4.38)	(6.89)	(5.07)	(7.24)
N	28	28	28	28	28	28	28
R-sq	0.987	0.990	0.984	0.991	0.981	0.967	0.991
adj. R-sq	0.979	0.983	0.972	0.984	0.968	0.944	0.985

t statistics in parentheses
* p<0.15, ** p<0.10, *** p<0.05

The addition of gun manufacturing data into our regression makes a couple significant changes between other RHS variables and major crimes. We added the gun manufacturing variable into an imputed data regression, and it was generally insignificant in terms of impact to the different types of major crimes. Although its change is miniscule, the coefficient "gunprod" is statistically significant at the 10% level for all major crime combined. Its presence makes the PHG variable have less of an impact on major crime of every type, but didn't show differences large enough to show significant omitted variable bias in the other RHS terms without it.

Conclusion

Based on our model improvements of adding additional data and including the gun manufacturing coefficient, we find that it is more possible than Moody & Marvel originally assumed that gun ownership does have a positive effect on certain types of violent crime. However, it is still not certain that gun ownership has significant effects on these crimes because of the possibility of reverse causation, as discussed earlier. Additionally, while Moody & Marvel found a negative relationship of prison population on crime, we found a significant positive relation of prison on crime which we believe makes intuitive sense. As prison populations increase, this logically means that more crimes are being committed. While this is likely a reverse causation, we believe it is a more accurate result than that obtained by Marvell & Moody. We believe that a legislation of gun ownership in the United States of America is not warranted at this time because there is not a clearly significant causation of gun ownership on major crimes. If anything, the results of our study prove that there is additional need for research and data on this topic, as we join the vast body of prior research presenting confounding results on the relationship between guns and crime.

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