An Examination of the Impact of Police Expenditures on Arrest Rates

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ABSTRACT

The efficiency of a police force can be seen through its ability to turn expenditures into arrests. Conventional wisdom suggests that the police measure that most consistently reduces crime rates is the arrest rate. Unlike the majority of research involving crime, this paper models arrest rates for violent crime, property crime and murder as a function of police expenditures per capita, crime rates, alcoholic beverage license per capita and unemployment. Panel data estimation and fixed effect models were employed to observe fifty states over the years 1980-2007. Over the 28-year period, police expenditures were significantly linked to each of the three arrest categories. Using time windows of 1980-1989 and 1990-2007, the difference in effects of expenditures on arrests is notable. During the 1980s, the impact of state and local police expenditures was statistically insignificant at the .05 level for all types of arrests. However, during the 1990s and 2000s police expenditures were statistically significant for all arrest rates. The evidence suggests that an increase in police expenditures per capita does positively influence arrest rates.

Introduction

Every community seeks to minimize crime rates. One method used by communities to deter crime is to increase police expenditures. The logic behind this line of thinking is that higher police expenditures will result in a more efficient and effective police force, thereby increasing the probability of arrest and decreasing a criminal's incentive to commit a crime.

Many economists have attempted to identify factors that deter crime. Oddly enough, there has been minimal research that analyzes the productivity of law enforcement agencies in terms of arrest rates as a function of police expenditures.

In a seminal early study, Cameron (1988) found that the impact of police enforcement on crime yielded inconclusive results, though his paper laid the groundwork for the theory linking improved enforcement to lower crime rates. He suggested that when more risk is involved in committing a crime, crime rates fall and noted that the criminal must consider the probability of getting caught, but more importantly, the harshness of the penalty. Criminals must weigh the personal gains of the crime against the odds of being caught and the severity of the potential sentence. In this way, investing in police expenditures can be linked to lower crime rates.

Later studies found that increased enforcement significantly reduces crime rates (Benson et al. 1994; Levitt 1997). Benson et al. (1994) highlighted the fact that even with an increase in police expenditures, which should be a deterrent, funds were not always allocated to the correct place and police incentives were not always taken into account. In a

seminal paper, Donohue and Levitt (2001) presented data that demonstrated a sharp decline in violent crime and murder rates since 1991, and identified incarcerations, police force size, and better police strategies as significant crime deterrents.

Counter to Cameron (1988) and Benson et al. (1994), Darlauf and Nagin (2011) found that the more severe and expensive punishments (longer sentences and capital punishment) did not act as a crime deterrent. They also reported that reallocating police expenditures from imprisonment to police duties, such as patrols, would be a more effective deterrent of crime. Ajilore and Smith (2010) found that over a period in which police expenditures increased, the incidence of crime decreased. Wan et al. (2012) found evidence that increased arrest rates act as a deterrent for future crimes. Their results suggested that a one percent increase in arrests resulted in a 0.1 and 0.19 percent decrease in property and violent crimes, respectively, in the short run. In the long run, the same one percent increase in arrests resulted in 0.14 and 0.3 percent decrease in property and violent crime, respectively.

Hypothesis and Model

We begin our analysis by testing the relationship between crime rates and police expenditures. We consider three different dependent variables: arrest rates for violent crime, murder and property crime. These variables were chosen as the dependent variables because previous literature did not use arrest rates, but rather crime rates, as dependent variables and the variables are important to the whole population as a crime deterrent. An arrest is defined as a person taken into police custody when suspected of committing a crime. The arrest rates were given as the number of arrests made per 100,000 people in a state. The natural logarithm of arrests were used

in order for results to be interpreted as percent changes.

Violent crime rates, property crime rates, murder rates, police expenditures per capita, unemployment, alcoholic beverage licenses revenue per capita and lags of each were used as independent variables. Crime rates are the number of crimes recognized (reported and verified to have occurred) by police per 100,000 people in a geographic area, over a period of time. The natural log of the crime rates was also used. Crime rates are expected to have a positive effect on arrest rates, as higher levels of crime result in additional police activity and therefore additional arrests. In the model, crime rates act as a control for different levels of arrest rates across the different types of crimes.

Alcohol and liquor are independent variables in the model and Speer et al. (1998) found that violent crimes increased and were more easily predicted when there was an increase in alcohol availability (density of stores). Alcoholic beverage licenses are used as a proxy in our model for alcohol availability. The variable is defined as the method by which liquor is sold, either through the government or gaining a license and selling as a private company. The expected relationship between arrest rates and alcoholic beverage licenses is positive. Results from Speer et al. (1998) suggests that as the number of alcoholic licenses increase, more alcohol becomes available for purchase, and the number of violent arrests should increase. Since consumers can find alcohol more easily, their consumption increases, and this may result in consumers that are more apt to commit crimes and subsequently leads to more arrests.

Police protection direct expenditures (police expenditures for shortened use in the paper) are defined as money spent on full time and part time police employees, current operations and capital outlay

(which includes construction, equipment, land and existing structures). Marvel and Moody (1996) discovered that crimes had very little effect on the amount of support (funds, personnel, etc.) given to police, but support had a significant impact on crime rates. Expenditures should be inversely related to arrest rates. Theory suggests that an increase in expenditures should increase the technology and manpower police have at their disposal, thus increasing arrest rates. The police expenditures and alcoholic beverage licensure variables were divided by the population of the state to obtain per capita numbers. They were then deflated using a regional Consumer Price Index (CPI) since a state CPI was unavailable and finally, expressed as a natural log. Unemployment is the percentage of people actively looking for work that cannot find a job. Raphael and Winter-Ebmer (2001) found that a decrease in the unemployment rate led to a drop in property crime rates. The sign found in their work is the expected sign in this model as well.

Lags were used for variables in which the effect on the dependent variable could be longer than one year. For instance, it is reasonable to assume that arrest rates may be influenced not only by current police expenditures, but by police expenditures in previous years since the impact of police funds may take several years to significantly impact arrest rates as new programs become more efficient and effective.

This paper uses panel data estimation and year fixed effects to examine state-level data over the time period 1980-2007.[1,2] Year fixed effects control for unseen or unobservable variations in the data. For example, the amount of cocaine present in street sales or in use over time is unable to be measured, but will be captured in the fixed effect. There were a varying number of observations in the data set because of incomplete or missing data, but generally averaged around 1,000 for the whole time period (1980-2007). Over a 28-year period using fifty states, there were a possible 1,400 observations; however, the years 2001 and 2003 did not have complete police expenditure data.

Due to the nature of time series data, autocorrelation was a concern. As is standard in the literature, we used the Durbin-Watson test to test for its presence and our results confirmed that our data did indeed suffer from autocorrelation. We used standard econometric methods to correct for autocorrelation. We also found evidence of heteroskedasticity in our model. Heteroskedasticity was corrected for using White's standard errors. These errors are reported in Tables 1-6. Each independent variable, with the exception of alcoholic beverage license was lagged by one year in the violent crime arrests and property crime arrests models. The murder arrests model has a two-year lagged crime rate variable and a one-year lagged unemployment variable.[3] For example, catching a suspected murderer may take more than a year, so a lag on the murder crime rate will allow for a murderer to be apprehended within this model in a longer time frame.

Regressions were run on two time periods: 1980-2007 and 1990-2007. The years were broken up in this manner so that a distinction could be made between the 1980s and all other years, since new technology was employed by police forces beginning in the 1990s. In both time periods, three regressions were run using violent crime arrests, murder arrests, and property crime arrests as the dependent variables. The results will demonstrate whether there was a significant relationship between police expenditures and arrest rates over the two time periods.

The variables are as follows:

> *lnVioA* = ln Violent Crime Arrest Rate
> *lnMurdA* = ln Murder Arrest Rate
> *lnPropA* = ln Property Crime Arrest Rate
> *lnVioCR* = ln Violent Crime Rate
> *V1* = ln Violent Crime Rate t-1
> *lnMurdR* = ln Murder Rate
> *M1* = ln Murder Rate t-1
> *M2* = ln Murder Rate t-2
> *lnPropCR* = ln Property Crime Rate
> *P1* = ln Property Crime Rate t-1
> *lnPolExp* = ln Police Expenditures Per Capita
> *E1* = ln Police Expenditures Per Capita t-1
> *lnABL* = ln Alcoholic Beverage License Per Capita
> *Unemp* = Unemployment (expressed as percentage)
> *U1* = Unemployment t-1 (expressed as percentage)

The following are the models that will be estimated using Ordinary Least Squares (OLS) regression techniques.

Violent Crime Arrest Model:

$$lnVioA = \beta0 + \beta1lnVioCR + \beta2V1 + \beta3lnPolExp + \beta4E1 + \beta5lnABL + \beta6Unemp + \beta7U1 + \mu$$

Murder Arrest Model:

$$lnMurdA = \beta0 + \beta1lnMurdR + \beta2M1 + \beta3M2 + \beta4lnPolExp + \beta5Unemp + \beta6U1 + \mu$$

Property Crime Arrest Model:

$$lnPropA = \beta0 + \beta1lnPropCR + \beta2P1 + \beta3lnPolExp + \beta4E1 + \beta5lnABT + \beta6Unemp + \beta7U1 + \mu$$

Results

For the time period, 1980-2007, Tables 1, 2 and 3 represent the regression output for violent crime arrests, murder arrests, and property crime arrests, respectively. For the time period 1990-2007, tables 4, 5 and 6 are outputs for violent crime arrests, murder arrests and property crime arrests. The results for murder arrests will not be discussed in the results section because the interpretations are similar to violent crime arrests and property crime arrests.

Table 1 displays the results for violent crime arrests from 1980-2007. The empirical results suggest that a ten percent increase in violent crime rates (about 46.7 more crimes per 100,000 people) leads to a 7.95 percent increase in arrests (around 14.01 more arrests per 100,000 people). The coefficient on violent crime rate was economically significant. The lag on violent crime results resulted in a much lower coefficient, but was still statistically significant. A ten percent decrease in police expenditures caused a 1.11 percent decrease in arrest rate.[4] The coefficient on alcoholic beverage licenses is notable. The negative sign suggests that an increase in alcoholic licenses leads to a decrease in arrests and counters previous research. We interpret the sign to mean that as the number of licenses increase, people have more choices of places to drink, which decreases crowds from venues as a whole, thereby decreasing the probability of potential fights and crimes in crowded areas. Additionally, a one percentage point increase on the one-year lagged unemployment rate leads to an economically significant 1.05 percent change in violent crime arrests. This result suggests that persistent unemployment leads to an increase in crime as the opportunity cost to commit a crime is lower when people are out of work. The model using murder arrests as the dependent variable can be found in Table 2. This is

Table 1

ln Violent Arrests	Coefficient	Standard Error*	P Value
Intercept	-0.8321	0.1906	<0.0001
ln Violent Crime Rate	0.7950	0.0161	<0.0001
ln Violent Crime $_{t-1}$	0.0634	0.0152	<0.0001
ln Police Expenditures Per Cap	0.1116	0.0236	<0.0001
ln Police Expenditures Per Cap $_{t-1}$	0.0286	0.0233	0.2190
ln Alcoholic Beverage Licenses	-0.0192	0.0070	0.0060
Unemployment Rate	0.0087	0.0061	0.1522
Unemployment Rate $_{t-1}$	0.0105	0.0059	0.0772

N = 1053 $R^2 = 0.7446$ Durbin-Watson = 1.992

*Whites Standard Errors

Table 2

ln Murder Arrests	Coefficient	Standard Error*	P Value
Intercept	-0.7218	0.1379	<0.0001
ln Murder Rate	1.0563	0.0208	<0.0001
ln Murder $_{t-1}$	-0.0116	0.0167	0.4891
ln Murder $_{t-1}$	0.0764	0.0155	<0.0001
ln Police Expenditures Per Cap	0.0409	0.0239	0.0872
Unemployment Rate	-0.0144	0.0072	0.0460
Unemployment Rate $_{t-1}$	0.0285	0.0077	0.0002

N = 1056   Adj. $R^2 = 0.7791$ Durbin-Watson = 2.040

*White's Standard Errors

for the time period 1980-2007. The results are similar to the results in Table 1 and can be interpreted in a similar manner.[5]

Table 3 uses property crime arrests as the dependent variable. Similar to violent crime arrests, the property crime rate and the lag are significant; however the coefficient on the lag is much smaller than the non-lagged coefficient.[6] Additionally, a ten percent change in police expenditures results in a 1.26 percent change in property crime arrest rates. Property crimes are influenced by unemployment, yet, unlagged unemployment was insignificant. Interestingly, unemployment lagged one year was significant and a one percentage point change in lagged unemployment leads to a 2.62 percent increase in property crime arrests. The change in significance from lagged to base unemployment is likely due to people getting restless after a year without a job (likely because their unemployment benefits or insurance have probably run out) and their need for income will lead them to steal to subsidize

their lack of money. The coefficient on alcoholic beverage license is economically significant and statistically significant at the one percent level.

Violent crime arrests, found in Table 4, cover the years 1990-2007. The difference between this group of years and the whole time period is that the lag of violent crime rates is insignificant and alcoholic beverage licenses are no longer statistically significant. The coefficient on police expenditures is larger, so in this case, a ten percent increase in police expenditures (about \$8.79 per person in the state) will lead to a 2.03 percent increase in arrest rates (around 3.578 more arrests per 100,000 people). The coefficient may seem small, but is economically significant because there are only 176.25 arrests per 100,000 per year in the average state. The lagged unemployment rate is significant, showing that a one percentage point change in unemployment brings about a 3.78 percent change in arrest rates.[7] This coefficient is more than three times the size

Table 3

ln Property Arrests	Coefficient	Standard Error*	P Value
Intercept	-2.0688	0.3940	<0.0001
ln Property Crime Rate	0.7734	0.0227	<0.0001
ln Property Crime Rate $_{t-1}$	0.1454	0.0335	<0.0001
ln Police Expenditures Per Cap	0.1257	0.0182	<0.0001
ln Police Expenditures Per Cap $_{t-1}$	0.0163	0.0179	0.3645
ln Alcoholic Beverage Licenses Per Cap	-0.0767	0.0079	0.0005
Unemployment Rate	0.0039	0.0051	0.4397
Unemployment Rate $_{t-1}$	0.0262	0.0045	<0.0001

N = 1062   Adj. R^2 = 0.3111   Durbin-Watson = 2.146

*White's Standard Errors

Table 4

ln Violent Arrests	Coefficient	Standard Error*	P Value
Intercept	-1.0392	0.2701	0.0001
ln Violent Crime Rate	0.7612	0.0228	<0.0001
ln Violent Crime $_{t-1}$	0.0220	0.0193	0.2547
ln Police Expenditures Per Cap	0.2030	0.0355	<0.0001
ln Police Expenditures Per Cap $_{t-1}$	0.0424	0.0342	0.2161
ln Alcoholic Beverage Licenses	-0.0072	0.0085	0.3968
Unemployment Rate	0.0162	0.0124	0.1926
Unemployment Rate $_{t-1}$	0.0378	0.0126	0.0028

N = 570   Adj. R^2 = .7430

*White's Standard Errors

Table 5

ln Murder Arrests	Coefficient	Standard Error*	P Value
Intercept	-1.0969	0.1703	<0.0001
ln Murder Rate	1.0512	0.0322	<0.0001
ln Murder $_{t-1}$	-0.0114	0.0281	0.6861
ln Murder $_{t-2}$	0.0761	0.0231	0.0010
ln Police Expenditures Per Cap	0.1148	0.0337	0.0007
Unemployment Rate	-0.0233	0.0147	0.1145
Unemployment Rate $_{t-1}$	0.0431	0.0197	0.0293

N = 573   Adj. R^2 = 0.7535

*White's Standard Errors

of the lagged unemployment coefficient for the time period 1980-2007. Murder arrest's regression for 1990-2007 is found in Table 5. Once again the results can be interpreted nearly the same as violent crime arrests.[8]

The final regression is different from the previous regressions. Table 6 is the output for property crime arrests from the time period 1990-2007. The only variable that is not significant at the ten percent level is the lag on property crime. Property crimes tend to not be as urgent to solve. Therefore police will not search for a property criminal a year after the crime has been committed and they will focus their resources on more violent offenders. Lagged police expenditures have a coefficient that is about one fourth the size of the unlagged police expenditures coefficient. The coefficient on lagged unemployment is larger than unlagged unemployment because, again, people need income after their unemployment insurance has run out and resort to crime to solve their problems.[9] A ten percent increase in alcoholic beverage licenses will lead to a -0.87 percent change in property crime arrests. The equivalent is a $0.16 increase per person in the state will cause arrest rates to drop by 6.19 arrests per 100,000.

Conclusion

Arrest rates impact every member of a population because if arrest rates go up, then the probability that criminals are incarcerated increases. An increase in arrest rates increases the opportunity cost of committing a crime and therefore can be considered a crime deterrent. The empirical results from this study suggest that an increase in police expenditures leads to an economically and statistically significant increase in arrest rates for murders, property crimes, and violent crimes. Future research could use the clearance rate, a measure of police efficiency, as the dependent variable. We found that alcoholic beverage licenses' may lead to a decrease in arrests because people are in situations where crime is less likely to occur since consumers have more venues to purchase and consume alcohol and crowds may be less concentrated as more establishments obtain alcohol and beverage licenses. The coefficient on alcoholic beverage licenses was found to be economically significant for violent crime arrests and property crime arrests. We found that unemployment had the biggest impact on arrest rates, suggesting that the opportunity cost of committing a crime is lowered the longer that people are out of work. Our research also suggests that it is beneficial to lag unemployment rates by at least one year since persistent unemployment increases the amount of leisure time criminals have to commit crimes. During the 1980s police expenditures did not significantly affect arrest rates; however in the 1990s and 2000s police expenditures did statistically and economically affect arrest rates. This supported Marvel and Moody's (1996) results that an increase in funds will increase arrest rates. In conclusion, our research provides empirical justification for investment of public resources in police expenditures in order to increase arrest rates and decrease crime rates.

Table 6

ln Property Arrests	Coefficient	Standard Error*	P Value
Intercept	-2.2367	0.6779	0.0010
ln Property Crime Rate	0.8133	0.0487	<0.0001
ln Property Crime Rate $_{t-1}$	0.0846	0.0530	0.1108
ln Police Expenditures Per Cap	0.1814	0.0301	<0.0001
ln Police Expenditures Per Cap $_{t-1}$	0.0475	0.0274	0.0828
ln Alcoholic Beverage Licenses Per Cap	-0.0865	0.0120	<0.0001
Unemployment Rate	-0.0227	0.0127	0.0746
Unemployment Rate $_{t-1}$	0.0357	0.0114	0.0017

N = 579   Adj. R^2 = 0.2594

***White's Standard Errors**

Table 7: Key Descriptive Statistics

Dependent Variable	N	Mean	Standard Deviation
Violent Crime Arrests	1079	176.25	87.67
Murder Arrests	1088	5.51	3.56
Property Crime Arrests	1088	711.76	235.28

Independent Variable	N	Mean	Standard Deviation
Violent Crime Rate	1300	466.99	239.37
Murder Rate	1300	6.26	3.55
Property Crime Rate	1300	4212.14	1153.42
Police Expenditures Per Cap	1300	87.89	36.32
Unemployment	1300	5.78	2.01
Alcoholic Beverage License Per Cap	1355	1.61	1.69

FOOTNOTES

[1] The District of Columbia was not included because of its outlier numbers of crime.

[2] State fixed effects were found to be insignificant and were not used in the model.

[3] The outcome of the F Tests are reported in footnotes below.

[4] 1980-2007 Violent Crime Arrests- H0: Police Expenditures = T-1=0; HA: not--- F Test= 2.845 >2.303. Reject null hypothesis, at least one of the coefficients is not 0.

[5] 1980-2007 Murder Arrests- H0: Murder Rate = T-1 = T-2 =0; HA: not --- F Test= 984.67>2.084. Reject null hypothesis, at least one of the coefficients is not 0.

[6] 1980-2007 Property Crime Arrests- H0 Police Expenditures =T-1 =0; HA: not --- F Test= 6.97>2.303. Reject null hypothesis, at least one of the coefficients is not 0. Property Crime Arrests- H0: Unemployment = T-1 =0; HA: not--- F Test= 5.54>2.303. Reject null hypothesis, at least one of the coefficients is not 0.

[7] 1990-2007 Violent Crime Arrests- H0: Violent Crime Rate = T-1 =0; HA: not--- F Test= 512.41>2.303. Reject null hypothesis, at least one of the coefficients is not 0. Violent Crime Arrests- H0: Police Expenditures = T-1 =0; HA: not--- F Test= 14.87>2.303. Reject null hypothesis, at least one of the coefficients is not 0. Violent Crime Arrests- H0: Unemployment = T-1 =0; HA: not--- F Test= 6.13>2.303. Reject null hypothesis, at least one of the coefficients is not 0.

[8] 1990-2007 Murder Arrests- H0: Murder Rate = T-1 = T-2 =0; HA: not--- F Test=436.18>2.084. Reject null hypothesis, at least one of the coefficients is not 0.

[9] 1990-2007 Property Crime Arrests- H0: Property Crime Rate = T-1 =0; HA: not--- F Test=31.57>2.303. Reject null hypothesis, at least one of the coefficients is not 0.

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