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# THE DETERMINANTS OF LOCAL GOVERNMENT POLICE EXPENDITURES: A PUBLIC EMPLOYMENT APPROACH

ROY W. BAHL, RICHARD D. GUSTELY, AND MICHAEL J. WASYLENKO\*

## ABSTRACT

*Explanation of the level of local government police expenditures is generally drawn from the results of empirical analyses. However, the assumptions of the underlying statistical model are not realistic for the police function and as a consequence the regression results do not provide useful clues as to the reasons for either the rapid growth in police spending and employment or the wide variation in per capita expenditures among cities. This paper shows—within the context of a traditional consumer maximization model—how the socio-economic characteristics and fiscal capacities of a community determine the level of police expenditures through the effects of these characteristics on the level of police wages and employment. The model is developed by combining an existing body of public finance research with a growing body of labor economics research dealing with the state and local government sector, particularly with estimating the employment demand function and the determinants of the wage rate. Our results suggest that important explanatory variables have been excluded from earlier expenditure determinants studies and have led to serious problems in interpreting statistical results. Moreover, our estimation of a structural model facilitates interpretation of the contributions of supply and demand variables to public expenditure levels as well as enabling us to trace exogenous shocks through the model to their ultimate effects on employment, compensation and expenditure levels.*

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**E**XPLANATION of the level of local government police expenditures is generally drawn from the results of empirical analyses. However, the assumptions of the underlying statistical model are not realistic for the police function and as a consequence the regression results do not provide useful clues as to the reasons for either the rapid growth in police spending and employment or the wide variation in per capita expenditures among cities.

The objective in this paper is to offer an alternative positive theory of police expenditures. Specifically, it is our intent to show—within the context of a traditional consumer maximization model—how the socio-economic characteristics and fiscal capacities of a community determine the level of police expenditures through the effect of these characteristics on the levels of police wages and employment. We test the model using fiscal data for the year 1972 for a cross-section of 79 metropolitan area city governments with populations above 100,000.<sup>1</sup>

## I. The Determinants Literature

The absence of a generally accepted theory of the determination of local government expenditures has given rise to numerous attempts to identify statistically the determinants of these expenditures. The rationale for such studies is straightforward: how communities actually reveal preferences for public goods in a context of varying or changing community characteristics is essentially an empirical question.<sup>2</sup> Accordingly, these statistical analyses usually have involved estimating a relationship between per capita local government expenditures and varying sets of socio-economic and demographic variables (e.g., racial mix, population density) and elements of the budget constraint (e.g., per capita state and federal aid) and identifying those variables with statisti-

cally significant coefficients as the “determinants.”

The statistical results derived in the more careful of these studies have tended to square with economic theory, though the basic assumptions of the model—particularly the output proxy choice—estimation problems and data incompatibilities are common criticisms (Morss, 1966). However, two important problems with this approach have not been adequately drawn out. The first relates to the nature of the choice model implied when expenditures are used as an argument in a utility function as the proxy for public sector output. The implication is for an individual to derive satisfaction from either an increase in public goods consumed or from an increase in the price of those goods. An alternative view of the implications of using the expenditure proxy for public output is a very unrealistic assumption that the price of public goods does not vary across the government units studied. The second major weakness in these studies is their consideration of only the reduced-form expenditure equation. Such an approach masks important relationships and therefore makes it difficult to explain *the process* by which any particular determinant affects expenditures. These weaknesses severely limit the explanatory power of determinants analyses.

In recent years, a related literature has emerged—centering on the determinants of public sector employment and wage rates—which partially takes into account these two shortcomings.<sup>3</sup> This work, however, is more directly relevant to labor market considerations and does not attempt to use the determinants of public sector wage rates and employment levels for the determination of the level of government expenditures (e.g., there is no concern with the comparative effects of increased wage rates and increased employment levels on increases in public expenditures).

The analysis in this paper takes the research on public sector compensation and employment levels into account in redefining a positive theory of local government police expenditures.

## II. The Model

Local government current expenditure on the police function (EXP) is the sum of direct labor costs (L), pension and fringe benefit costs (F) and nonlabor expenditures such as uniforms, equipment and supplies (S). Direct labor costs, in turn, are the product of average wage (W) and the number of employees (N); pension and fringe benefit costs are assumed to be some proportion ( $\alpha$ ) of the total wage bill; and nonlabor current expenditures some amount ( $\beta$ ) per employee. Hence, the basic expenditure identity is:

$$\text{EXP} = N [W(1 + \alpha) + \beta] \quad (1)$$

The research question posed here is how do variations in community characteristics and local government fiscal capacity act to affect expenditures through their effects on employment and compensation. Empirically, the goal is to develop structural equations to estimate  $W(1 + \alpha)$  and N, and to calculate  $\beta$  in order to derive the elasticity of police expenditures with respect to the exogeneous variables in the model.

The model developed is for a community which produces and consumes a public good (police), other public goods (Z), and private goods (X) at prices  $[W(1 + \alpha) + \beta]$ ,  $P_z$ , and  $P_x$ , respectively. The proxy for the police good is employment in the police sector (N), and it is only from increments in private goods, other public goods and police employment that any increment in utility is derived.<sup>4</sup> Implied here is a Leontief type fixed-factor production function for the police sector. Specifically, we assume that the increment of one unit of employment-output must be accompanied by a fixed amount of nonlabor inputs, with the latter being valued at  $\beta$ . In order to get a unit of output (a policeman), the police department must absorb the cost of a uniform, a billy club, some fraction of the cost of a car, dispatching equipment, etc.<sup>5</sup>

Certainly, police employment is not a perfect proxy for police output, but there are strong arguments that it may be the best available proxy. It clearly is superior

to the public expenditure surrogate in not including the public good price as an argument in the utility function; hence, it allows definition of a budget constraint which permits inter-city variations in the price of police output. The very high labor intensity of the local public sector, particularly the police function, lends some credence to the assumption that changes in output and employment are proportional. Finally, whether changes in police employment and police output are proportional is less relevant than whether the community (or community decision makers) think they are. While it seems reasonable to assume that the consumer-voter would see his welfare as being raised by increases in the number of policemen on the street, it seems unlikely that the same individual would see his welfare as being increased (at least in the short run) by increments in the wage rate paid policemen. Certainly politicians, who translate community preferences into year-to-year budget changes, would tend to take this view.

The choice of the police function for application of this model has certain important advantages, some of which do not hold for other public functions. It is always a municipal government function and, therefore, the fiscal statistics are comparable and not distorted by special district arrangements. In addition, there are not good private sector substitutes for the bulk of services provided by police departments; hence it seems reasonable to assume that intercity variations in police expenditures are not markedly affected by different mixes of publicly and privately provided police services. Police employment is relatively homogeneous—83 percent, on average, are uniformed—making more credible the necessary assumption in this model that the composition of the police labor force does not vary with factors that affect the wage and employment level, and that police productivity does not vary among our cross-section of cities beyond what variations in average education level would lead one to expect.<sup>6</sup> Finally, we limit this analysis by concentrating only on explanation of current expenditures, and the

police function has a relatively low level of capital expenditures.

The aggregate community preference function then, is

$$U = U(N, Z, X) \quad (2)$$

which is to be maximized subject to the budget constraint

$$Y + AID = (W[1 + \alpha] + \beta)N + P_z Z + P_x X \quad (3)$$

where AID = any lump-sum grant from a higher level government

W = the wage received by police employees

Y = income in the community after the imposition of taxes by all higher level governments

$P_z$  = price of other public goods

$P_x$  = price of private goods

Maximizing (2) subject to (3) yields standard first order conditions which imply that police employment is determined by the price of police employees, the price of other public goods, the price of private goods, the income level, and the grant-in-aid level of the city.

### III. Empirical Model and Data

This estimation involves using three structural equations—a compensation equation, an employment equation, and a crime equation—in order to identify the determinants of intercity variations in police compensation rate and employment.

#### A. The Compensation Equation

The average total compensation of policemen is specified here as a function of a set of community characteristics which include the opportunity wage of a policeman in the private sector, the overall skill level of workers in the metropolitan area, the level of unionization of the police force, and the level of police employment. Average total compensation of policemen

(TC) is average wage and salaries of policemen plus average pension and fringe benefit payments.<sup>7</sup>

The opportunity wage has been shown a significant determinant of public sector wage rates in other studies (Schmenner, 1973; Ehrenberg, 1973; Ashenfelter, 1971), though the measure chosen to represent this effect has varied. In this analysis, the opportunity wage (OW) is measured as the average yearly earnings of manufacturing sector employees—lagged by one year. The rationale for using such a variable is the assumption that a local labor market exists, and, hence, there is a wage roll-out from the basic to the service (including public) sector.<sup>8</sup> This expected positive relation between wage rates in the two sectors can result from either competitive forces which tend to erase wage differentials, or a demonstration effect which causes public employee unions to demand wages roughly equivalent to those obtained by private sector unions. The choice of the manufacturing wage as the opportunity cost to a policeman reflects an assumption that the most likely alternative employment for policemen is blue-collar manufacturing occupations. To adjust for the possibility that police wages are affected by skill differences between police and manufacturing employees, we include the median education of the city population over 25 years of age (ED). The education variable may also adjust, *cet. par.*, for the greater supply of qualified police applicants in cities where average education level is higher (see Ehrenberg, 1973b).

O. Ashenfelter (1971), R. Ehrenberg (1973), and R. Schmenner (1973) in research on police and fire salaries find evidence that unionization has a significant effect on the level of wage rates. The extent of public sector unionization (U) in a city is measured by the portion of police employees who are affiliated with the union (U) and it is assumed that larger fractions imply stronger unions.

The police employment variable is measured as total police employment per thousand population ( $N_p$ ). The relationship for police compensation is:

$$TC = f(OW, ED, U, N_p) \quad (4)$$

The sign of the opportunity wage, unionization and police employment variables is expected to be positive. The sign of the education variable cannot be stated *a priori*. To the extent it measures quality differences that are not reflected in the opportunity wage variable, the expected sign of the regression coefficient will be positive. To the extent a high education level in the city implies a larger supply of qualified applicants, the expected sign of the education variable is negative.

### B. The Employment Equation

The demand for police employees is specified as a function of the price of a police employee, the price of other public goods, the price of private goods, the income and grant-in-aid level in the city, and taste or preference variables. The dependent variable is full-time equivalent police employment, expressed per 1,000 of population ( $N_p$ ). The price of a police employee is specified as the average total compensation of an employee plus the necessary expenditure on nonlabor inputs per employee ( $TC + \beta$ ). The average wage rate in the other four common city functions was used to measure the price of other public goods. However, this variable is highly correlated ( $r = .8$ ) with police compensation and was dropped from the empirical analysis. The price of private commodities ( $P_x$ ) is measured as an index of the cost of living in the SMSA (See Appendix A) and is treated as an exogenous variable. Income ( $Y_p$ ) and grants-in-aid per thousand population ( $G_p$ ) are used to describe the level of resources available to the community. Four variables are entered to account for intercity variations in preferences for police services: population size (POP), median education level (ED), the crime rate per thousand population in 1972 (C72), and the percentage of the city population who are nonwhite (NW). The demand for police employees is stated as:

$$N_p = f(TC + \beta, P_x, Y_p, G_p, POP, ED, C72, NW) \quad (5)$$

Except for ( $TC + \beta$ ) and ED, the signs of all the coefficients of the variables are

expected to be positive. The sign of the coefficient of the price of a police employee is expected to be negative. The coefficient of the median education variable may be negative, reflecting greater use of private substitutes for policemen, or positive, reflecting a preference for a greater number of police output units.<sup>9</sup> In formulating the model, we make an additional assumption of equilibrium in the demand and supply of police employees.

### C. The Crime Equation

It seems plausible that in the longer run the crime rate and police employment are simultaneously determined, hence, a separate equation is used to estimate the crime rate. Ehrlich (1973) has modeled the supply of offenses, crime, by maximizing the expected value of a person's utility function for income earned in legitimate and illegitimate activities. He specifies his model using a system of three equations which reflects the interrelations between the crime rate, the expenditure on police services, and the probability of being caught committing the crime.

We have modified Ehrlich's system to two simultaneous equations in police employment and crime. The determinants of the supply of crime hypothesized here are similar to Ehrlich's,

$$C72 = CR(N_p, UNEMP, Y_p, AVSS, NW) \quad (6)$$

where UNEMP, AVSS, NW represent the unemployment rate in the city in 1970, the average income level in the city in 1970, the average prison sentence served (in months) by an offender in the relevant state in 1960, and the percentage of city population that is nonwhite.

The expected sign of the coefficients of the police employment and average sentence variables is negative, while the expected sign of the coefficient for the unemployment and percentage nonwhite variables is positive. The average family income variable (personal income per thousand population) is included to reflect higher levels of community income and wealth and hence should be positively

associated with the crime rate. Therefore, a positive coefficient for income would indicate, other things being equal, that the greater the affluence the higher is the incidence of crime per capita.<sup>10</sup>

### D. Estimation

The compensation, employment, and crime relationships represent a system of three simultaneous equations, and they are specified for estimation as linear-in-logarithms. In specifying the crime relationship for estimation, the amount of crime is assumed to follow a lagged process in adjusting to changing numbers of policemen and to social and economic conditions. Therefore, the ratio of the observed values of the current crime rate ( $C72$ ) to crime in the previous period ( $C71$ ) is specified as a power function of the ratio of the equilibrium level of crime ( $C^*$ ) to the observed value of crime in the previous period.<sup>11</sup>

Each equation in the system satisfies the rank condition for identification and the system of equations is overidentified. Therefore, Two-Stage Least Squares (TSLS) is used to estimate each equation in the system.<sup>12</sup>

## IV. Statistical Results

All estimated coefficients of the independent variables in the compensation equation have the expected sign and they are statistically significant (See Table 1). The average level of police wages is positively and significantly related to the level of manufacturing wages with an elasticity of about 0.8.<sup>13</sup> The education variable has a positive effect on the police compensation rate and unionization is found to positively influence the level of police wages. Since the weekly working hours of policemen do not vary among cities in our sample,<sup>14</sup> we may interpret the coefficient of the union variable in the compensation equation (.161) as indicating that policemen who are working in completely unionized cities ( $U = 100$  percent) earn about 17.5 percent more, other things equal, than their counterparts in cities where there is no unionization ( $U = 0$ ). Our estimate for the effect

TABLE 1

Results of Estimation of Compensation,  
Employment and Crime Equations<sup>a</sup>

Compensation

$$TC = .339 (OW)^{.800} (e)^{.161(U)} (ED)^{1.184} (\hat{N}_p)^{.273}$$

(5.00)\*\*      (2.25)\*\*      (2.24)\*\*      (2.04)\*\*

Mean value of ln (TC) = 9.34  
S.E.E. = 0.18  
R<sup>2</sup> = .45b

Employment

$$N_p = .012 (TC+\beta)^{-.320} (P_x)^{.173} (Y_p)^{.735} (G_p)^{.037} (\hat{C72})^{.378} (POP)^{.068} (ED)^{-1.973} (NW)^{.071}$$

(1.78)\*\*    (.41)      (3.12)\*\*    (1.65)\*      (2.67)\*\*    (2.14)\*\*    (4.20)\*\*    (2.34)\*\*

Mean value of ln (N<sub>p</sub>) = .750  
S.E.E. = .170  
R<sup>2</sup> = .68

Crime

$$C72 = .059 (\hat{N}_p)^{-.231} (UNEMP)^{.065} (Y_p)^{.237} (AVSS)^{-.188} (NW)^{.027} (C71)^{.972}$$

(2.28)\*\*    (1.73)\*      (2.60)\*\*    (2.31)\*\*      (1.41)\*    (19.13)\*\*

Mean value of ln (C72) = 3.72  
S.E.E. = .09  
R<sup>2</sup> = .92

<sup>a</sup>The figures in the parentheses are the absolute values of the t-statistics. \* indicates statistical significance at the 0.1 level for the appropriate t-test; \*\* indicates statistical significance at the 0.05 level. Since all the equations are estimated using TSLS, the t-values are only asymptotically valid, and with only 79 observations they should be interpreted loosely. The simple correlations between the logarithms of the variables do not reveal significant multicollinearity (see Table B-2). The highest value is .56 between the logarithms of N<sub>p</sub> and C71.

<sup>b</sup>R<sup>2</sup> is not meaningful for TSLS estimates; however, we report it, as well as the more meaningful mean value of the natural logarithm of the dependent variable and the standard error of the regression for the linear-in-natural logarithm form.

of unionization on policemen's salaries falls around the 6-16 percent range estimated by Ashenfelter (1971) and the 2-18 percent range estimated by Ehrenberg (1973b) for firemen's wages.

The variables in the demand equation for policemen have the expected sign and, with the exception of the price of private goods and grants-in-aid, are statistically significant at the .05 level. The grant variable is statistically significant at the .1 level and the price of private goods

variable is not statistically significant. The own price elasticity for police employment is  $-.320$ , which indicates that the demand for police employment is price inelastic. Income per thousand population and per capita aid are positively related to the level of police employment reflecting the stimulative effect on the public employment decision of a relaxation of the budget constraint. The relationship between crime and employment in the employment equation indicates that police

employment responds positively to a difference in the crime rate (in the short run). The coefficient of the education variable is negative, even after account has been taken of income and crime rate differences, indicating a lower relative preference for police services on the part of more highly educated populations (see footnote 9). The larger percentage of the population that is nonwhite and a larger population size also have a positive effect on the number of police employees.

Ehrenberg (1972, 1973a) is the only other author who has estimated equations comparable to our employment equation. His results also suggest a price inelastic demand for policemen—his own price elasticity estimate for police employment is  $-0.281$  in the short run. His result is very close to the estimate obtained here, despite the fact that Ehrenberg used pooled cross-section and time series data for individual states during 1958-69.

Estimation of the crime equation indicates that the number of police employees have a dampening effect on the crime rate, and that all the variables in the crime equation have the expected sign and, except for unemployment, are statistically significant. The positive value for per capita income indicates that the potential material gain to criminal activity, proxied here by higher average income, has a positive influence on the crime rate, other things equal. These results are consistent with those obtained by Ehrlich (1973), and McPheters and Stronge (1974) but not with the finding of Pogue (1975).

Pogue finds that police expenditures have no statistically significant impact on the level of crime. However, his formulation of the crime equation does not include the lagged value of crime as an independent variable. When crime in 1971 is omitted from our equation, our results are similar to Pogue's. Thus, we conclude that the level of police employment dampens the level of crime across this sample of cities.

## V. Local Expenditure Determination

Derivation of a reduced-form expenditure equation requires, in addition to the

structural equations in employment, compensation, and crime, an estimate of nonlabor current expenditures. The value estimated for total nonlabor expenditures per police employee ( $\beta$ ) in 1972, computed as an average from the *Municipal Yearbook 1973*, is \$1314. After substituting the value of  $\beta$  and the employment, crime and compensation equations into equation (1), the equation can be differentiated with respect to each of the exogenous variables and the aggregate response of police expenditure per thousand population to a change in an exogenous variable can be separated into a compensation and an employment effect.<sup>15</sup>

For example, in order to estimate the effect of differences in the level of the opportunity wage (OW) on the levels of compensation, employment, crime, and expenditure, the estimated system of three simultaneous equations is totally differentiated with respect to OW and solved

for  $\frac{dTC}{dOW}$ ,  $\frac{dN_p}{dOW}$ ,  $\frac{dC72}{dOW}$ . These results are

then substituted into the expression presented in footnote 15, which is used to calculate the elasticity of total compensation, employment, and expenditure with respect to OW. This process is repeated for each of the exogenous variables. The elasticity of crime with respect to each of the exogenous variables (X) is calculated directly from  $\frac{dC72}{dX}$  as above and the

means of C72 and the exogenous variable. These elasticities are reported in Table 2.

The results in Table 2 suggest a different interpretation of intercity variation in per capita police expenditure than that offered in the traditional determinants literature. Per capita police expenditures are most sensitive to the level of per capita income, the manufacturing wage, and the price of other goods. The elastic response of police expenditures to per capita income is primarily due to an employment effect—cities with higher per capita incomes demand more police services—and a compensation effect resulting from the hiring of more policemen. A one percent

TABLE 2

Elasticities of Police Expenditure Per Thousand Population and Crime Per Thousand Population With Respect to Exogenous Variables<sup>a</sup>

<u>Exogenous Variables</u>	<u>Elasticity of Crime</u>	<u>Elasticity of Police Expenditure Per Thousand Population</u>	<u>Wage Effect</u>	<u>Employment Effect</u>
Manufacturing Wage	.058	.402	.651	-.249
Unionization	.008	.055	.090	-.035
Price of Private Goods	-.044	.233	.046	.187
Income Per Thousand Population	.032	1.104	.217	.887
Intergovernmental Aid Per Thousand Population	-.006	.035	.007	.028
Unemployment Rate	.061	.034	.007	.027
Average Length of Prison Sentence Served	-.175	-.097	-.019	-.078

<sup>a</sup>All of the elasticities are evaluated at their mean values. The mean values of the variables are reported in Appendix Table B-1. See Section V of the paper for an explanation of the derivation of the figures in the table.

higher manufacturing wage induces a 0.402 percent higher level of per capita spending by raising police expenditures by 0.651 due to induced higher police compensation, but lowering police expenses by 0.249 due to the employment dampening effect of the higher compensation. The elasticity of police expenditure with respect to differences in unionization, the price of private goods, and intergovernmental aid is relatively small, when these effects are considered separately.<sup>16</sup> Two of the exogenous variables which directly affect the crime level in this model, unemployment and the average sentence served, have a small effect on the level of police expenditure. However, the results here suggest a greater length of sentence service is associated with both

a lower crime rate and a lower level of police expenditure.

The cross-section elasticity of the crime level is largest with respect to differences in the average sentence served. However, the crime effects should be interpreted with the caution that they depend on the result that the level of police employment affects the crime level, and police employment is statistically significant in the crime equation only when the lagged crime rate is included as an independent variable.

## VI. Conclusions

The very restrictive assumption of the traditional cross-section expenditure determinants model, that the price of public

goods does not vary between units of government, severely limits the ability of such models to explain local public sector behavior. We attempt to resolve this shortcoming in a study of local government police expenditures by combining an existing body of public finance research with a growing body of labor economics research dealing with the state-local government sector—particularly with estimating the employment demand function and the determinants of the wage rate. Our results suggest that important explanatory variables have been excluded in earlier determinants studies and have led to serious problems in interpreting statistical results. Our estimation of a structural model facilitates interpretation of the contributions of variables to public expenditure as well as enabling us to trace the exogenous shocks through the model to their ultimate effect on employment, compensation and expenditure levels.

Certain of the policy implications of these theoretical and empirical results are particularly important. First, an increase in real income accompanied by an equal increase in the opportunity wage for public sector employees is likely to result in a substantial expenditure increase with

much of the increase being due to compensation rate increases and relatively little to service (employment) level increases. Second, the increase in the crime rate and the decrease in the police compensation level exerted by reduced numbers of policemen partially reduces the size of the substitution effect occasioned by any increase in the police wage rate. Third, these results suggest that the level of police expenditures in a city is significantly affected by collective bargaining outcomes in *both* the public and the private sector.

With appropriate adjustments, this model could be extended to explain the level and growth in expenditures for other state and local government functions. The results of such analysis would likely show the same results found here, i.e., that expenditure levels vary among cities not only because of variations in the need for services but because of variations in the cost of providing any given level of services. Remedial public policy designed to accommodate the urban fiscal problem, e.g., general revenue sharing or categorical grants, must eventually recognize both the cost and demand sides of the expenditure determinants equation.

APPENDIX TABLE B-1

Variable Names, Description and the Mean Values

Variable Names	Description	
TC	Average annual total compensation of policemen in 1972	\$ 11,769.20
OW	Average annual wages of manufacturing production workers for a 40 hour work week in 1971	\$ 7,864.24
U	Proportion of police employees who are affiliated with a local or national union in 1968	0.69
ED	Median education level of city residents who are 25 years or older in 1970	12.04
N <sub>p</sub>	Number of police employees per thousand population in 1972	2.21
TC+β	Average annual total compensation of policemen plus the average value of expenditure on nonlabor inputs per police employee in 1972	\$ 13,082.77
P <sub>r</sub>	Relative cost of living in an SMSA in 1972 <sup>(a)</sup>	0.98
Y <sub>p</sub>	Income per thousand population in 1969	\$3,270,610.00
G <sub>p</sub> (b)	Grants-in-aid per thousand population in 1972	\$ 73,957.40
POP	Population size in thousands in 1970	316.35
C72	Total crime per thousand population excluding accidental murder and larceny under \$50 in 1972	43.17
NW	Percentage of the population that is nonwhite in 1970	16.87
UNEMP	Percentage of the civilian labor force that is unemployed in 1970	4.82
AVSS	Average sentence served (in months) by an offender who was released from a state or federal prison for the first time in 1960 (by state)	28.75
C71	Total crime per thousand population excluding accidental murder and larceny under \$50 in 1971	43.83
EXP	Police expenditure per thousand population in 1972	\$ 28,956.20

(a) The base is the average urban cost of living and is equal to 1.00.

(b) excluding education aids.

**Appendix**

**A. Estimation of Cost of Living**

The cost of living index (median level) for 39 SMSA's, available from the Handbook of Labor Statistics, is regressed on percent of the total employment in the SMSA in manufacturing (MANEMP), region (North, NCentral, South) and SMSA size dummy variables (POP1 for over one million, POP2 for 500,000 to 1,000,000, and POP3 for 250,000 to 500,000). From the results of this equation the index (COL) was predicted for SMSA's not in the sample of 39 and the SMSA index was assumed to hold for the central city. The estimated equation is:

$$\begin{aligned}
 \text{COL} = & 105.23 + 2.78 \text{ POP1} + 5.50 \text{ POP2} \\
 & \quad (1.2) \quad (1.8) \\
 & - 4.62 \text{ POP3} - 0.28 \text{ MANEMP} \\
 & \quad (1.6) \quad (2.4) \\
 & + 6.57 \text{ North} + 0.66 \text{ NCentral} \\
 & \quad (2.5) \quad (3) \\
 & - 7.36 \text{ South} \quad \quad \quad \hat{R}^2 = .65 \\
 & \quad (3.3)
 \end{aligned}$$

The numbers in parentheses are the t-statistics.

**B. Sample and Data Sources**

The sample of 79 cities used in this study was chosen on the basis of availability of complete data on police department salaries and expenditures as reported in the *Municipal*

*Yearbook 1973*. All the data for the variables which are used in the estimation with the exception of the data on unionization were obtained from published data sources. The mean values of each of the variables are reported in Table B-1 below, a correlation matrix for the natural logarithms of the variables is reported in Table B-2, and the data sources for the variables are listed in Table B-3.

**FOOTNOTES**

<sup>1</sup>For a more complete description of the data, see Appendix B.

<sup>2</sup>Over one hundred such studies are identified in reviews of the expenditure determinants literature by R. Bahl (1968) and G. Wilensky (1970). For examples of determinants studies, see J. Weicher (1970), T. Borchering and R. Deacon (1972), T. Bergstrom and R. Goodman (1973), and R. Gustely (1974).

<sup>3</sup>See, for example the excellent work of R. Ehrenberg (1972), (1973a), (1973b); and J. Landon and R. Baird (1971).

<sup>4</sup>Ehrenberg makes a similar argument in (1973a).

<sup>5</sup>The U.S. Bureau of the Census lists current nonlabor expenditures as supplies, materials and contractual services. More detailed lists for individual states are given in D. Greytak, *et al.* (1974, and N. Walzer (1970).

<sup>6</sup>In cities where police productivity is higher, this higher productivity could be reflected in both higher police wages and lower police employment, other things being equal. Since the assumption of the same police productivity is so important for our model, we have selected a sample of cities for our empirical work that, we think, minimizes the problem of productivity differentials among cities. Because most differentials in police productivity probably occur as a result of different amounts of administrative personnel and/or capital equipment per policeman, our sample consists

APPENDIX TABLE B-2

Correlation Matrix for the Natural Logarithms of the Variables

	TC	OW	U	ED	N <sub>p</sub>	TC+B	P <sub>x</sub>	Y <sub>p</sub>	G <sub>p</sub>	POP	C72	NW	UNEMP	AVSS	C71	P <sub>z</sub>
TC	1															
OW	.66	1														
U <sup>a</sup>	.45	.39	1													
ED	.15	.02	.17	1												
N <sub>p</sub>	.35	.15	-.11	-.55	1											
TC+B	1.0	.66	.45	.15	.35	1										
P <sub>x</sub>	.26	.27	.12	.01	.18	.26	1									
Y <sub>p</sub>	.57	.36	.24	.50	.00	.57	.31	1								
G <sub>p</sub>	.24	.23	-.16	-.28	.33	.24	.25	-.04	1							
POP	.13	.06	.09	-.36	.50	.13	.12	.04	.13	1						
C72	.36	.33	.01	-.16	.50	.36	.17	.16	.15	.27	1					
NW	-.12	.03	-.28	.49	.54	-.12	-.12	-.25	.23	.39	.37	1				
UNEMP	.50	.50	.26	.04	.15	.50	.15	.02	.17	.18	.47	.04	1			
AVSS	.20	.10	.10	.18	-.24	.20	-.12	.11	-.01	-.10	-.08	-.07	.04	1		
C71	.31	.26	.01	-.26	.56	.31	.14	.09	.18	.31	.96	.44	.44	-.04	1	
P <sub>z</sub>	.80	.60	.46	.16	-.08	.80	.43	.61	.21	.13	.41	-.20	.45	.15	.32	1

<sup>a</sup>U was not run in natural log-form.

## APPENDIX TABLE B-3

Data Sources<sup>a</sup>

Police compensation, police employment, and police expenditure on nonlabor inputs and total police expenditures for 1976 are from the Municipal Yearbook 1973.

The average hourly manufacturing wage rate in the SMSA is from Employment and Earnings in States and Areas 1939-1971.

The union variable is the percent of policemen in the city affiliated with a union and is from unpublished data in ICMA files.

Population, median education, median income, percentage nonwhite, per capita income, and unemployment are from the Census of Population 1970.

The grants-in-aid variable is from Local Government Finances in Metropolitan Areas 1972-73.

The index of the Cost of Living is from the Handbook of Labor Statistics 1973.

The crime variables are those reported in the Uniform Crime Reports for the U.S.

The average prison sentence served variable is from the National Prisoner Statistics; Prisoners Released from State and Federal Institutions 1960.

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<sup>a</sup>Full citations of the source publications are listed in the references.

of cities with populations above 100,000 on the presumption that cities in this size class would have similar numbers of police administrative personnel and amount of capital equipment per policeman, and, therefore, similar police productivity. We attempt to account for remaining skill differences among policemen on average wage rates by including the median community education level as an independent variable.

<sup>7</sup>The average wage is obtained by dividing total wage and salary payments by the number of employees. Included in payrolls are wages and salaries as well as overtime pay before deductions of taxes, health insurance, etc. Retirement system expenditures are employer contributions, excluding social security. More detailed data published by the Bureau of Labor Statistics could not be used because these figures did not cover all city government employees in any given department.

<sup>8</sup>The urban wage roll-out thesis is summarized in W. Thompson (1965): the general reference for the

competitive thesis in labor economics is M. Reder (1962).

<sup>9</sup>Edward Gramlich has questioned the inclusion of the median education variable in the demand equation and the rationale for an expected negative coefficient. Our specification of the police supply equation follows closely that of other authors (see Ehrenberg 1973b and Ehrenberg and Goldstein 1975). Ehrenberg's (1973b) analysis suggests that the higher the median education level the greater is the supply of qualified applicant public employees and, therefore, the lower is the wage of public employees. However he estimates only the reduced-form equation for the demand and supply of police employees and finds that the median education variable has a negative, although statistically insignificant, effect on the level of police wages. If our hypothesis about the positive sign of the median education variable in the supply equation for police is correct, then for the reduced-form coefficient of median education to have a negative sign, median education should also be included in

the demand equation, and the sign of its coefficient should be negative. Explanation of this negative relationship is not obvious, but in communities where the education level is higher, other things equal, there may be more reliance on private substitutes for police services, e.g., burglar alarm systems.

<sup>10</sup>Per capita income is neither the only nor the best measure of wealth in a community. A measurable alternative, the percent of families with income above \$15,000, was found to be highly correlated with per capita income. More appropriate measures of wealth stored in homes and businesses are not available. Thus, per capita income is used here as a proxy for higher average levels of income and wealth. For similar formulations of the crime equation, see Sjoquist (1973), McPheters and Stronge (1974) and Pogue (1975).

<sup>11</sup>The econometric specification of the crime relation is then:  $\frac{C72}{C71} = \left(\frac{C^*}{C71}\right)^\gamma$   $0 < \gamma < 1$ , where  $C^*$  is the equilibrium level of crime and is related to the variables in the crime relation (6). If (6) is specified as  $CRIME^* = C_0(N_p)^{\epsilon_1} (UNEMP)^{\epsilon_2} (Y_p)^{\epsilon_3} (AVSS)^{\epsilon_4} (NW)^{\epsilon_5}$ , the equation to be estimated here, taking into account the lagged adjustment process is:  $C72 = C_0^*(N_p)^{\epsilon_1\gamma} (UNEMP)^{\epsilon_2\gamma} (Y_p)^{\epsilon_3\gamma} (AVSS)^{\epsilon_4\gamma} (NW)^{\epsilon_5\gamma} (C71)^{1-\gamma}$ .

<sup>12</sup>The police employment equation is one of three simultaneous demand equations which are derived from the maximization of the utility function (2) subject to the budget constraint (3). Therefore, in the estimation of the demand for police employment, the price of other public goods and the price of private goods should be treated as endogenous variables to avoid simultaneous equations bias. The price of other public goods is dropped from the estimation because of its high collinearity with the price of police employees, and the proxy for the price of private goods (COL) is predicted from exogenous variables (see Appendix A). Thus, the problem of simultaneous equation bias is avoided.

<sup>13</sup>We should note, however, that the police compensation variable includes retirement benefits whereas the manufacturing wage variable does not. Therefore, the size of the true wage roll-out effect is overstated.

<sup>14</sup>As reported in the *Municipal Yearbook 1973*, p. 179-195.

<sup>15</sup>For example, the response of expenditure per thousand population (EXP) to a change in the opportunity wage rate is as follows:

$$\begin{aligned} \frac{dEXP}{dOW} &= \frac{dW}{dOW} N_p + \alpha \frac{dW}{dOW} N_p + W \frac{dN_p}{dOW} \\ &+ \alpha \frac{dN_p}{dOW} W + \beta \frac{dN_p}{dOW} + \frac{dW}{dOW} \frac{dN_p}{dOW} \\ &+ \alpha \frac{dW}{dOW} \frac{dN_p}{dOW} \end{aligned}$$

The first two terms on the right show how an increase in the opportunity wage tends to raise police expenditures: by bidding up the wage rate and pension payment for all current employees (wage effect). The next three terms show how the increased public sector wage rates induce a decline in employment and thus

have a dampening effect on expenditures (employment effect). The last two terms are interaction terms and show the dampening effect on expenditures of the simultaneous occurrence of higher wage rates and more policemen (mix effect). This mix effect is very small in magnitude and is not reported in Table 2.

<sup>16</sup>There is some debate in the positive public expenditure analysis over the relative importance of the income and grant variables as expenditure determinants. Though we have considered a restrictive case—the police function for city governments assuming all grants to be completely fungible—the partials of per capita police expenditures with respect to grants and income are \$0.0137 and \$0.0098, respectively.

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