AN ECONOMIC ANALYSIS OF POLICE AND FIRE PROTECTION IN KANSAS CITIES

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by

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CHAPTER I

INTRODUCTION

The Problem

The primary function of municipal government is to provide the necessary public services to the citizens within its jurisdiction. In attempting to meet this responsibility, many cities find themselves in a dilemma: how can an adequate or rising quality of services be provided without placing an undue burden on the taxpayer? The problem is compounded by the fact that marginal returns from additional expenditures on many public services are generally unknown. This causes a distortion of priorities, as cities expend great sums of money on some services which may have low returns, while neglecting others.

Kansas cities and towns have not been exempt from these problems. Certain cities in the state have been especially hard pressed to provide adequate services: (1) the smaller, predominantly Western Kansas towns that have been experiencing either out migration or little population growth; and (2) cities with a high population growth rate, such as those on the outskirts of major metropolitan areas. The small town with a declining population base must place an increasing per capita tax burden on the people remaining in a community just to maintain a constant quality level of service, while the larger, rapidly expanding cities are faced with large capital investments for new facilities to meet the increased requirements.

During the period from 1960 to 1970, total expenditures in most Kansas towns increased greatly. The specific services examined in this thesis--police and fire protection--have recorded corresponding expenditure increases. For illustrative purposes, six Kansas cities were selected on the basis of wide geographical and city size dispersion for a comparison of the percentage change in population they experienced from 1960 to 1970 in relation to the percentage increase in police and fire protection and total city expenditures during that period. Expenditures (expressed as constant 1958 dollars) rose dramatically for police and fire protection for all six cities, while all cities except Liberal had a large percentage increase in total government expenditures. Table 1-1 shows the percentage increases in population and expenditures for the sample.

TABLE 1-1

CHANGES IN POPULATION AND EXPENDITURES[a] DURING THE 1960 DECADE FOR SIX KANSAS CITIES

City	Percentage Increase in Population	Percentage Increase in Police Exp.	Percentage Increase in Fire Prot. Exp.	Percentage Increase in Total City Gov't. Exp.
Atchison	1.3	75.4	47.7	66.2
Liberal	-1.0	76.6	131.8	-1.3
Garden City	28.1	132.4	47.4	79.4
Pittsburg	4.7	112.2	61.1	90.3
Lawrence	82.6	192.4	65.0	151.7
Wichita	13.1	80.5	86.0	57.4

Note: [a]Expenditures were expressed in constant (1958) dollars to remove affects of inflation.

These six cities are representative of the majority of Kansas cities, thus similar expenditure trends are assumed to hold true for the other cities also.

Objectives

Given the situation of accelerating costs, it becomes even more important for city officials to be informed of relative cost effectiveness among the group of services supplied by municipal government. In addition, for evaluation and comparison purposes, a compilation of cost information for all cities would be useful information. Any cost data obtained would have to reflect not only the actual city expenditures, but also the service quality and the particular characteristics of each city, since these two factors have a strong influence on expenditure levels. This study is an attempt to determine this type of information for the police and fire expenditure functions. The sample of cities analyzed consisted of the thirty-three largest cities for police protection and seventy-eight Kansas cities and towns, all of them over 2,500 population, for fire protection.

The primary objectives of the study are: (1) to develop cost-output models for both police and fire protection that would account for the per capita expenditure variation among cities for these services; and (2) to study whether economies of scale exist for police and fire protection.

Secondary goals include (1) development of a determinant model for the crime rate in Kansas cities, which would indicate whether each city's crime rate was higher or lower than expected based on city characteristics; and (2) to examine the influence of police activity on the crime rate.

Chapter II gives the empirical results of the police expenditure analysis, while Chapter III presents the findings with regard to fire protection. A review of literature and the methodology used in the analysis is incorporated within these two chapters.

CHAPTER II

AN ECONOMIC ANALYSIS OF THE POLICE EXPENDITURE FUNCTION IN THIRTY-THREE KANSAS CITIES

Introduction

A sizeable portion of city expenditures is devoted to the law enforcement activity through maintenance of a police force. In Kansas, for all towns over 10,000 population in 1970, police expenditures ranged from $106,707 in Merriam to $4,822,208 in Wichita.[1] On a per capita basis, Merriam spent $9.83 per person for the low figure, while Kansas City's $23.99 outlay per capita was the high value. The other Kansas cities spent varying amounts within that range, with the mean police expenditure per capita being $14.76. Attempting to explain the causes for this expenditure variation between these 33 cities is the purpose of this chapter. The rationale used in selecting a sample based only on cities over 10,000 population was the belief that small towns cannot realistically be compared with larger cities in regard to police protection expenditures. Empirical evidence indicates that crime rate increases with city size. The anonymity afforded an individual in larger cities might be one explanation for this difference.

The objectives of this chapter are: (1) to investigate the variation in crime rates that exist between cities in Kansas; (2) to determine the social costs, based on increased crime, of city expansion; (3) to test

[1]For a complete listing of expenditures for all cities over 10,000 population, refer to Appendix Table A-1.

whether an effective police force can reduce the crime rate; and (4) to observe whether economies or diseconomies of scale exist for the provision of police protection.

Factors Contributing to the Incidence of Crime

A measure of the scope of the problem faced by a city's police force is the crime rate. One cannot use this as a basis for comparing police effectiveness from one city to another, however, since the propensity to commit crime varies from city to city. For example, to conclude that Junction City, which had the highest crime rate in the state in 1970,[2] has an ineffective police force without looking at the special law enforcement problem that exists there, would be an injustice to that police department. The proximity of the Fort Riley military installation with its large aggregation of young males--a group with one of the higher crime rates in society--presents Junction City with a crime control problem substantially greater than that faced by other towns of similar size.

Because the law enforcement problem is so dependent on the unique characteristics of each city, the first part of this study involved an examination of the factors contributing to the crime level.

As outlined in the FBI's annual Uniform Crime Reports, the amount and type of crime that occurs in any particular area is heavily influenced by the following conditions:[3]

1. The density and size of the community's population.
2. The age, sex, and racial composition of the population.

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[2]Refer to Appendix Table A-1 for a listing of crime rates by city.

[3]U.S., Department of Justice, Federal Bureau of Investigation, Crime in the United States: Uniform Crime Reports - 1970, (Washington, D.C.: U.S. Government Printing Office, 1971), p. vii.

3. Economic status and mores of the population.
4. Degree of stability of the population.
5. Climate.
6. Educational, recreational, and religious characteristics.
7. Effective strength of the police force.
8. Quality of police personnel.
9. Effectiveness of the prosecuting officials and the courts.
10. Public attitude toward law enforcement problems.
11. The administrative and investigative efficiency of the local law enforcement agency.

Previous economic studies dealing with the determinants of crime have generally focused on one or more of the above mentioned conditions, attempting to measure the influence of each on the crime rate.

Morris developed an equation in which per capita crime rates were a function of police numbers, racial composition, median income levels, population density, age structure and sex structure. Using data from 754 cities ranging in size from under 25,000 to over 1 million inhabitants, Morris found that the estimated coefficients for percent nonwhites, median age, density, and police per capita were significant. Median age was negatively correlated with the crime rate, while the three other variables were positively related.[4]

Phillips, Votey, and Maxwell, investigating the influence of economic opportunity on the crime tendencies of American youth, showed empirically that an increasing unemployment rate among 18 and 19 year olds causes an increase in the incidence of crime for that group.[5]

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[4]Douglas Edmund Morris, "Economies of City Size: Per Capita Costs of Providing Community Services," (unpublished Ph.D. dissertation, Oklahoma State University, 1973), pp. 16-21.

[5]Llad Phillips, Harold L. Votey, Jr. and Darold Maxwell, "Crime Youth, and the Labor Market," Journal of Political Economy, LXXX, No. 3 (May/June, 1972), pp. 491-503.

Pressman and Carol, hypothesizing that crime might be one of the diseconomies of scale causing the flight of inner city residents to the suburbs, attempted to determine if certain measures of urbanization - population density and in-migration rates - were related to crime rates. While the rate of in-migration was found to be positively related to crime rates, no relationship between population density and crime rate was discovered. Additional tests showed positive and significant (at .05 confidence level) correlations between number of police per capita and crime, between mean annual temperature and crime, and between percent nonwhites and crime. No relationship between education levels and crime was observed. While not statistically significant, correlations indicated that crimes against persons were inversely related to family income, while property crimes were directly related to family income.[6]

A similar study by the Urban Institute examined the correlation between the crime rate and each of five population and socioeconomic variables. Based on a sample of 147 cities over 100,000 in population, percent nonwhites, percent black males aged 15-24, and population size were positively correlated with crime and statistically significant.[7]

Katzman hypothesized that an area's crime rate can be largely explained solely by the sex, age, class, and ethnic composition of the area residents and those non-residents that frequent the area. He emphasized that crime in America is largely a lower class phenomenon, with most crimes committed

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[6]Israel Pressman and Arthur Carol, "Crime as a Diseconomy of Scale," Review of Social Economy, XXIX, No. 2 (Sept., 1971), pp. 227-236.

[7]The Urban Institute, The Challenge of Productivity Diversity: Improving Local Government Productivity Measurement and Evaluation, Part III: Measuring Police-Crime Control Productivity (Washington, D.C.: n.n., 1972), pp. 52-56.

by lower-class people, against other lower class people, in the lower class districts.[8]

National arrest statistics compiled by the FBI provide information as to the characteristics of criminal suspects. When arrests are categorized according to the age, race, and sex of the offenders, they show that youth, Negroes, and males tend to be arrested much more than in proportion to their population numbers.[9] Arrest statistics for Kansas report similar trends.[10]

Specifying an Explanatory Model for the Crime Rate in Kansas

The city crime rates used in this study were obtained from the Kansas Bureau of Investigation publication Crime in Kansas - 1970. These crime rates are based on the number of serious crimes reported to the police.[11] The seven crimes designated as "serious" are murder and nonnegligent manslaughter, forcible rape, robbery, aggravated assault, burglary, larceny, and auto theft.[12]

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[8] Martin T. Katzman, "The Economics of Defense Against Crime in the Streets," Land Economics, XLIV, No. 4 (Nov., 1968), p. 432.

[9] Federal Bureau of Investigation, Uniform Crime Reports - 1970, pp. 119-159.

[10] Kansas Bureau of Investigation, Crime in Kansas: 1970, pp. 37-47.

[11] The total number of serious crimes actually committed is impossible to determine, since many crimes are never reported to the police. A national survey of crime victimization revealed that only approximately 52% of the violent crimes and 45% of the serious property crimes that occurred were reported. For further information concerning the extent of unreported crime in the United States, see the report by the President's Commission on Law Enforcement and Administration of Justice, The Challenge of Crime In a Free Society (Washington, D.C.: U.S. Government Printing Office, 1967), pp. 21-22.

[12] These seven crimes are frequently referred to as "index crimes" because they are the ones used by the FBI in determining the national crime index.

While the seven crimes mentioned above are the ones about which the public expresses the most concern, there is a considerable difference in seriousness among the individual crimes. An auto theft is quite different from a murder or rape both in degree of harm done to the victim and the level of public outrage directed toward the offense. Because of this "inequality of crime seriousness," consideration was given to the idea of weighing each city's crime rate based on the particular mix of crime that occurred. No legitimate weighing procedure was found however. Attempts were made to obtain average prison sentence lengths imposed for committing each of the seven serious crimes, and weigh each crime accordingly, but such data were not available. District Court statistics for Kansas report the verdict of each case, but do not list the sentence. Even if the sentence lengths had been obtained, their usefulness as an indicator of crime seriousness would be somewhat limited, because relative seriousness of crimes is a value judgment.

The Model

Based on the FBI's crime factors, previous studies, and state and national crime and arrest statistics, the initial specification of the Kansas crime rate explanatory model for the 33 largest cities in the state was of the following form:

$$CR = f(P, D, Y, DC)$$

where

CR = Crime rate by city for serious crimes, 1970
P = Population index, 1970
D = Density index (population per square mile), 1960
Y = Median income of families index, 1970
DC = A composite demographic measure reflecting the population's propensity to commit crime, 1970

The four factors selected as independent variables in the model - population size, population density, median income and demographic composition - were believed to be the major determinants of the level of crime present in Kansas cities. Prior to empirical testing it was hypothesized that population size, density, and the demographic variable were positively correlated with the crime rate, and income negatively correlated. A crime rate increase as cities expand in size was felt to be related to the breakdown of inter-personal relationships in larger cities; there appears to be a greater tendency to commit crimes - especially property crimes - when the offender feels few close ties to his neighbors and the community in general. Congested living conditions, as measured by population density, also appear to be causally related to the crime rate. Crowded living areas tend to breed discontent and resentment; in addition, such areas often lead persons inclined toward crime to group together and reinforce each other. Economic status - in this model measured by median family income - is another widely cited indicator of crime potentiality. Poverty may induce disadvantaged persons to use illegal means to obtain money. The fourth independent variable in the model - the special demographic variable reflecting each city's age, sex, and racial composition - was intended to reflect the greater frequency of arrests observed for certain population groups.

The figures for population, density, and median family income for each of the 33 cities tested were taken directly from readily available sources, while the special demographic variable, indicating the propensity to commit crime of each city's population, was a composite figure computed from both population data and crime statistics. The specific method used in computing the demographic variable is outlined in the following section.

An Index of the Propensity to Commit Crime

The basis for determining each city's crime potential was Kansas arrest statistics indicating that the age, race, and sex composition of the population is a reliable indicator of the amount of crime. The actual statistics used were state arrest data published in Crime in Kansas - 1970.

Arrests in Kansas are separately categorized by age, sex, and race of the offender, but no cross classification of arrests within these three factors exist (i.e., the number of arrests of eighteen year old white males, for example, is not given). For purposes of this study it was assumed that there is no interaction effect between the categories, thus the arrest percentage for any combination of age, sex, and race categories is obtained by multiplying the respective marginal portions. If $p_{i,j,k}$ = the probability that an arrested individual is age i, sex j, and race k, then the marginal probabilities for each category are $p_{i..}$, $p_{.j.}$, and $p_{..k}$, ($p_{i..}$, for example, is the probability that an arrested individual is age i irregardless of sex or race involved). If there are no interaction effects present among the three categories (with present information there is no reason to hypothesize differently), then the probabilities for the individual cells (cross classification) will equal the product of the respective marginal probabilities,

$$p_{i,j,k} = p_{i..}p_{.j.}p_{..k}$$

Multiplying P_{ijk} by the total number of arrests gives the number of arrests in age i, sex j, and race k,

$$(1) \quad n_{ijk} = n_{...}p_{ijk} = n_{...}p_{i..}p_{.j.}p_{..k}$$

It can be shown that the maximum likelihood estimator of the marginal probabilities is given by the ratio of number of arrests in that marginal category divided by total number of arrests,

$$\hat{p}_{i..} = \frac{n_{i..}}{n_{...}}, \qquad \hat{p}_{.j.} = \frac{n_{.j.}}{n_{...}}, \text{ and } \hat{p}_{..k} = \frac{n_{..k}}{n_{...}}$$

By substituting the estimated marginal probabilities for the actual probabilities in equation (1), an equation for estimating the number of arrests in all subcategories can be derived.

The procedure just outlined was used to determine the probability that persons who are arrested would be in a particular age, race, and sex classification. A second probability indicating the per capita arrest probability for all age, sex, and race classifications was then derived by dividing the estimated number of arrests per subcategory by the corresponding state population categories. Appendix Table A-2 lists these probabilities.

The 1970 Census of Population contains information by age level as to the number of persons who are white males, white females, Negro males, and Negro females in each city over 10,000 population in Kansas. Multiplying the number of persons in each group per city by the corresponding estimated per capita arrest probability by category and summing the resulting figures gave the expected arrests per city for the white and Negro population. To include arrests of people whose race was other than white or Negro, the expected number of arrests for the white and Negro population was increased in proportion to the population of other races.

The number of arrests (A) generally do not equal the number of crimes (C) that occur, since not all crimes are solved, i.e., (2) $C = bA$ $(b > 1)$. In Kansas in 1970 there were approximately 5.25 more crimes reported to police than arrests made.[13] Using equation (2) with b assumed to equal 5.25, the total expected crimes per city was calculated.

[13] Kansas Bureau of Investigation, Crime in Kansas - 1970, pp. 27, 37.

The remaining step in calculating the special demographic variable involved dividing the expected crime rate by city population in thousands, in order to get an index figure for propensity to commit crime comparable from city to city.

Since it is an aggregate measure of a city's population characteristics, it is somewhat difficult to interpret values of this variable precisely. In general, because it is a weighted value based on "propensity to commit crime," a high value of this measure indicates a greater proportion of males, nonwhites, or youth, while a low value would describe a population composed of a larger proportion of females, whites, and older persons.[14]

Kansas Crime Rate Model Results

Using ordinary least squares multiple regression with all variables defined as linear in form, the following crime rate equation was estimated:[15]

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[14]The validity of the two assumptions used in calculating the propensity to commit crime index: (1) the average proportion of crimes committed by Negroes and whites, and males and females is the same at all age levels; and (2) arrests are related to crimes committed by a factor of 5.2528, are both questionable. As noted by Gilbert Geis in "Statistics Concerning Race and Crime," Race, Crime and Justice, ed. by Charles E. Reasons and Jack L. Kuykendall (Pacific Palisades, Calif.: Goodyear Publishing Company, Inc., 1972), p. 65: "This point is worth repetition: arrest statistics and the detailed characteristics (such as race, sex, and age) of persons arrested are no more than descriptions of the persons who, for a veritably endless array of reasons (many of which are beyond our knowledge), are subjected to arrest. If we find, for example, that 20 percent of the persons arrested in California are females, this cannot be taken to mean that 20 percent of the state's criminals are females or that 20 percent of the offenses known to the police are committed by females, or that 20 percent of any particular offense, even if this is the figure for arrested females in regard to that offense, are committed by females. It may be that females are either more or less readily apprehended than males in regard to certain offenses. . . . All that can be concluded with safety, it seems apparent, is that a certain percentage of persons arrested are females. If you want to know about the criminal behavior of females, you will not find out about it in the statistical reports of the nation's law enforcement agencies."

[15]Throughout this paper, the following notations for significance level will be used: * = significance probability .05 or better ($\alpha \leq .05$)
** = significance probability .01 or better ($\alpha \leq .01$)

$$(3)\quad CR = \underset{(t=-0.319)}{-5.474} + \underset{(t=1.68)}{0.7358P} + \underset{(t=2.076)}{9.583^{*}D} - \underset{(t=-1.23)}{6.983Y} + \underset{(t=2.764)}{1.00^{**}DC}$$

$$R^2 = 0.623$$

$$s = 11.502$$

In later regression runs using this data, experimentation with other functional forms was performed. By visual examination of data plots in which the crime rate was compared with each of the independent variables, alternate forms were suggested. Best results in terms of a higher R^2 value[16] and significant t-statistic were obtained by defining population as a logarithmic function (base 10) and converting the income values to the -2 exponential power. Density and demographic characteristics were left in linear form. The estimated crime rate equation obtained after incorporating these changes in functional form was:

$$(4)\quad CR = \underset{(t=2.197)}{-22.09^{*}} + \underset{(t=2.889)}{19.42^{**}\log P} + \underset{(t=1.782)}{7.674D} + \underset{(t=2.382)}{26.87^{*}Y^{-2}}$$

$$+ \underset{(t=2.089)}{0.7313^{*}DC} \qquad R^2 = 0.6835 \qquad s = 10.539$$

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[16] As noted by Rao and Miller, selecting the appropriate definition of an independent variable by the criterion of the highest R^2 value is acceptable from an empirical standpoint, since "the precise empirical definition of variables should be selected so as to put the theory in question in its best light" (quote from Milton Friedman and David Meiselman, "The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States, 1897 - 1958," Stabilization Policies, Commission on Money and Credit (New York), 1963, p. 181., cited by Rao and Miller). They hasten to add, however, that "this procedure should not be misused. It applies only to the choice among a well-selected and theoretically acceptable set of alternative definitions of a given variable. It may happen that a nonsensical definition of the variable will give the highest R^2; this, of course, does not mean it is the appropriate one to use. Basing the choice of appropriate definition of an independent variable on a maximum R^2 is justified only when the model has been fully specified and all the other variables of the model are well defined. This procedure is a guide in empirical research, and not a theoretical rule." Potluri Rao and Roger Miller, Applied Econometrics (Belmont, Calif.: Wadsworth Publishing Company, Inc., 1971), pp. 18-19.

Examination of the correlation matrix revealed no serious multicollinearity between the independent variables.[17]

The signs of the coefficients on equation (4) are as expected; it had been hypothesized that an increasing crime rate would be associated with increasing population, density, and demographic composition values, and inversely related to income. Caution must be exercised when evaluating the income coefficient listed above; it is positive because the actual income values were transformed by an exponent of -2. A value raised to a negative number moves inversely with the number from which it was derived. Also it should be mentioned that the values used for population, density, and income in the regression analysis were not the actual figures for these variables but rather were index numbers derived by setting the low value for each variable equal to one, and dividing the other 32 figures by that factor.

A Social Cost of Increasing City Size - Higher Crime Rates

Based on the coefficients estimated for equation (4), by holding all factors except population constant at their mean value, the "penalty" cities of varying sizes pay in terms of crime can be calculated. Table 2-1 shows the estimated crime rate for cities of various sizes. Refer to Figure 2-1 for a graphic presentation of this information.

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[17] The procedure used in checking for serious multicollinearity was to apply the "rule of thumb" suggested by Klein that multicollinearity is "tolerable" if $r_{ij} < R$, where r_{ij} = the sample correlation between independent variables i and j and R = the multiple correlation coefficient for the regression equation. David Huang, Regression and Econometrics Methods (U.S.A.: John Wiley and Sons, Inc., 1970), pp. 153-154.

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FIGURE 2-1

ESTIMATED CRIME RATE BY CITY SIZE

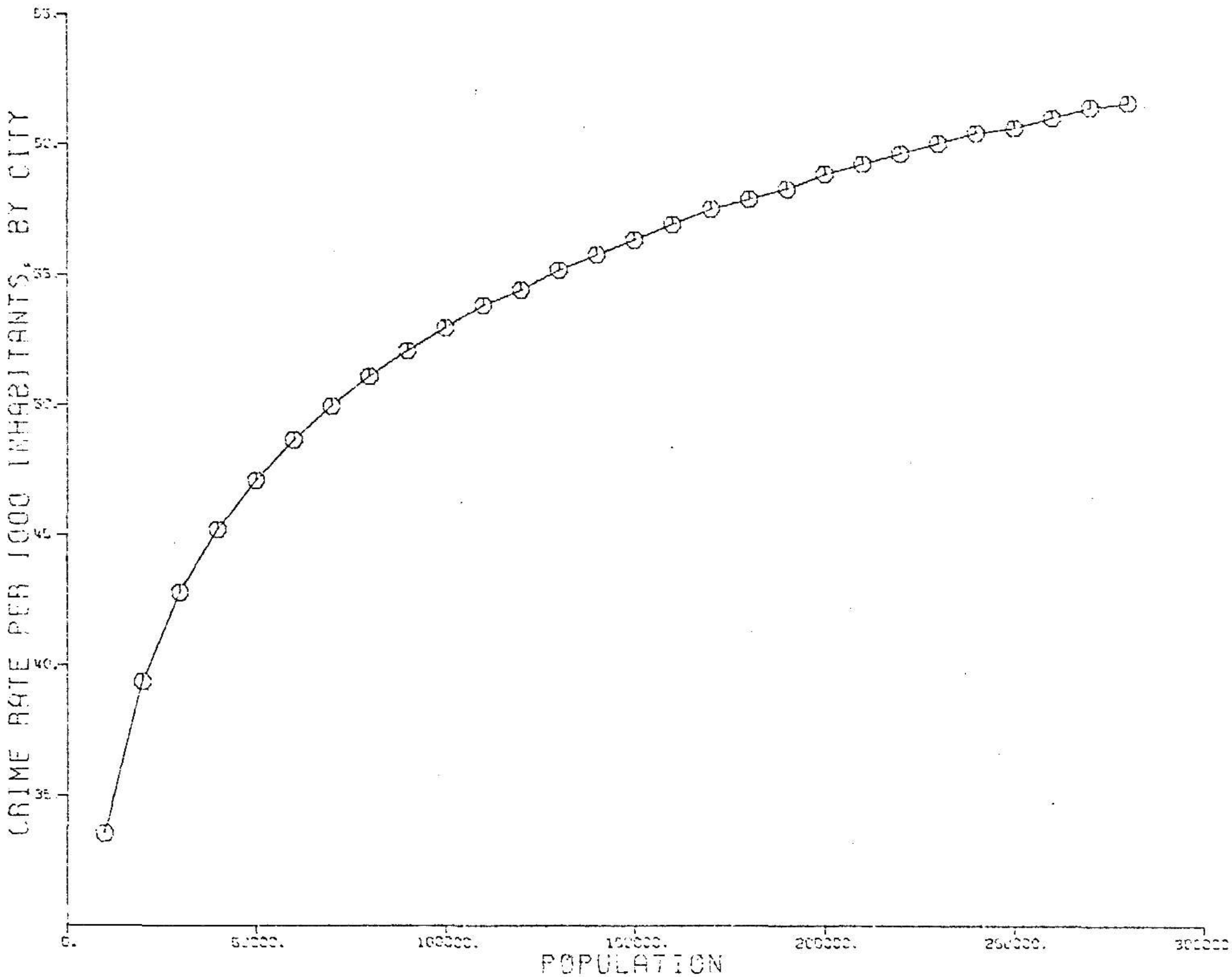

TABLE 2-1

ESTIMATED CRIME RATE BY CITY SIZE

Population	Estimated Crime Rate (per 1,000 inhabitants)
10,000	33.51
20,000	39.35
30,000	42.78
40,000	45.19
50,000	47.08
100,000	52.92
150,000	56.32
200,000	58.85
250,000	60.59
280,000	61.56

Source: Crime rates calculated from the regression equation estimated for the 33 cities in Kansas over 10,000 in population: $CR = -22.09 + 19.42 \log P + 7.674D + 26.87Y^{-2} + 0.7313DC$. Mean values used to hold density, income^{-2}, and demographic composition constant were 1.954, 0.598, and 33.939, respectively.

Affect of Police Expenditures on Crime

To determine whether the level of per capita police expenditures influences a city's crime rate, that factor was included with the other four previously discussed independent variables and tested using least squares regression. For the thirty-three cities analyzed, little evidence of a relationship between per capita police expenditures and the crime rate was discovered, as shown in equation (5).

$$(5)\quad CR = \underset{(t=-2.413)}{-30.82^{*}} + \underset{(t=2.368)}{16.81^{*}\log P} + \underset{(t=1.663)}{7.178D} + \underset{(t=2.104)}{24.25^{*}Y^{-2}}$$

$$+ \underset{(t=2.051)}{0.7159DC} + \underset{(t=1.095)}{0.8553P.\ Exp.} \qquad R^2 = 0.697,\quad s = 10.506$$

Based on these results, population size, density, income and propensity to commit crime all appear to be more closely related to a city's crime rate than does police expenditures.

The Influence of the Police Force on the Crime Rate

The basic mission of a police force consists of four functions:

1. To deter or prevent crime.
2. To apprehend offenders.
3. To regulate traffic flow and enforce compliance with the traffic laws of the community.
4. To act in a service role, by encouraging legal conduct, aiding citizens in need, and in general being "public servants" of the community.

To determine the effectiveness of an individual city's police force, it would be desirable to devise a quality measure based on the degree to which each of the above functions was performed, with each function weighed according to that community's feeling as to the importance of each. Unfortunately, data used in devising such a measure would be very difficult to obtain. In addition, since it would be based to a large extent on subjective factors - such as how the citizenry viewed their police force - the validity of comparing one city's police with another city's might be questionable. No attempt was made in this study to devise such an overall quality measure. Instead, the effectiveness of a police force was studied from the viewpoint of how well they met the first two objectives listed above - deterrence and apprehension.

Measuring Police Effectiveness

The Deterrence Function

One attempt to measure the quality of each police force involved evaluating deterrence effectiveness. The logic on which this measure rests is that if a city's crime rate is significantly less than the expected rate based on the city characteristics, then the police force must be doing an effective job of preventing and controlling crime. While that idea seems reasonable (consider the effect passing a patrol car has on the speeding motorist, for example), quantifying this measure so that comparisons among police forces can be made is difficult.

In addition, it appears that only certain types of crimes - those in which the objective of the criminal is economic gain - can be deterred by police action. The violent crimes (murder, rape, robbery, and assault) apparently are only slightly susceptible to deterrence. These crimes - especially murder, rape, and assault (termed "crimes of passion") - are usually committed with little thought as to the possibility of eventual apprehension and punishment. As pointed out by the President's Commission on Law Enforcement and Administration of Justice, "More than nine-tenths of all murders are cleared by arrest, and a high proportion of those arrested are convicted. Yet people continue to commit murders at about the same rate year after year."[18] Zimring studied the effectiveness of threats of punishment in preventing criminal acts, and concluded that crimes committed for material gain were more susceptible to deterrence than crimes of passion, since crimes of passion are associated with greater emotional arousal and because there are more substitute means of obtaining money other than criminal activity than there are substitute ways of achieving the ends sought in aggressive crimes.[19]

Gary Becker, applying mathematical analysis to the subject of crime and punishment, stated in "Crime and Punishment: An Economic Approach," Journal of Political Economy, LXXVI (March/April, 1968), p. 176, that the

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[18]The President's Commission on Law Enforcement and Administration of Justice, Report of the Commission, The Challenge of Crime in a Free Society (Washington, D.C.: U.S. Government Printing Office, 1967), p. 4.

[19]Franklin E. Zimring, Perspectives on Deterrence, Crime and Delinquency Issues: A Monograph Series, Public Health Service Publication No. 2056 (Washington, D.C.: U.S. Government Printing Office, 1971), pp. 53-54.

supply of offenses (number of criminal acts) may be explained in terms of the economists' usual analysis of choice; that is, "a person commits an offense if the expected utility to him exceeds the utility he could get by using his time and other resources at other activities." This implies that a potential criminal weighs the benefits to be gained from illegal activity against the costs (apprehension, conviction, punishment) involved. An effective police force would apprehend many of the criminal offenders in the area, thus the probability of apprehension for any potential criminal would be high. This would increase the costs, making fewer criminal ventures attractive.[20] Thus existing theories of deterrence would seem to indicate that measuring police effectiveness by their ability to deter crime would be appropriate only for property crimes.

Measuring Deterrence

As a means of measuring deterrence effectiveness of the police force in each of the thirty-three cities analyzed, attempts were made in this study to compare the actual crime rate for each city with the expected rate.

The residual statistics obtained from the crime rate regression analysis (equation (4)) indicated the deviation of each city's actual crime rate from the estimated crime rate based on population size, density, median income, and demographic composition. Negative residual values (indicated actual crime rate was lower than the estimated rate) were felt to indicate an effective police force, at least from the crime prevention standpoint.

However, when these residual values were compared with per capita police expenditures by regression analysis, there was little evidence that

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[20]Gary Becker, "Crime and Punishment: An Economic Approach," Journal of Political Economy, LXXVI (March/April, 1968), p. 176.

per capita police expenditures had much affect on deterrence ability. Equation (6) reports the regression results.

$$\text{(6)} \quad \text{Residuals} = \underset{(t=-0.989)}{-\,9.383} \;+\; \underset{(t=1.005)}{0.6358\text{P.Exp.}} \qquad R^2 = .0316,\; s = 9.86$$

where

Residuals = the difference between the actual crime rate and the rate estimated from the equation $CR = -\,22.09 + 19.42 \log P + 7.674D + 26.87Y^{-2} + 0.7313DC$

P. Exp. = per capita police expenditures.

Refer to Figure 2-2 for a graphic illustration of this information.

These results tend to contradict the widely prevaling attitude that greater police expenditures will substantially repress criminal activity.

While in this study only the difference between the actual crime rate and a community's "expected" crime rate was investigated as a possible measure of police deterrence ability, the Urban Institute study cited previously suggested several ways in which this factor might be measured. These suggestions were to:

(1) Compare changes in the index crime rate against changes in the number of police per capita during preceding years. Considering only the type of crimes relatively deterrable by police patrol might present the most accurate picture of deterrence productivity.

(2) Devise an etiological model that could be used to develop estimates of the expected crime rate for a given area. The difference between the crime rate estimated by the model and the observed crime rate would be a measure of the deterrence effectiveness of the police.[21]

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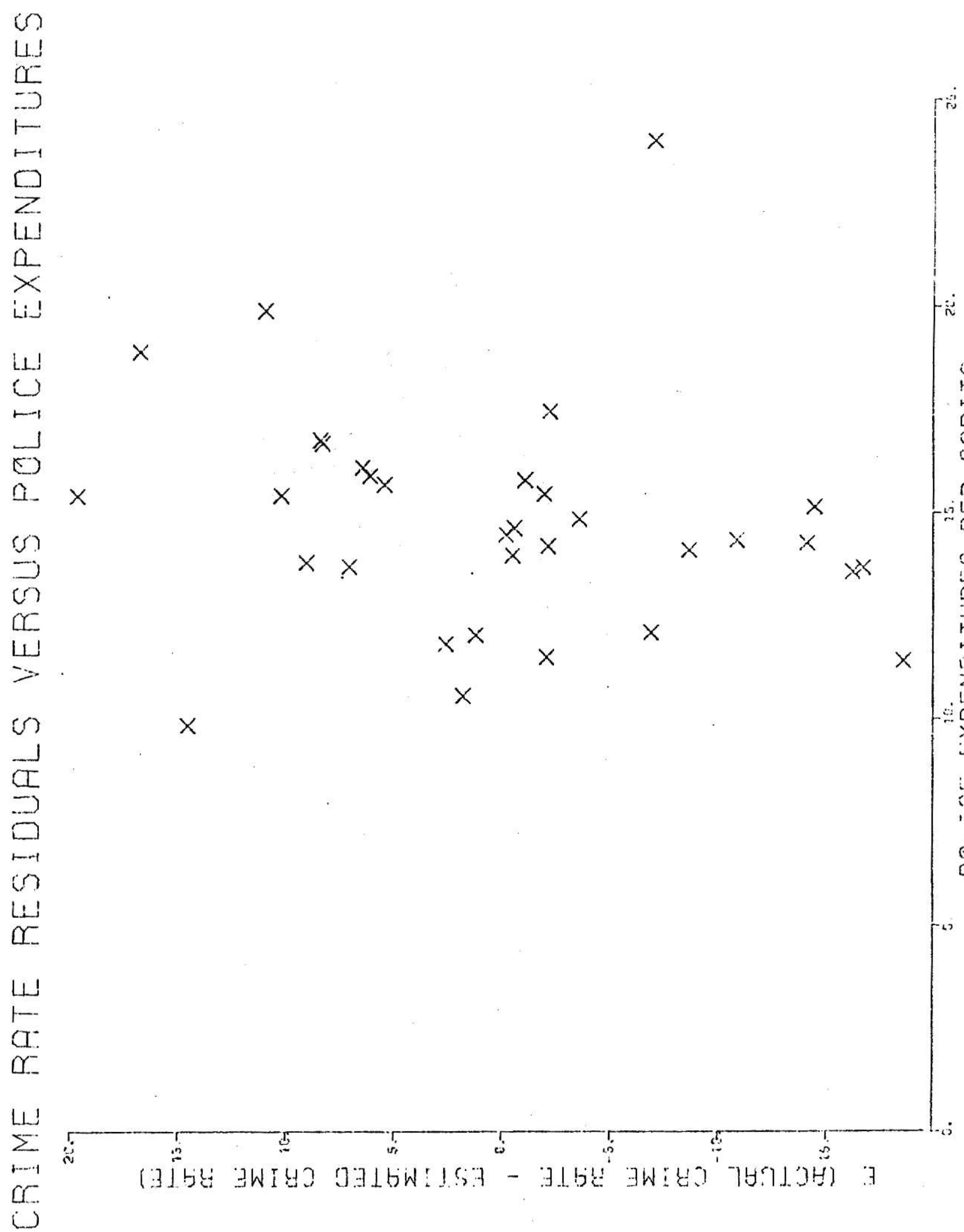
[21] The idea of measuring deterrence by use of an expected crime rate was developed prior to examining the Urban Institute study; it was somewhat encouraging to find that they suggested a similar procedure.

FIGURE 2-2


CRIME RATE RESIDUALS VERSUS POLICE EXPENDITURES
E (ACTUAL CRIME RATE - ESTIMATED CRIME RATE)
20.
15.
10.
5.
0.
-5.
-10.
-15.
POLICE EXPENDITURES PER CAPITA
0.
5.
10.
15.
20.
25.

(3) Construct a "morbidity" ratio that would indicate whether the crime rate is changing as fast as the conditions causing crime.

(4) Conduct a survey featuring interviews with criminals, ex-convicts, citizens in high crime neighborhoods, and police in order to estimate the level of inhibition to commit crime resulting from police activity.[22]

After outlining these measures, however, the authors concluded there was really no satisfactory way to record crimes deterred by police presence. All that can be measured precisely is the amount of non-deterrence; that is, the level of reported crime.

The Apprehension Function

The second indicator of police force effectiveness examined in this study was the ability of each police force to solve the crimes that occur within its jurisdiction.

The measure of a police force's ability to apprehend criminal suspects is the crime clearance rate. A crime may be cleared either by the arrest of a suspect, or, in unique cases, by an exceptional clearance. As defined in the FBI's Uniform Crime Reporting Handbook, an offense is "cleared by arrest" when at least one person is (1) arrested, (2) charged with the offense, and (3) turned over to the court for prosecution. A crime is solved for crime reporting purposes by exceptional clearance when there is some reason outside the police control that stops them from arresting, charging, and prosecuting the offender. A frequent reason for exceptional clearances is that the victim refuses to cooperate in the prosecution; other examples include a denial of extradition of a suspect

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[22]The Urban Institute, Measuring Police-Crime Control Productivity, pp. 34-38.

in custody in another jurisdiction, and the case where the offender is prosecuted for a less serious charge than that for which he was arrested.[23]

For purposes of this study, the clearance rate was hypothesized to influence a city's crime rate. If the police force is able to solve a high percentage of the crimes in the community, then other potential criminals may be deterred from criminal activity because they perceive there is a high probability of arrest. In addition, since certain individuals are habitual offenders, arresting and convicting criminals removes them from the street, thus reducing the number of crime-prone individuals in the population.[24]

Relationship Between the Crime Rate and Clearance Rate

Crime clearance rates for Kansas cities are not published; however, the Kansas Bureau of Investigation has this information available in raw form, and agreed to release it for use in this study. The KBI data listed, by city, all crimes that occurred by category, and the number of these crimes cleared. Computing the clearance rates involved dividing crimes cleared by the total number of crimes. In order to partially eliminate unusual cases that might cause a city in one particular year to have a higher or lower clearance rate than normal for that police force, both 1970 and 1971 data were used in figuring the rates.[25]

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[23]U.S., Department of Justice, Federal Bureau of Investigation, Uniform Crime Reporting Handbook, (Washington, D.C.: U.S. Government Printing Office, 1966), p. 50.

[24]The Urban Institute, Measuring Police-Crime Control Productivity, p. 15.

[25]A complete listing of the average clearance rates by city for each of the seven serious crimes is presented in Appendix Table A-3.

To test whether an effective police force can influence the crime rate, regression analysis was used to measure the amount of variation in the crime rate between cities that could be accounted for by the clearance rate. Results showed that a completely random relationship existed between a city's total crime rate and its crime clearance rate - the simple correlation coefficient (R) for these two variables was 0.00944. Figure 2-3 provides a visual comparison of the crime and clearance rates by city.

Dis-aggregating the crime rate into violent crimes and property crimes and comparing these with their respective clearance rates showed a slightly better correlation. Subdividing violent crimes into "crimes of passion" (murder, rape, aggravated assault) and robbery, and property crimes into its component parts - burglary, larceny, and auto theft - did not improve the correlation. For no crime or aggregation of crimes were the crime rates and clearance rates highly correlated as can be seen in Table 2-2.

TABLE 2-2

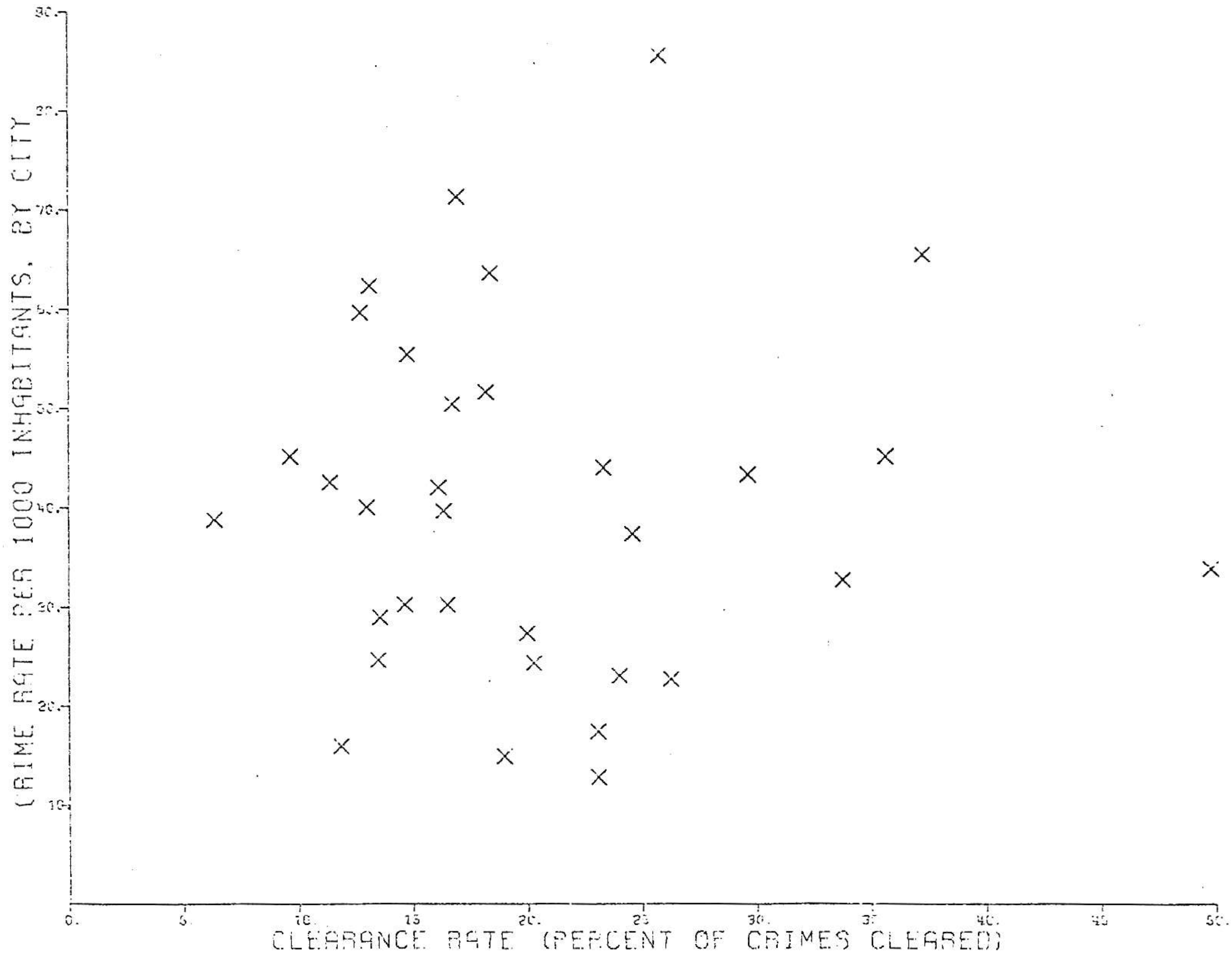
VALUES OF CORRELATION COEFFICIENT (R) FOR CRIME RATES COMPARED WITH THEIR RESPECTIVE CLEARANCE RATES

Type of Crime	Partial Correlation Coefficient
All serious crimes	0.00944
A. Violent crimes	-0.3558*
1. Murder, Rape, Aggravated Assault	-0.3494*
2. Robbery	-0.09547
B. Property crimes	-0.00647
1. Burglary	-0.1956
2. Larceny	0.09007
3. Auto Theft	-0.2655

Note: The small samples used in computing the violent crime rate and its two component parts and their corresponding clearance rates for some of the 33 towns tested, necessitates that caution be used in order that the results of the violent crime - clearance rate correlations listed above not be overemphasized.

FIGURE 2-3

CRIME RATE VERSUS CLEARANCE RATE, CITIES 10,000+



Implications of Results

These results indicate that neither measure tested--deterrence effectiveness and apprehension ability--adequately reflects police quality. A measure reflecting total police performance is needed. Milton Rector, President of the National Council on Crime and Delinquency has suggested three indices which should be used in evaluating a police force:[26]

1. The number of arrests and the quality[27] of arrests.
2. Some measure of how police respond to emergencies, such as assisting people in trouble, dealing with family disputes, heart attacks, fires, lost children, etc.
3. How people feel toward their police force.

For this study, however, a lack of time and resources prevented the development of a quality measure incorporating all these factors.

Factors Affecting Police Per Capita Expenditures

An issue with important implications for public policy is whether larger cities are able to provide police protection at a lower per capita cost than can smaller cities, at the same level of quality. While generally the provision of public services is amenable to the concept of economies of scale, whether or not the specific service under investigation here - police protection - shows decreasing or increasing costs as a city expands in size is difficult to determine theoretically. While a larger city is able to spread its administrative and fixed costs of facilities over a

[26] Milton G. Rector, "Merit Badges for Good Cops?" The Kansas City Times, June 20, 1973, p. 12B.

[27] The Urban Institute Study Measuring Police-Crime Control Productivity noted that "measuring only the number of arrests or clearances does not attest to their ultimate disposition or quality. This could lead to perverse incentives. A 'quality of arrest' indicator is therefore needed. Data on the disposition of arrests, such as the percent of felony arrests that 'survive' a preliminary court hearing, can be used as indicators of the quality of the arrests."

greater population, thereby reducing per capita costs for those factors, the crime control problem increases with city size. As reported earlier in this chapter, based on the 33 Kansas cities tested, when density, income and demographic characteristics of each city are held constant, the estimated crime rate rises from 33.5 for a city with a population of 10,000 up to 61.6 for a population of 280,000. Since these two factors - greater operating efficiency achieved by spreading fixed costs over a larger population base, and an increasing crime control problem as a city expands in size - have opposite influences on per capita expenditures, no hypothesis was made concerning existence of economies or diseconomies of scale for this service prior to empirical testing of the data for the 33 Kansas cities analyzed.

In developing a model to explain variation in per capita police expenditures, primary emphasis was placed on incorporating variables in the model that would reflect the level of crime in each city and the effectiveness of the police performance. The variable used in the model as a measure of the crime control problem was the crime rate; while, for lack of any better measure, the clearance rate was included as a quality measure. In order to determine other variables that should be included in such an economic model, a review of literature was undertaken to determine which factors previous studies had found to be of greatest significance in explaining police per capita expenditure variation.

Expenditure Determinant Studies

A study conducted in the mid 1950's in the St. Louis City - County area analyzed several local governmental expenditure functions, including police protection. A model was developed that explained 87 percent of the per capita police expenditure variation between jurisdictions, with the nonwhite population, quality level (based on the subjective rating of experts) and per capita assessed valuation variables explaining most of the variation.[28]

Adams studied 478 county areas, made up of a composite of all local governments within the county, by expenditure category and found that density, transients, percent foreign-born, and urbanization explained most of the variation in per capita expenditures for police protection. Density was the most important factor. Using nine variables, Adams obtained an R^2 value of 0.750 for his regression equation.[29]

Brazer, testing data from 462 cities with a 1950 population greater than 25,000, also found that density was the most important explanatory variable for police expenditures. Other significant variables were median family income, intergovernmental revenue, employment level and population. However, his regression equation explained only 26% of the variation in per capita police expenditures. Although Brazer found that the relationship between population size and police per capita expenditures was statistically significant, the population variable explained little of the variation. Brazer obtained better results in terms of an R^2 value when he separately analyzed cities from three states - California, Massachusetts, and Ohio. Using these smaller, more uniform samples, he obtained R^2 values of 0.437 for his California sample, 0.656 for the Massachusetts cities

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[28]John C. Bollens, ed., Exploring the Metropolitan Community (Berkeley and Los Angeles: University of California Press, 1961), pp. 335-340.

[29]Robert F. Adams, "On the Variation in the Consumption of Public Services," The Review of Economics and Statistics, XLVII, No. 4 (November, 1965), pp. 400-405.

analyzed, and 0.712 for the group of Ohio cities, with population and rate of population growth the two variables most important in explaining per capita expenditures.[30]

Economy of Scale Studies

Previous empirical studies that have attempted to measure whether economies of scale exist for the provision of police protection have generally shown that increased population size does not reduce per capita police expenditures.

Schmandt and Stephens tested 1959 data for nineteen cities in Wisconsin and found no significant scale economies when per capita police protection expenditures were correlated with service level and population.[31]

Hirsh devised a cost function for police protection and found that the average unit cost curve for the service was about horizontal, implying population size has no affect on per capita expenditures.[32]

Morris derived a figure termed "the social cost of crime" based on the number of police per capita required to hold crime constant for each size. This police per capita figure multiplied by police salary level equaled the "social cost of crime." Using an adjusted crime rate of 3,000 per 100,000 population, Morris calculated that the social cost of crime was at a minimum ($10.24 per capita) in cities with a population of 375,000. Large diseconomies of scale were found for the very large cities -

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[30] Harvey E. Brazer, City Expenditures in the United States, Occasional Paper 66, (National Bureau of Economic Research, Inc., 1959), pp. 36-44.

[31] Werner Z. Hirsch, The Economics of State and Local Government, Economics Handbook Series (New York: McGraw-Hill Book Company, 1970), p. 180.

[32] Ibid., p. 183.

the per capita social cost of crime was $34.17 for cities of over one million population. The average for all cities was $19.37 per capita.[33]

Shepherd, investigating police expenditures for Kansas in 1964, analyzed a sample composed of 40 of the 87 second class cities then in existence and all of the first class cities (15). He found that the trend for both groups of cities was toward increasing per capita expenditures as city population size increases.[34] No attempt was made to incorporate level of service quality into his analysis.

Specifying a Police Protection Expenditure Model for Kansas

Based on the previously mentioned considerations, the police expenditure model developed for Kansas was of the following form:[35]

$$P.\ Exp. = f(P, D, Y, CR, CLR, DC, M)$$

where

P. Exp. = Per capita police department expenditures, by city, 1970
P = Population index, 1970
D = Density index, 1960
Y = Median income of families index, 1970
CR = Crime rate, 1970
CLR = Crime Clearance Rate, 1970-71 Average
DC = A measure of the population's propensity to commit crime, 1970
M = Miles of street per 1,000 population, 1970 or 1971

The crime clearance rate was intended to serve as the "quality" measure of police protection each city received, while the other factors served as indicators of the potential magnitude of the crime control problem faced

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[33] Morris, "Economies of City Size," pp. 35-37.

[34] Robert Edwin Shepherd, "Economies of Scale in the Local Government of Kansas" (unpublished Master's thesis, Kansas State University, 1964), pp. 84-86, 96-99.

[35] Refer to Appendix Table A-1 for a listing of data used in the police expenditure analysis.

by each police force. Street mileage was included in order to account for the traffic control function of police.

With all variables defined as linear in form, ordinary least squares multiple regression gave the following results:

$$\text{(7)}\quad \text{P. Exp.} = \underset{(t=1.524)}{8.003} + \underset{(t=0.8787)}{0.950P} + \underset{(t=0.4097)}{0.5313D} + \underset{(t=0.5653)}{0.7783Y} + \underset{(t=1.556)}{0.06584CR}$$

$$+ \underset{(t=0.6112)}{0.0336CLR} + \underset{(t=0.1086)}{0.01024DC} + \underset{(t=0.4328)}{0.1172M} \qquad R^2 = 0.32036,\ s = 2.57095$$

These results indicated either there were several important factors excluded from the model that have an important influence on per capita police expenditures, or that per capita police expenditures, at least among the 33 Kansas cities tested, are largely random in nature. The t-values for every coefficient in the above equation were not significant indicating little confidence can be placed in the reliability of these estimates. The R^2 value shows that only approximately 1/3 of the variation between cities in per capita police expenditures can be accounted for by the seven factors specified in the regression equation.

In addition, using the "rule of thumb" suggested by Klein described earlier in this chapter, a small amount of multicollinearity between certain of the independent variables was detected. The sample correlations between crime rate and density, between crime rate and demographic characteristics, and between street mileage and density were all higher than the multiple correlation coefficient for the regression equation.

Some testing of alternative definitions of certain of the independent variables in terms of functional forms other than the linear form was done, but little improvement in either the t-values of the coefficients or the R^2 value for the total regression equation was discovered.

Two other independent variables, per capita property valuation and per capita receipts from retail trade and selected services, were incorporated into the model in later regression runs. Both were insignificant; in addition, each of them was highly inter-correlated with income.

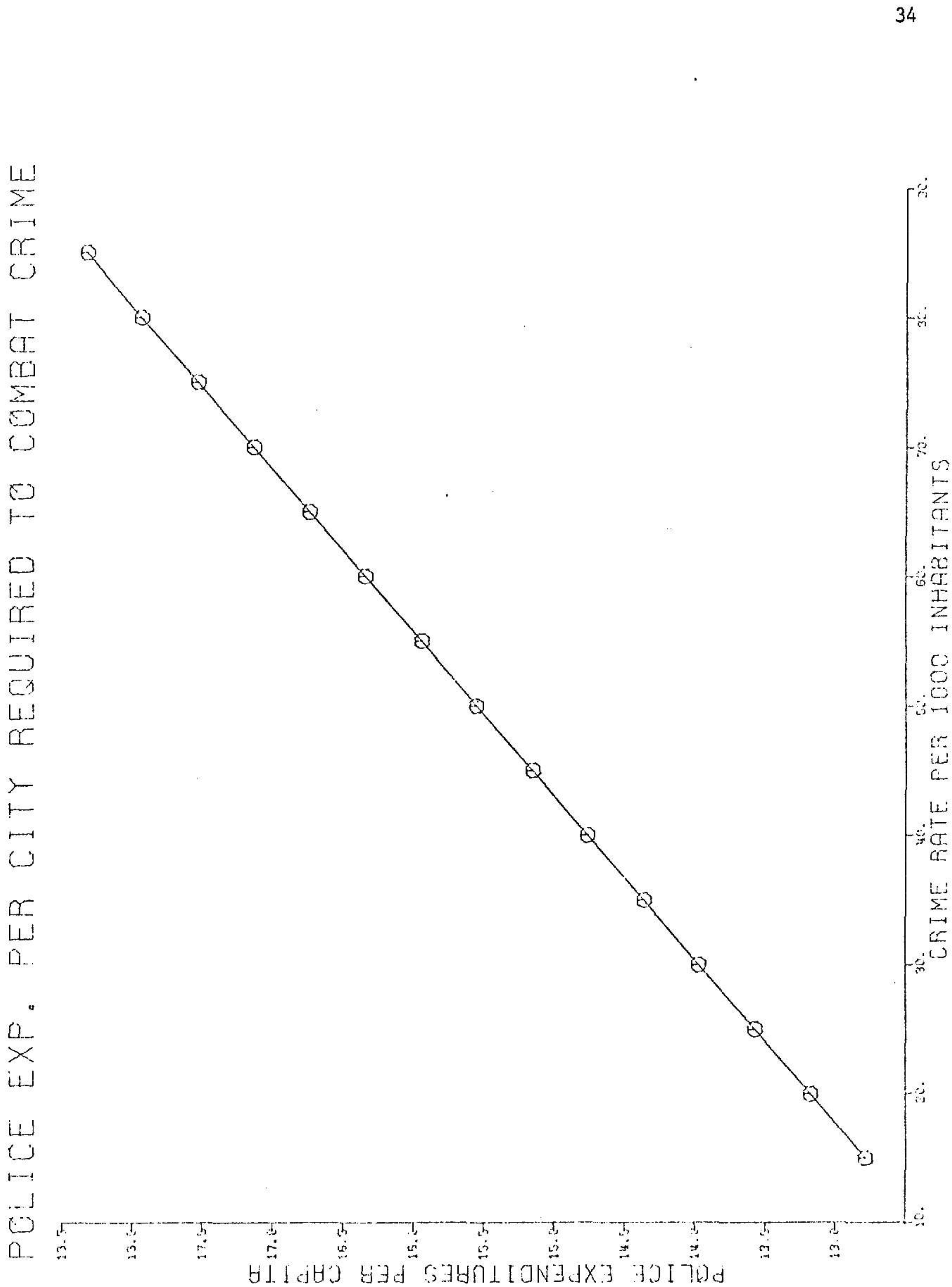
The Influence of the Crime Rate on Per Capita Police Expenditures

Since the crime rate was the only variable that was statistically significant and since it consistently explained more of the variation in per capita police expenditures than all the other variables combined, regression analysis was performed to determine the precise effect of the crime rate on per capita expenditures. The estimated equation obtained was:

$$(8)\quad \text{P. Exp.} = \underset{(t=10.88)}{11.58^{**}} + \underset{(t=3.243)}{0.07917^{**}}\,\text{CR} \qquad R^2 = 0.25336, \quad s = 2.41991$$

These results indicate that about 1/4 of the variation in per capita police expenditures between cities can be attributed to the crime rate. Based on this equation, the police per capita expenditure necessary to combat crime at varying levels of criminal activity can be calculated. Refer to Figure 204 for a graphic presentation of the increase in police expenditures needed to combat increasing levels of crime.

FIGURE 2-4


POLICE EXP. PER CITY REQUIRED TO COMBAT CRIME
CRIME RATE PER 1000 INHABITANTS
POLICE EXPENDITURES PER CAPITA

CHAPTER III

FACTORS AFFECTING PUBLIC FIRE PROTECTION EXPENDITURES IN KANSAS TOWNS

Introduction

Fires in Kansas towns and cities are responsible for a significant amount of human and property loss. In the six year period from 1965-70, 428 deaths were attributed to fire in the state, and the property loss (for city fires only) was over 45 million dollars.[1] Providing adequate fire protection for its citizenry quite properly is an important concern of local municipal governments.

A high degree of fire protection involves many factors: a sufficient water supply, a reliable fire alarm system, adherence to building codes, a strong building inspection and fire prevention program, public consciousness toward fire safety, and a well trained, adequately equipped fire department. Each of these factors must be present if a community is to minimize fire risk.

The Sample

The objectives of this chapter are (1) to develop and test a fire protection cost-output model for Kansas that will account for the variation in public costs of fire protection between cities; and (2) to determine whether economies of scale exist for the provision of fire protection. The

[1]Refer to Appendix Table B-3 for a summary of city fire losses in Kansas from 1965-70, and Table B-4 for a detailed fire loss compilation.

cost figures used are the 1970 fire department expenditures as reported in the city budgets filed with the Department of Post-Audits of the State Auditor's Office. The output measure is the number of people protected by each fire department, which for this study is assumed to equal the total city population.

The sample analyzed consisted of 78 Kansas cities - all incorporated cities over 2,500 population in the state (1970) for which data were available. Baldwin City, Girard, Hillsboro, Lansing, Lenexa, Osage City, and Wamego were excluded for lack of a population density figure comparable to that used for the other cities. The fire protection expenditures for Augusta and Mulvane were combined with police costs and could not be separated, causing deletion of these cities. In addition, Ulysses and Hugoton were also excluded from the sample, since expenditure data for 1970 were not available.

An Overview of the Public Fire Protection Structure in Kansas

Of the 78 cities in the sample, most of them provide fire protection directly by maintaining a fire department within the city governmental structure. The major exception to this type of organizational framework is found in Johnson County, where several of the cities--Fairway, Mission, Mission Hills, Overland Park, Prairie Village, and Roeland Park--contract for protection with three fire districts providing service to many of the towns in that area. The other exception is Haysville in Sedgwick County which contracts with that county for fire protection.

Forty-one of the cities studied provide rural fire protection services on a contract basis to townships, institutions, or individuals desiring such service. The typical fee is usually a flat annual fee, or an annual fee plus a specified amount for every rural fire run that must be made.

The type of manpower arrangements used by these cities is split between all volunteer fire personnel (26 cities), full time firemen only (29 cities), and a combination of volunteer and full time personnel (23 cities). The particular combination of the two used ranged from 1 full time fireman and numerous volunteers in Baxter Springs, Columbus, Eureka, Galena, and Russell; to 23 full time firemen and 10 volunteers in Great Bend.[2]

Developing the Kansas Fire Protection Cost-Output Model

The Dependent Variable

The dependent variable specified for the regression equation was per capita public fire protection expenditures. An alternative measure of output which could have been used instead of population protected was the amount of property protected. Both measures reflect the magnitude of the fire protection responsibility faced by a fire department. Hitzhusen tested both output measures on two separate data sets, one composed of a sample of New York cities, the other made up of Texas cities. His results were inconclusive as to which output measure was most appropriate. For the sample of Texas cities he found that more of the variation in the dependent variable was accounted for when the cost equation was expressed in terms of property value protected rather than population protected, while in a similar test using New York data the reverse was true.[3]

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[2]Refer to Appendix Table B-2 for further information concerning the number of firemen, salary of volunteers, number pieces of motor fire apparatus, and related information for each city in the sample.

[3]Fredrick J. Hitzhusen, "Some Policy Implications for Improved Measurement of Local Government Service Output and Costs: The Case of Fire Protection" (unpublished Ph.D. dissertation, Cornell University, 1972), pp. 155, 175.

The Independent Variables

Given the city expenditure figures available and the desire to check for the existence of economies or diseconomies of scale based on population size, the specification of the dependent variable--per capita public fire protection expenditures--followed directly. Identifying variables that would account for the variation in per capita expenditures among cities was more difficult. After some deliberation, it was decided to include the following factors as independent variables in the initial fire protection model tested:

1. Population size
2. Population density
3. City classification index based on the fire defense and physical condition of the town
4. Per capita valuation of real estate and personal property
5. Per capita receipts from retail and service establishments
6. Percent of dwelling units built in 1939 or earlier
7. Fire department manpower arrangements

Additional variables considered but not included in the model were the number of occupants per housing unit, percent of houses owner occupied, the level of manufacturing, amount of fire fighting apparatus available, existence of contractual arrangements with other jurisdictions to provide them fire department services when needed, amount of intergovernmental revenue a city receives, percent of transients, and the record of past fire losses for each city.

The rationale followed in selecting the seven independent variables incorporated in the initial testing of the model is presented on the succeeding pages.

Population size

Although conflicting results have been reported, research results have generally substantiated the hypothesis that economies of scale exist for the provision of fire protection services; that is, as population size increases, per capita costs of providing a constant quality level of public fire protection decreases. It should be emphasized that only public costs of fire protection are being considered; while it is recognized that private costs for fire protection--primarily fire insurance premiums--make up a significant portion of the total fire protection costs, it is beyond the scope of the present study to include these private costs in the analysis.

Will, using a dollar value for per capita standard service requirement for fire protection services as the dependent variable, found that per capita requirements decrease with increasing city size.[4] Morris, using both public and private cost figures, also found significant economies of scale.[5] The Metropolitan St. Louis Survey project reached an opposite conclusion--that study indicated that per capita expenditures fell slightly up to a population of 110,000, then increased dramatically at population sizes beyond that level.[6] Both the Morris and St. Louis Study's results are somewhat questionable, however, because of the limited number of observations in their samples in the large population range. The largest city in Morris' sample was 366,000, yet he drew implications for cities

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[4]Robert E. Will, "Scalar Economies and Urban Service Requirements," Yale Economic Essays, V, No. 1 (Spring 1965), p. 60.

[5]Douglas Edmund Morris, "Economies of City Size: Per Capita Costs of Providing Community Services" (unpublished Ph.D. dissertation, Oklahoma State University, 1973), p. 80.

[6]John C. Bollens, ed., Exploring the Metropolitan Community (Berkeley and Los Angeles: University of California Press, 1961), pp. 334-335.

over 1 million population. The St. Louis Study had only one large city in the sample, St. Louis City, with most of the other jurisdictions being considerably smaller. All three of these studies suggest that economies of scale for fire protection may exist in Kansas cities, since most are small, with only three larger than the 110,000 level. Logic indicates that the large capital investment required for fire apparatus would cause small towns to spend more per capita than larger towns in order to provide comparable service.

Population density

A factor indicating potential fire loss in an area is the degree of congestion of burnable property. As a proxy for this factor, the density of population--the number of persons per square mile of land area--was used as an independent variable.

Several studies of local governmental expenditures have shown the importance of population density as an explanatory variable. Brazer found density to be second only to intergovernmental revenues per capita in importance in explaining fire expenditures per capita.[7] Pidot using principal components analysis devised a component he termed "metropolitanism," characterized by high population density and numerous other factors, that was highly significant (t=10.83).[8] Adams, testing county data made up of a composite of all local governmental units within each county in his sample, found density to be the most important explanatory variable for

[7]Harvey E. Brazer, City Expenditures in the United States, Occasional Paper 66, (National Bureau of Economic Research, 1959), pp. 25-26.

[8]George B. Pidot, Jr., "A Principal Components Analysis of the Determinants of Local Government Fiscal Patterns," The Review of Economics and Statistics, LI, No. 2 (May 1969), pp. 181-184.

fire expenditures.[9] Hypothesizing that larger areas requiring several stations allow a more efficient placing of fire facilities and also spread fire department administrative overhead costs, the Metropolitan St. Louis Study used area in square miles instead of relating it to population via application of a density measure. The area variable was statistically significant. An attempt to incorporate a specific measure of residential congestion--dwelling unit density--did not, however, give meaningful results.[10]

Hitzhusen found the density variable to be of little importance for the Texas and New York municipalities he studied. In his equations using units of population protected as the output quantity, none of the public cost equations for the Texas sample were statistically significant; while for the New York model the density factor was significant only at the 0.25 level.[11]

Despite Hitzhusen's findings, it was felt density might have a significant influence on fire department per capita expenditures in Kansas, so it was included in the model. Data limitations presented a problem--the latest city density figures are from 1960--as listed in the 1967 County and City Data Book. While most towns in the state have not grown enough in the past ten years to invalidate the 1960 figures, the density information for certain Johnson County towns in particular may be considerably different in 1970 than they were in 1960. The population of Merriam,

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[9] Robert F. Adams, "On the Variation in the Consumption of Public Services," The Review of Economics and Statistics, XLVII, No. 4 (Nov. 1965), p. 404.

[10] Bollens, Exploring the Metropolitan Community, pp. 331-334.

[11] Hitzhusen, "The Case of Fire Protection," pp. 155-156, 175-176.

Mission, and Shawnee all roughly doubled in the 1960 decade, while Overland Park's population was over 3½ times as large in 1970 as it had been in 1960.

Density instead of area was used in this analysis, because it was felt that density was less highly correlated with another of the independent variables, population size.

Fire protection quality

In order to evaluate per capita expenditure variation between cities, the level of service quality must be held constant. A quality measure for fire protection by city is available on a state wide basis in Kansas. The Insurance Services Office of Kansas, as a service to its member insurance companies, classifies cities based on their fire defenses and physical conditions. The classification a city receives is based on several factors: water supply (34%), fire department (30%), structural condition of buildings (14%), fire alarm system (11%), fire prevention codes (7%) and building codes (4%).[12] A fire defense survey team rates each city by assigning deficiency points (a measure of the degree of deviation from the optimum level) to each of the above factors based on a comprehensive set of standards. The deficiency points are summed to determine the overall classification of the city.[13] The classification

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[12]Morris, "Economies of City Size," p. 73.

[13]The classification method described is no longer in use--the "Standard Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physical Conditions," which listed the fire defense criteria, was replaced in 1973 by the "Grading Schedule For Municipal Fire Protection." The primary difference between the two is that the number of grading features has been reduced to four by combining Fire Prevention and Building Department into Fire Safety Control and eliminating Structural Conditions. Since the "Standard Schedule" was in effect when the city ratings used in this project were determined, that was the classification procedure outlined in the body of this paper.

procedure is based on a one to ten scale, with a one rating indicating the maximum degree atainable, while class 10 indicates little or no fire protection.

For purposes of this study, the ideal measure of actual fire department quality would be the deficiency points assessed against the fire department. To be an inclusive measure of total fire department effectiveness, the deficiency points assessed against the fire alarm and fire prevention factors should be included, since these activities are normally financed through the fire department. The total deficiency points attributable to these three factors would be an inverse measure of quality, since the greater the number of deficiency points, the poorer the quality.

Unfortunately the deficiency point breakdown by factor, i.e., water supply, fire department, fire alarm, etc. for Kansas could not be obtained for this study. The Insurance Services Office of Kansas would not release this information without written authorization from each city involved. Due to a time limitation, it was not possible to survey the cities requesting permission for access to this material. Therefore, the quality measure used in this study was the overall index classification of the town, which is not confidential information.

Although it isn't as precise an indicator of actual fire department effectiveness and readiness as the deficiency point breakdown, the index classification should correspond with the quality of the fire department. In a classic study of this whole procedure for determining a city's classification, Nolting compared the grading of the component factors with the total grading of the city for 267 cities over 30,000 in 1938. He found that for the fire department factor 48 of the cities had a better fire department classification than overall city classification, 104 were worse than the total city grading, and 115 of the fire departments had the same rating as the overall city classification.[14] It is hypothesized that a similar situation existed in Kansas cities in 1970, yet, it is believed that the disparity between the city classification and the fire department classification is not severe enough to ruin the validity of the city classification as a proxy for fire department effectiveness.

The present method of classifying cities does not vary significantly from the procedure followed back in the 1920's and 30's. Therefore, the Nolting study is still applicable today, as is a 1934 study by Stone, Fire Insurance Classification of Cities and Fire Losses. Stone criticized the city ratings because they did not consider performance of the fire personnel, only number of firemen; they failed to measure the degree of public concern existing in a city for fire prevention, which he termed the "moral hazard"; and they failed to take account of a city's record of past fire losses.[15] The same criticisms can still be made today.

Several of the previously cited studies included some form of the city index rating into their analysis as an indicator of fire protection quality.

Hitzhusen used the total AIA deficiency points assessed against the fire department, fire alarm, and fire prevention activities as the quality measure for his New York data, and included the water supply with these factors for the analysis of the Texas sample of cities. The results of his equations utilizing population protected as the output quantity measure indicated that quality was a significant explanatory variable in all cases for both sets of data.[16]

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[14]Orin F. Nolting, How Municipal Fire Defenses Affect Insurance Rates, The International City Manager's Association (Public Administration Clearing House, 1939), p. 43.

[15]Harold A. Stone, Fire Insurance Classification of Cities and Fire Losses, Publication No. 43 (Chicago, Illinois: Public Administration Services, 1934), p. 19.

[16]Hitzhusen, "The Case of Fire Protection," pp. 148-150, 155-156, 173-176.

The Metropolitan St. Louis Survey used the 1-10 rating classification of cities indirectly. The actual quality measure used was a standardized average inverse of fire insurance premiums, which are partially based on the classification of the city. Leaders of the survey did not feel it was valid to use the actual 1 to 10 ratings, since it was felt they reflected only the difference between the difficulty of protection and the actual amount of protection provided, and thus could not be used for comparison between cities. For example, city A may have a better fire department than City B, but A's rating may be worse if the physical characteristics of City A are such that the fire potential is greater than in City B. The 1 to 10 ratings would be a straight-forward index of quality only if the demand for fire protection--the kinds of buildings, area, density, etc.--were uniform.[17]

Morris made extensive use of the class of fire protection a city received in his analysis of per capita fire protection expenditures. He hypothesized that a city's fire defense classification was a function of city size and per capita expenditures on fire department services. His results showed a close correlation between city size and fire defense classification. He concluded that as city size increases, the classification falls until at a population of one million or greater, the city classification becomes constant at the highest level possible - 1.[18] That conclusion is questionable because (1) his sample included no cities over 366,000 in size and thus it was incorrect for him to make assumptions as to the situation existing at higher population levels than that; and (2) a recent

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[17]Bollens, Exploring the Metropolitan Community, pp. 332-333.

[18]Morris, "Economies of City Size," p. 78.

survey of fire chiefs in cities over 10,000 population by the National League of Cities, with 797 out of 1,800 questioned responding, or 44%, showed only four cities over 100,000 had fire departments with a class 1 rating.[19] Assuming that the overall city index is roughly synonomous with the fire department rating, the findings of Morris that the city rating equals 1 at high population levels is not confirmed by available evidence.[20]

Property valuation

A factor which indicates the fire loss potential of a community is the valuation of property. A city with a high per capita property valuation will have a greater fire protection responsibility than will one with a lesser amount of property to protect.

The question arises as to what property component would best measure fire risk. The total assessed valuation of tangible personal property, sent in annually to the Kansas Property Valuation Department by the county clerks for each city, township and county in the state, is composed of assessed values for real estate, personal property, and public services companies. It was decided to use only the real estate and personal property figures, since public services historically had a low fire loss record in relation to their value (see Appendix Table B-3). To make the figures uniform from city to city, the assessed value of real estate was divided by the median assessment ratio[21] for urban areas in the county in which the

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[19]Raymond L. Bancroft, Municipal Fire Service Trends: 1972, National League of Cities Research Report (Washington, D.C.: National League of Cities, 1972), pp. 5, 39.

[20]Refer to Appendix Table B-5 for the listing of fire department ratings by city size compiled by the National League of Cities Survey.

[21]Kansas Property Valuation Department, Kansas Real Estate Ratio Study: Ratios of Assessed Values to Sale Prices - 1971 (Topeka, Kansas) pp. 23-24.

city was located, in order to convert all figures to sales value. Personal Property is assessed state-wide at a constant 30% of actual value; thus each city's assessed value of personal property was divided by 30%. The calculated sales values for real estate and personal property were then combined and the result divided by city population to get a per capita figure for real estate and personal property.

The Metropolitan St. Louis Survey found average per capita assessed valuation of real property had an important effect on per capita expenditures. This was as expected, since property valuation indicates both the ability of a community to pay for services and the amount of property to be protected against fire. The St. Louis Study did not include personal property, but would have if the data had been available.[22]

Brazer would have liked to use taxable property values in his analysis, but he could not obtain this information for all cities on a uniform basis. He noted that a study by Scott and Feder of 192 California cities with 1950 populations of 2,500 or more showed that equalized property valuations per capita explained a far larger part of variation in city expenditures than any of their other variables.[23]

Some consideration was given to using an income measure in lieu of the per capita property valuation figure (both could not be used because it was hypothesized that they were highly correlated with each other). The fire department's main responsibility is property protection, however, so

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[22] Bollens, Exploring the Metropolitan Community, pp. 333-334.

[23] Stanley Scott and Edward L. Feder, Factors Associated with Variations in Municipal Expenditure Levels (Bureau of Public Administration, University of California, 1957), cited by Brazer, City Expenditures in the United States, p. 24.

it seemed appropriate to leave that factor in the equation. In addition, previous studies that included some income measure generally found it had little effect on per capita public fire protection expenditures.

Commercial activity

In the six year period from 1965-70, 36.55%[24] of the city fire losses in Kansas occurred in establishments engaged in either wholesale, retail, or service trade. It was decided to include per capita combined retail and services receipts as an independent variable in the regression equation as a measure of the level of commercial activity. Wholesale trade was omitted because raw farm products are included in this category, yet would not raise the fire loss potential of a city by any substantial amount. A city with a large agricultural trade would have a much larger wholesale trade figure than a similar city in a nonagricultural area, yet the possibility of fire loss would not vary much between the two cities. For example, Dodge City had wholesale sales of $88,846,000 in 1967,[25] a much greater level of wholesale activity than other Kansas cities of similar size, primarily because one of the largest cattle auctions in the United States is located there. Cattle are a valuable commodity, yet they don't burn easily, and their stay in Dodge is not lengthy. The crux of this illustration is that Dodge City's fire potential is not reflected by its large wholesale trade figure.

Besides the problem caused by inclusion of agricultural products in the wholesale trade figures, a lack of data for cities from 2,500 to 5,000

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[24]See Appendix Table B-3.

[25]U.S. Department of Commerce, Bureau of the Census, Census of Business, 1967, BC 67-WA18, Wholesale Trade: Kansas (Washington, D.C.: U.S. Government Printing Office, 1969), p. 8.

population was an additional reason level of wholesale activity was not included in the analysis.

The source of the retail trade and selected services receipts data was the 1967 Census of Business for Kansas. Data were available for all cities with a population of 2,500 or more in 1967. The types of service establishments included in the selected services category were hotels, motels, tourist courts, and camps; personal services, such as laundries, beauty and barber shops, photographic studios, shoe repair stores, funeral homes, etc.; miscelleneous business services; auto repair, auto services, and garages; miscellaneous repair services; motion pictures; and other amusement and recreation services.[26]

A factor related to commercial activity is the level of manufacturing in a city. About 10% of city fire losses in Kansas occur in manufacturing plants. No attempt was made to include a measure of manufacturing in this analysis, however, since data on manufacturing activity are available for only the larger towns in the state.

The Metropolitan St. Louis Survey used the combined receipts of wholesale, retail, and service establishments as their measure of commercial activity. They did not include manufacturing plants in their analysis, feeling that their location was more accessible to fire fighting equipment than crowded downtown commercial properties, and that many large industrial firms have their own fire fighting facilities.[27] In that study concern was expressed that the commercial activity variable was inter-correlated with assessed property valuation.

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[26] U.S. Department of Commerce, Bureau of the Census, Census of Business, 1967, BC 67 - SA 18, Selected Services: Kansas (Washington, D.C.: U.S. Government Printing Office, 1969), pp. 44-56.

[27] Bollens, Exploring the Metropolitan Community, p. 332.

Housing Characteristics

Since 37% of the actual city fire loss, and about ½ of the total number of fires, occur in dwellings, housing characteristics are an important factor in fire potentiality. The 1970 Census of Housing lists numerous bits of information with regard to housing characteristics on a city wide basis. Number of occupants per housing unit, age of dwellings, percent of houses owner occupied, and density of dwelling units were the factors considered for inclusion in the regression model. Age of dwellings, using the percent of dwellings built prior to 1939 as the specific figure (a la Hitzhusen) was the factor selected. It was felt that older houses, which are often of wood frame construction, would be a fire hazard contributing significantly to the fire protection responsibilities of the fire department.

Prior research has failed to show the importance of housing characteristics on per capita fire department expenditures. As previously noted, the Metropolitan St. Louis Survey found that dwelling unit density had little impact,[28] while Hitzhusen found that the percent of structures built prior to 1939 was not significant for most of the equations he tested.[29]

Fire department manpower arrangements

In order to account for the type of fire personnel used in Kansas cities, a set of dummy variables were devised. These were intended to measure the influence of the type of manpower arrangement in use in each city--all volunteer, all full time, or some combination of the two. The

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[28]Ibid., pp. 331, 334.

[29]Hitzhusen, "The Case of Fire Protection," pp. 155, 175.

dummy variables were incorporated in the regression equation as two independent variables, with the first variable representing full time personnel, and the second one a mixture of full time and volunteer personnel. The all volunteer arrangement was the constant term. If both variables were zero, an all volunteer department was specified; if the first variable was one and the second zero; it indicated entirely full time personnel; and if the first variable was zero and the second one, it described a department using some mixture of both full time and volunteer personnel.

Although many of the city fire departments in Kansas provide service to nearby rural areas on request, and, therefore, provide protection to more people than is indicated by just using city population figures, no attempt was made to incorporate this factor into the analysis.

Considerable deliberation was given to including some measure of past fire losses for each city in the fire protection expenditure model. Unfortunately, the state Fire Marshal Department, which tabulates fire loss figures, keeps fire loss data by city only for Wichita, Kansas City, and Topeka. County fire loss figures are available, but cannot legitimately be related back to the cities, especially in counties with many towns.

Other factors briefly considered as variables in this model included the percent of transients in each city, the amount of intergovernmental revenue a city receives, the ethnic composition of the population, and the rate of growth of population.[30] None were included in the initial fire

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[30] Adams used per capita motel, hotel, and camping receipts as a proxy for the number of transients in a community and found it was second only to density in explaining fire expenditure variation between cities. Brazer and Pidot each used intergovernmental revenue in their analysis and obtained good results. While local fire protection usually receives no state or federal intergovernmental revenues, it was hypothesized that a city receiving considerable outside aid might release other funds for increased fire protection. Hitzhusen and Adams each included variables reflecting the ethnic composition of the population in their regression equations; Adams found it was an important factor in expenditure variation, while Hitzhusen's results were inconclusive. Brazer, Adams, and the Metropolitan St. Louis Study all included some factor related to population growth in their studies, but generally obtained poor results.

protection model, since they weren't believed to influence fire department expenditures in Kansas to any large extent.

The Kansas Fire Protection Model

The initial model tested can be described as follows:[31]

F. Exp. = f(P, D, Cls, PV, S, Age, FT, Mix)

where

F. Exp. = Per capita public fire protection expenditures for 1970
P = Population, 1970
D = Population density, 1960
Cls = City fire defense classification, 1972
PV = Per capita real estate and personal property valuation, 1970
S = Per capita combined retail and services receipts, 1967
Age = Percent of year-round housing units built in 1939 or earlier, 1970
FT = Dummy variable for manpower arrangements (Full Time Fire Personnel)
Mix = Dummy variable for manpower arrangements (Mixture of Full Time and Volunteer Fire Personnel

Ordinary least squares regression was used to estimate the equation. All the independent variables were hypothesized to have a linear relationship with the dependent variable except for population, which was assumed to be curvilinear. A logarithmic function (base 10) of population was the specific functional form selected.

The sample used for testing included observations from 75 Kansas cities and towns. Three of the 78 cities studied were deleted because no figure for retail and service receipts was available for them; these cities were Mission Hills, Roeland Park, and Fairway.

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[31]Refer to Appendix Table B-1 for a listing of the data used in the fire protection expenditure analysis.

Results

Using the specification of the model just described, the following results were obtained:[32]

$$(1)\quad F.\ Exp. = \underset{(t=1.378)}{9.869} + \underset{(t=1.427)}{0.0004869D} + \underset{(t=2.026)}{0.0004839^{*}PV} - \underset{(t=-0.394)}{0.0001534S}$$

$$- \underset{(t=-5.487)}{2.325^{**}Cls} + \underset{(t=3.013)}{0.06655^{**}Age} + \underset{(t=4.617)}{4.804^{**}FT}$$

$$+ \underset{(t=3.902)}{2.981^{**}Mix} + \underset{(t=0.3482)}{0.442\ \log P} \qquad R^2 = 0.818,\ s = 2.321$$

The city fire defense classification was the first variable to enter the stepwise multiple regression equation; the multiple correlation coefficient (R) between per capita costs and the city "rating" was 0.816, giving an R^2 value for that variable alone of 0.667.

The estimated population coefficient using the logarithmic function was not significant, so the population variable was re-defined as linear in form. Slightly poorer results were obtained--the t-statistic for the population coefficient and the R^2 value for the total equation were both reduced. Examination of the correlation matrix for all variables tested suggested an explanation for the lack of influence of population size on per capita expenditures. The two variables most important in explaining expenditure variation--rating and full time fire fighting personnel--were strongly correlated with population. These two variables appeared to be absorbing much of the influence that population might have on per capita expenditures. When population (log form) was the lone independent variable incorporated in the regression equation, a marked improvement in significance for that variable was observed (equation 2).

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[32]Unless otherwise stated, all regression results reported in this chapter are free from serial correlation among the error terms and serious multicollinearity between pairs of independent variables. The Durbin-Watson Test was used to check for serial correlation; the method suggested by Klein (refer to Chapter 2) was followed to determine whether multicollinearity was present.

$$(2)\quad F.\ Exp. = -21.52^{**} + 7.368^{**}\log P \qquad R^2 = 0.408$$
$$(t=-5.226) \quad (t=7.087) \qquad s = 2.986$$

Besides the population variable, density and per capita retail and services receipts were also not significant at the 95% level. Eliminating these three variables from the equation gave the following results:

$$(3)\quad F.\ Exp. = 14.90^{**} + 0.0003656PV - 2.393^{**}Cls + 0.04435^{**}Age$$
$$(t=4.610) \quad (t=1.872) \quad (t=-7.045) \quad (t=2.906)$$
$$+ 5.591^{**}FT + 3.149^{**}Mix \qquad R^2 = 0.811$$
$$(t=6.562) \quad (t=4.473) \qquad s = 2.315$$

These results indicate that property valuation, age of dwellings, and type of fire fighting personnel used are positively correlated with per capita expenditures, while the city classification is negatively related. A lower classification indicates a higher level of fire protection, however, so expenditures and quality of protection provided do move in the same direction.

The coefficients for the dummy variables measuring the affect of fire fighting manpower arrangements on expenditures can be interpreted directly in dollar terms. For the sample of cities tested, a department composed entirely of full time firemen had costs of $5.59 more per capita than an all volunteer department, while departments employing a mixture of full time and volunteer personnel cost $3.15 more.

Revision of the Model

Since the coefficient for per capita combined retail and services receipts was not significant (t=-0.394), that variable apparently has a negligible influence on fire protection expenditures. Therefore, the per capita retail and services receipts variable was deleted from the model, permitting the three cities earlier excluded from the sample for lack of receipts data to be added to the group of cities analyzed.

Equation (4) shows the estimated coefficients obtained using the revised model and the expanded sample.

$$(4)\quad \text{F. Exp.} = \underset{(t=1.387)}{9.667} + \underset{(t=1.233)}{0.0003754D} + \underset{(t=5.189)}{0.0007037^{**}PV} - \underset{(t=-5.498)}{2.313^{**}Cls}$$

$$+ \underset{(t=3.834)}{0.07172^{**}Age} + \underset{(t=5.815)}{5.370^{**}FT} + \underset{(t=4.205)}{2.970^{**}Mix}$$

$$+ \underset{(t=0.017)}{0.01953P} \qquad R^2 = 0.827 \quad s = 2.336$$

As expected, equation (4) corresponded closely with equation (1). The primary difference between the two is the increased significance of the property valuation coefficient in equation (4). That difference can be explained by the method of financing the fire protection activity used in the three Johnson County cities added to the sample. Mission Hills, Roeland Park, and Fairway all receive protection from fire districts outside the city governmental structure. These fire districts are funded by a mill levy on assessed property valuation in the area protected. Thus the close relationship between property valuation and expenditures is understandable, since some of the 78 city's expenditures for fire protection are based directly on property valuation.

Implications of Results

In all cases in which the city fire defense classification was included in the regression equation, it explained more of the variation in per capita fire protection expenditures than any of the other independent variables. This seems to be convincing evidence that the quality of fire protection received is the most important factor in explaining differences between cities in per capita expenditures. Figure 3-1 shows the relationship between city fire defense classification and per capita expenditures.

The Affect of Fire Protection Quality on Per Capita Expenditures

Using as a foundation the procedure devised by Morris in a similar study involving 26 Oklahoma cities ranging in size from 7,787 to 366,481, the public costs of providing equal quality fire protection by size of city can be calculated.

Morris developed an equation of the form Cls = f(F. Exp., P)[33] to determine the influence of per capita expenditures for fire department services and population size on the city fire defense classification. The estimated coefficients for his equation were

$$\log Cls = \underset{(t=35.905)}{0.8330^{**}} - \underset{(t=2.531)}{0.0081^{*}}\,F.\ Exp. - \underset{(t=8.556)}{0.00077^{**}}\,P;$$

the R^2 value equaled 0.81.[34]

Using these coefficients, Morris calculated the classification a city would receive if each city spent an equal amount per capita on fire protection. His results showed that "a 10,000 size city would be very near Class 6 while a city with 600,000 inhabitants would be classified as Class 2."[35] In essence he computed what may be termed an "equal expenditure curve" showing the reduction in quality of fire protection as city size decreased.

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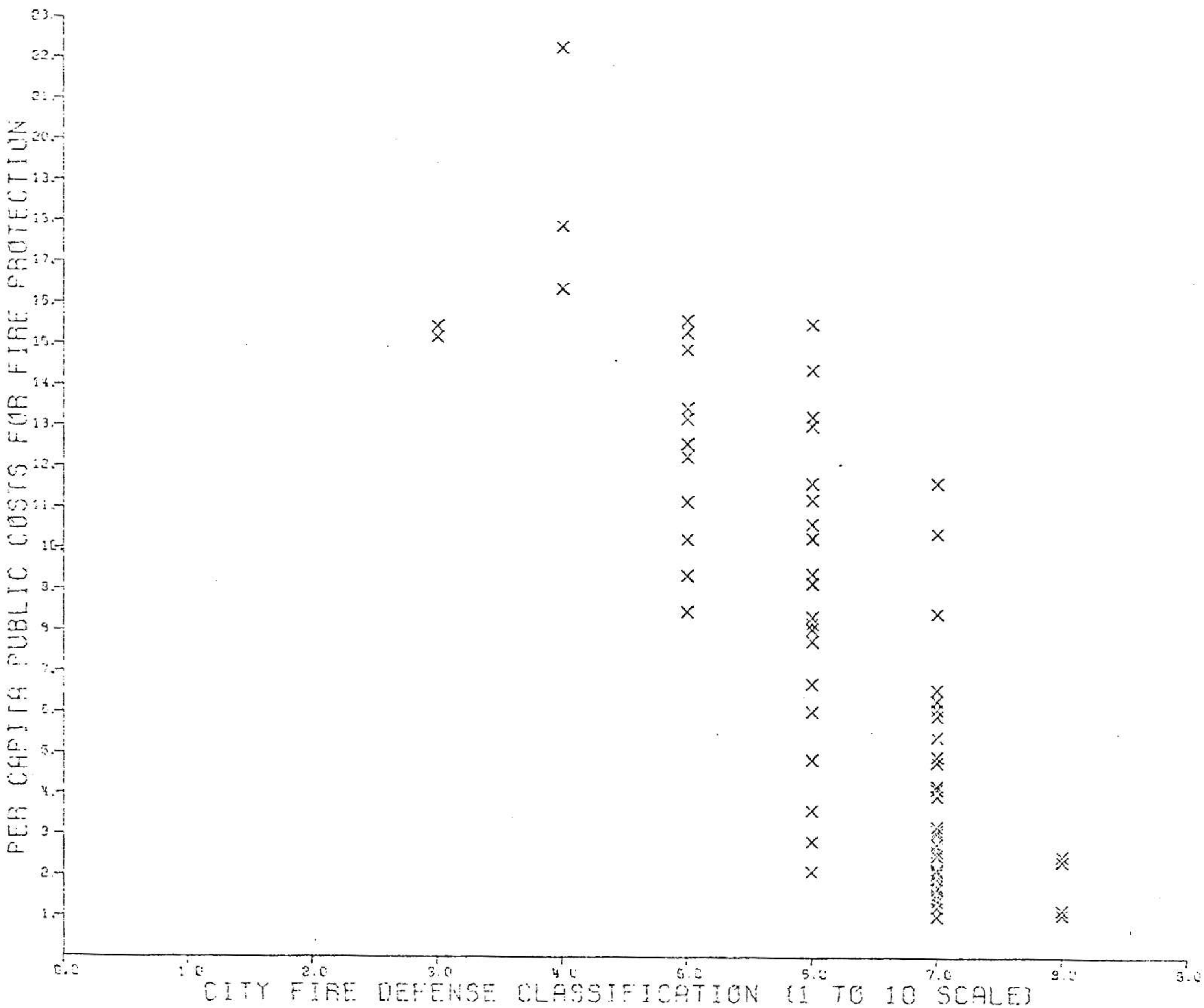
[33] The symbols have been changed to conform with those used previously in this study. In Morris' equation C=city classification, F=per capita expenditure by cities for fire department services, and S=city size.

[34] Morris, *op. cit.*, pp. 76-78.

[35] *Ibid.*, p. 77.

FIGURE 3-1

CITY FIRE DEFENSE RATING COMPARED TO COSTS



Economies of Scale in the Provision of Fire Protection

Applying the equation developed by Morris to the Kansas data used in this study, the following coefficients were obtained:

$$\text{(5)}\quad Cls = \underset{(t=16.53)}{10.82^{**}} - \underset{(t=-7.538)}{0.1114^{**}} F.\ Exp. - \underset{(t=-5.289)}{0.9534^{**}} \log P$$

$$R^2 = 0.718$$
$$s = 0.572$$

In order to determine per capita fire protection expenditures by city size at a constant level of quality, simple algebraic manipulation was performed, transforming equation (5) into the form

$$\text{(6)}\quad F.\ Exp. = \frac{Cls}{-\ 0.1114} - \frac{10.82}{-\ 0.1114} - \frac{-\ 0.9534}{-\ 0.1114} \log P$$

The city classification was set constant at 4.0. While there are only five cities in the state with a rating of 4 or less, that high standard was selected on the assumption that it would be desirable from a fire protection standpoint for all cities to move toward that level of service.

Figure 3-2 shows the per capita fire protection expenditures required for equal quality protection for different city sizes, as computed from equation (6). Definite economies of scale for the fire protection service are evident when cities are compared at an equal quality level.

This finding is contradictory to the results of Shepherd; he found that the general tendency is toward increased costs as population increases.[36] Shepherd's study was limited, however, in that he considered only the relationship between per capita fire protection expenditures and population. While he did not attempt to incorporate other variables into his model,

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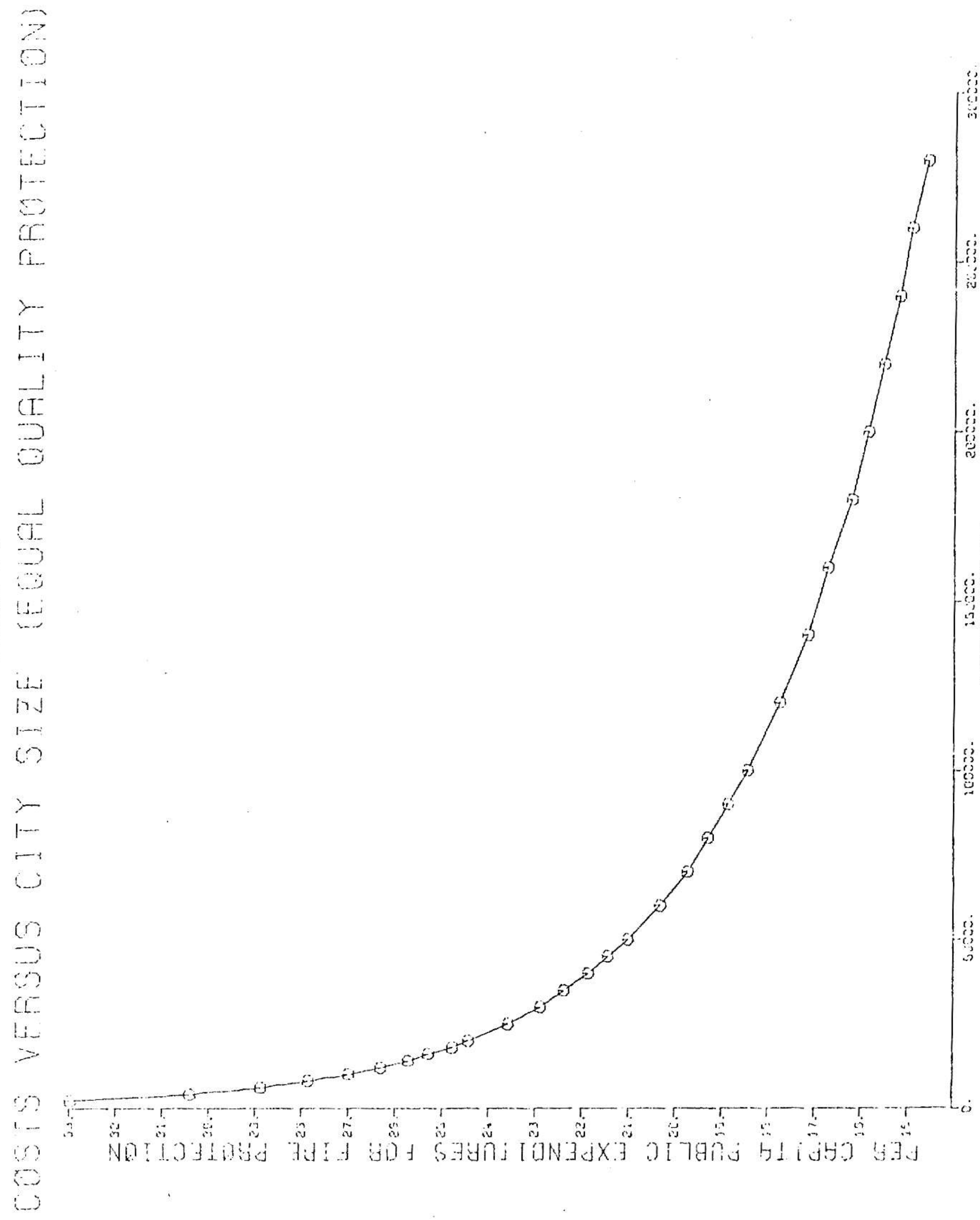
[36]Robert Edwin Shepherd, "Economies of Scale in the Local Government of Kansas," (unpublished Master's thesis, Kansas State University, 1964), pp. 86-88, 99-102.

FIGURE 3-2


COSTS VERSUS CITY SIZE (EQUAL QUALITY PROTECTION)
PER CAPITA PUBLIC EXPENDITURES FOR FIRE PROTECTION
POPULATION

Shepherd recognized the limitations in his analysis. He noted that "other factors than population, service levels perhaps being rather important, among them, are obviously important in determining per capita expenditures for this service."[37]

Categorization of Cities by Type of Fire Personnel

The dummy variables reflecting the type of personnel used to fight fires in each city were highly significant, as indicated in equations (1), (3), and (4). Since fire departments using only full time personnel tend to have some characteristics often not possessed by volunteer or mixed departments--a more structured organizational setup, a full time chief, greater equipment needs such as aerial fire apparatus for fighting fires in high buildings, etc.--the sample of 78 cities was divided into three categories based on the type of personnel used, and regression analysis was performed on each data set. Table 3-1 presents the results of these regressions. City classification, property valuation, and age of dwellings accounted for much of the variation in expenditures among cities in both the full time and the mixed personnel categories. In addition, the population variable was significant for the mixed grouping. None of the variables were able to account for the per capita expenditure variation among cities having all volunteer fire departments.

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[37] _Ibid._, p. 88.

TABLE 3-1

ESTIMATED COEFFICIENTS AND t-VALUES OF REGRESSION EQUATIONS FOR THE THREE CATEGORIES OF CITIES BASED ON TYPE OF FIRE FIGHTING PERSONNEL USED: THE DEPENDENT VARIABLE, PER CAPITA PUBLIC FIRE PROTECTION EXPENDITURES IS A FUNCTION OF THE INDICATED INDEPENDENT VARIABLES

Independent Variable	Full-time		Mixture[a]		All Volunteer	
	Regression Coefficient	t Statistic	Regression Coefficient	t Statistic	Regression Coefficient	t Statistic
Constant	13.69	1.185	-25.77	-2.051	9.038	0.926
Population (Log-Base 10)	0.0497	0.027	7.433**	3.383	-0.9108	-0.5013
Density	0.00018	0.296	0.00067	1.678	-0.00018	-0.377
City Classification	-2.357**	-3.413	-2.724**	-4.804	-0.4149	-0.422
Property Valuation	0.00088**	4.771	0.0013**	3.619	0.000092	0.399
Percent Dwellings Built 1939 or Earlier	0.09324**	2.884	0.2211**	5.167	-0.00368	-0.163
R^2 for equation	0.747		0.79		0.06	
s for equation	2.31		1.93		1.55	

[a]Durbin-Watson Test for Serial Correlation was in inconclusive range.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The purpose of this study was to focus on the factors influencing police and fire protection expenditures in Kansas cities. As an expenditure determinant study, its primary objectives were to account for the variation among cities in per capita costs of police protection and fire protection and to determine if any particular size of city is "optimum in terms of being able to supply a standard level of police or fire protection at some minimum per capita cost."

Police Protection

When evaluating the crime control effectiveness of a police force, consideration must be given to the socioeconomic characteristics of each city, since the prevailing level of crime is heavily dependent on these factors. For the thirty-three Kansas cities analyzed, the crime rate was found to be positively related to population size, density, and a special demographic variable reflecting the population's propensity to commit crime, and negatively related to income. All the variables were statistically significant except density. Population size proved to be the most important in accounting for crime rate variation.

While the crime rate variation could be accounted for, poor results were obtained for the model developed to account for the variation among cities in per capita police expenditures. Of the seven variables included in the police protection expenditure model for Kansas--population, density, income, the crime rate, the crime clearance rate, the special demographic measure, and street mileage--only the crime rate accounted for much of the expenditure variation between cities. Since cities with high crime rates are aware of the problem and therefore tend to spend more per capita to combat crime, the influence the crime rate has on a city's per capita police expenditures is understandable. However, the failure of any of the other variables to have a significant affect on per capita expenditures is surprising.

A remedy frequently recommended by city officials to combat rising crime rates is to expend larger amounts for police protection, believing that will alleviate the problem. Results of this study indicate that is not necessarily true. As noted in Chapter II, "little evidence of a relationship between per capita police expenditures and the crime rate was discovered." These findings concur with a recent study conducted by the Council on Municipal Performance (C.O.M.P.) which found that increasing the size of a police force failed to lead to a crime rate reduction. The authors of the C.O.M.P. study stated that cities do not seem to have powers commensurate with their responsibilities, since some of the "root causes" of crime can be effectively combatted only at the national level.[1] This implies that reliance on the police force to reduce a city's crime rate may be overemphasized.

However, while increased expenditures for police protection may not reduce the crime rate much, some citizens may place great value on having a large, highly visible police force in terms of a perceived feeling of increased

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[1]David G. Manley, "Police Force Size No Check on Crime," The Kansas City Times, June 21, 1973, p. 3B.

security and a "freedom from fear." This factor, admittedly difficult to quantify, must be considered by city officials when making policy decisions as to whether police numbers should be increased.

In general, the larger the city the greater the level of criminal activity. Thus while a larger city may be able to provide an equal level of police protection more efficiently than a smaller city if crime rates for each city were the same, the increase in the amount of service required to combat the higher crime rates in the larger city negates the economies obtained by spreading capital investment costs over a greater population.

Because the crime rate is positively and significantly related to city size, there appear to be diseconomies of scale associated with providing police protection. A limitation on any positive statement concerning economies of scale for the thirty-three Kansas cities analyzed was the failure to develop an adequate quality measure that would allow comparison of per capita expenditures among cities at an equal quality level.

A worthy objective of further research would be development of a reliable quality measure reflecting the effectiveness with which all major police functions were performed. Police forces rating highest could be visited to determine the reasons for their effectiveness, with the findings passed on to other departments.

This study provides evidence for city officials desiring rapid city growth that a crime increase would probably be one of the undesirable consequences of such growth.

Fire Protection

As reported in Chapter III, the quality of fire protection supplied--as measured by the city fire defense classification--accounted for more of the variation in per capita fire protection expenditures than any of the other factors tested. While the larger cities in Kansas have higher per capita expenditures than do the smaller towns, they provide a considerably greater level of protection. When service levels were held constant, these larger cities were shown to be able to provide fire protection at a lower per capita rate, indicating economies of scale exist for this service.

In computing the economies of scale curve (Figure 3-2), the city classification was set constant at 4.0, a high quality of fire protection. Many towns may feel that the increased expenditures necessary to reduce their fire defense classification from 7 or 8, for example, down to a rating of 4 or 5 is not justified--that the increased fire protection received is not worth the added costs involved. That is a question each city must resolve for itself. Citizens should realize, however, that, since fire insurance premiums are based partially on the fire defense rating of the town, increased public costs for fire protection which improve a city's classification may result in substantial reductions in private fire protection costs (i.e., fire insurance premiums). Thus, increased expenditures for fire protection may have dual benefits: (1) greater level of protection than previously offerred, and (2) lower insurance rates.

A fact that became apparent as this study progressed was the disparity in per capita expenditures between departments using full-time firemen and those relying on volunteers. The twenty-nine cities using full-time firemen had mean per capita expenditures of $12,54, while the twenty-six all volunteer departments had mean per capita expenditures of only $2.58. While a considerable amount of this difference in costs can be traced to higher quality protection plus a greater fire protection responsibility in the bigger cities (besides having a greater population, the larger cities had considerably higher levels of population density and per capita property valuation), just the difference in type of personnel caused the departments using full time firemen to have per capita costs $5.37 greater than the all volunteer departments.[2] Thus, the temptation is great for a medium sized town to utilize volunteer personnel, even though fire response time is longer for volunteers and they are generally much less well trained than full-time firemen.

The question of whether to use full-time or volunteer firemen is appropriate only for medium to large sized cities. The small town of 4,000, for example, generally has such an infrequent outbreak of fire that a full-time force of firemen would just be a financial burden. One city official contacted in this study compared employing a full-time force of firemen with the hiring of a plumber to sit on one's lawn waiting for a pipe to break; he indicated that a small town just can't afford a group of men waiting around for fires to occur. The only way to resolve this argument would be to compare fire loss records between cities roughly identical in all characteristics influencing fire protection except type of personnel used. Such information is unavailable.

Perhaps the best arrangement for a moderate sized city would be to use a mixture of full-time and volunteer personnel. The full-time personnel could move the fire fighting equipment to the fire and put out small fires, while the volunteer component could be called out for major emergencies.

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[2]The source of this figure is equation (4) in Chapter III. With the all volunteer department serving as the constant, the coefficient for the dummy variable reflecting full-time firemen used was 5.37, indicating per capita costs were that much higher for departments using all full-time personnel than for volunteer departments in cities having identical characteristics except for manpower arrangements.

For cities in close geographic proximity, consolidation of the fire protection service appears to be desirable. Results of this study indicate that per capita savings could be realized by combining several local fire departments in an area into one coordinated unit. The fire protection arrangement in Johnson County, in which many of the cities receive protection from three fire districts in that area, is a good example of this type setup.

Where consolidation isn't feasible, mutual aid contracts between neighboring fire departments might be an alternative means of bolstering the fire fighting facilities of a community without increased expenditures.

Unfortunately, for many Kansas communities consolidation or mutual aid agreements with other fire departments is not feasible, due to the long distances between cities. When applicable however, consolidation of fire departments is a public question that should be seriously considered.

APPENDIX

TABLE A-1

THE DATA USED FOR CRIME RATE AND POLICE EXPENDITURE ANALYSIS FOR THE 33 LARGEST KANSAS CITIES

City	Total[a] Police Expend. 1970	Per Capita Police Expend. 1970	Total[b] Crime Rate 1970	Crime[c] Clearance Rate 1970-71 Ave.	Residual Values[d] (Actual Minus Estimated Crime Rate)	Pop.[e] 1970	Pop. Index	Density[f] 1960	Density Index
Wichita	4,822,208	17.44	65.5	37.21	-2.25	276,554	26.74	5024	2.47
Kansas City	4,034,975	23.99	71.3	16.92	-7.06	168,213	16.27	6005	2.95
Topeka	1,983,506	15.87	59.6	12.72	6.08	125,011	12.09	3453	1.70
Overland Park	955,201	12.09	28.9	13.56	-6.92	79,034	7.64	4060	2.00
Lawrence	549,607	12.03	55.4	14.78	1.19	45,698	4.42	4267	2.10
Salina	595,025	15.78	45.1	35.60	-1.08	37,714	3.65	5024	2.47
Hutchinson	567,349	15.38	63.6	18.38	19.63	36,885	3.57	3648	1.79
Prairie Village	434,555	15.44	24.6	13.47	-1.99	28,138	2.72	4226	2.08
Manhattan	379,568	13.77	62.3	13.13	9.03	27,575	2.67	6051	2.98
Leavenworth	343,790	13.67	22.7	26.24	-16.75	25,147	2.43	3021	1.49
Emporia	328,663	14.09	43.3	29.59	-8.66	23,327	2.26	5350	2.63
Shawnee	299,434	14.62	24.3	20.26	-0.59	20,482	1.98	3240	1.59
Pittsburg	299,350	14.84	42.5	11.40	-3.60	20,171	1.95	3736	1.84
Junction City	358,803	18.87	85.6	25.75	16.73	19,018	1.84	5667	2.79
Olathe	259,050	14.46	27.3	19.96	-0.21	17,917	1.73	2113	1.04
Great Bend	220,780	13.68	33.8	49.75	7.04	16,133	1.56	2526	1.24
Newton	237,708	15.40	39.6	16.34	10.19	15,439	1.49	3460	1.70
Hays	181,851	11.81	42.0	16.11	2.57	15,396	1.49	4425	2.18
Coffeyville	251,796	16.66	51.6	18.19	8.29	15,116	1.46	3343	1.64
Garden City	231,796	15.67	37.3	24.57	5.41	14,790	1.43	3937	1.94
Dodge City	202,383	14.33	23.0	24.00	-10.88	14,127	1.37	4097	2.01
Liberal	145,422	10.55	45.1	9.65	1.78	13,789	1.33	6006	2.95
Arkansas City	262,552	19.87	50.4	16.72	10.92	13,216	1.28	4075	2.00
Parsons	184,537	14.18	38.7	6.35	-2.15	13,015	1.26	3239	1.59
Atchison	190,174	15.14	30.2	14.65	-14.47	12,565	1.22	4042	1.99

TABLE A-1 - Continued

City	Median[g] Income of Families 1970	Income Index	Measure[h] of Demographic Characteristics 1970	Total[i] Street Mileage 1970 or '71	Street Mileage Per 1000 Population	Per Capita[j] Valuation of Real Estate Personal Prop. 1970	Per Capita[k] Retail Trade, Service Receipts 1967
Wichita	9,523	1.39	40.1	1058.00	3.83	6,780	2,266
Kansas City	9,165	1.33	53.5	727.03	4.32	7,126	1,529
Topeka	9,652	1.40	38.1	523.36	4.19	6,578	2,134
Overland Park	14,146	2.06	26.2	351.29	4.44	9,188	1,499
Lawrence	9,365	1.36	45.3	177.77	3.89	5,888	1,716
Salina	8,720	1.27	29.8	216.43	5.74	6,594	2,356
Hutchinson	8,500	1.24	33.0	170.00	4.61	6,550	2,657
Prairie Village	14,653	2.13	25.2	115.00	4.09	10,314	1,303
Manhattan	9,006	1.31	39.1	100.57	3.65	6,817	1,909
Leavenworth	9,360	1.36	38.4	113.96	4.53	5,085	1,695
Emporia	8,369	1.22	39.6	84.53	3.62	5,498	2,340
Shawnee	12,143	1.77	28.0	145.00	7.08	7,214	542
Pittsburg	7,054	1.03	31.6	139.00	6.89	5,912	1,848
Junction City	6,875	1.00	51.3	68.00	3.58	5,158	1,964
Olathe	10,204	1.48	33.8	275.00	15.35	7,678	1,858
Great Bend	9,328	1.36	28.8	98.00	6.07	7,386	3,247
Newton	9,012	1.31	26.6	83.81	5.43	5,699	1,972
Hays	8,862	1.29	34.6	60.50	3.93	6,667	2,432
Coffeyville	7,476	1.09	36.9	72.00	4.76	4,088	2,390
Garden City	9,318	1.36	29.5	73.57	4.97	6,152	3,141
Dodge City	8,945	1.30	30.1	89.90	6.36	6,211	3,476
Liberal	9,240	1.34	34.8	55.26	4.01	5,685	2,747
Arkansas City	7,534	1.10	30.0	64.79	4.90	4,870	2,302
Parsons	7,772	1.13	37.9	64.40	4.95	4,469	2,330
Atchison	8,088	1.18	41.7	64.59	5.14	4,609	1,912

TABLE A-1 - Continued

City	Total Police Expend. 1970	Per Capita Police Expend. 1970	Total Crime Rate 1970	Crime Clearance Rate 1970-71 Ave.	Residual Values (Actual Minus Estimated Crime Rate)	Pop. 1970	Pop. Index	Density 1960	Density Index
El Dorado	206,036	16.74	44.0	23.31	8.39	12,308	1.19	4473	2.20
Winfield	162,590	14.26	17.4	23.06	-14.13	11,405	1.10	3706	1.82
Ottawa	125,931	11.41	14.9	18.98	-18.61	11,036	1.07	3049	1.50
Merriam	106,707	9.83	30.2	16.50	14.52	10,851	1.05	2034	1.00
McPherson	147,199	13.57	12.8	23.08	-16.25	10,851	1.05	3845	1.89
Leawood	166,465	16.09	15.9	11.86	6.44	10,349	1.00	2575	1.27
Independence	118,885	11.49	40.0	13.00	-2.09	10,347	1.00	3507	1.72
Chanute	144,348	13.96	32.7	33.72	-0.51	10,341	1.00	3875	1.91

City	Median Income of Families 1970	Income Index	Measure of Demographic Characteristics 1970	Total Street Mileage 1970 or '71	Street Mileage Per 1000 Population	Per Capita Valuation of Real Estate, Personal Prop. 1970	Per Capita Retail Trade, Service Receipts 1967
El Dorado	8,169	1.19	27.9	61.50	5.00	5,098	1,903
Winfield	8,214	1.19	27.2	59.90	5.25	4,570	2,243
Ottawa	7,717	1.12	30.2	62.60	5.67	5,786	2,790
Merriam	12,484	1.82	29.5	96.00	8.85	9,061	1,618
McPherson	9,363	1.36	29.7	57.07	5.26	6,369	2,409
Leawood	21,227	3.09	26.0	72.00	6.96	14,741	850
Independence	7,590	1.10	39.3	66.50	6.43	4,650	2,702
Chanute	7,692	1.12	26.3	69.90	6.76	5,114	2,432

Footnotes to TABLE A-1

Sources:

[a]Expenditure data are from city budgets filed with the Department of Post-Audits of the State Auditor's Office.

[b]Kansas Bureau of Investigation, Crime in Kansas: 1970, pp. 48-57.

[c]From unpublished data obtained from the Kansas Bureau of Investigation.

[d]The residual values state the difference between the observed crime rate (actual rate) and the predicted crime rate based on the estimated parameter values obtained for crime rate equation (4), discussed in the main body of this paper. The coefficients used to compute the residuals varied slightly from those obtained for equation (4). The equation used was:

$$CR = \underset{(t=2.203)}{-22.15^{*}} + \underset{(t=2.885)}{19.39^{**}\log P} + \underset{(t=1.771)}{7.635D} + \underset{(t=2.383)}{26.92^{*}I^{-2}} + \underset{(t=2.098)}{0.7341^{*}DC}$$

$$R^2 = 0.683 \qquad s = 10.543$$

[e]U.S. Department of Commerce, Bureau of the Census, U.S. Census of Population: 1970, General Population Characteristics - Kansas, PC(1) - B18 Kansas, pp. 55-56.

[f]U.S. Department of Commerce, Bureau of the Census, County and City Data Book, 1967, (Washington, D.C.: U.S. Government Printing Office, 1967), p. 588.

[g]U.S. Department of Commerce, Bureau of the Census, U.S. Census of Population: 1970, General Social and Economic Characteristics - Kansas, PC(1) - C18 Kansas, (Washington, D.C.: U.S. Government Printing Office, 1972), p. 198.

[h]Calculated in manner described in text. Population composition (age, race, sex) data from U.S. Census of Population: 1970, General Population Characteristics - Kansas, PC(1) - B18 Kansas, pp. 79-80, 88-95; characteristics of offenders from Crime in Kansas: 1970, pp. 39-40, 43, 46.

[i]The League of Kansas Municipalities, Directory of Kansas Public Officials, 1971-72 (Topeka, Kansas: The League of Kansas Municipalities), pp. c-2 to c-84; and The League of Kansas Municipalities, Directory of Kansas Public Officials, 1972-73: Cities, Schools, Buyer's Guide (Topeka, Kansas: The League of Kansas Municipalities), pp. c-2 to c-84.

Footnotes to TABLE A-1 - Continued

[j]Taxable tangible property valuation figures by city were obtained from the Kansas Property Valuation Department. While the total valuation figure includes real estate, personal property, and public service company assessed values, only real estate and personal property were included in the valuation figure used in this study. The assessed values were converted to sales values by dividing assessed personal property by 30% (state-wide assessment ratio) and real estate by the median assessment ratio for urban areas in the county in which the city was located. The county assessment ratios came from Property Valuation Department, Kansas Real Estate Ratio Study: Ratios of Assessed Values to Sales Prices - 1971, pp. 23-24.

[k]U.S. Bureau of the Census, Census of Business, 1967, Retail Trade: Kansas, BC 67 - RA 18 (Washington, D.C.: U.S. Government Printing Office, 1969), pp. 8-15; and U.S. Bureau of the Census, Census of Business, 1967, Selected Services: Kansas, BC 67 - SA 18 (Washington D.C.: U.S. Government Printing Office, 1969), pp. 8-11.

TABLE A-2

PROBABILITY OF ARREST FOR SERIOUS CRIMES FOR PERSONS IN KANSAS BY AGE, SEX, AND RACE GROUPING, 1970[a]

	10 and under	11-12	13-14	15	16	17	18	19	20-24
White Male	.001795	.012756	.027849	.035346	.046642	.039706	.035657	.026263	.015225
White Female	.00038	.002695	.005982	.007611	.009788	.008385	.007236	.005172	.003239
Negro Male	.009368	.070313	.162661	.232238	.290137	.279888	.248022	.156451	.078647
Negro Female	.001887	.014505	.034121	.045543	.064923	.054715	.04794	.035371	.021879

TABLE A-2 - Continued

	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65 and over
White Male	.007831	.005462	.003487	.00242	.002133	.001371	.001019	.000894	.000471
White Female	.001617	.001089	.000687	.00048	.000423	.000261	.000192	.000161	.000068
Negro Male	.055569	.041734	.025892	.020829	.019974	.01283	.009458	.008764	.004158
Negro Female	.011257	.007524	.004818	.003742	.003625	.002389	.001733	.001512	.000677

[a]Calculated from: The Kansas Bureau of Investigation, Crime in Kansas: 1970, pp. 39-40, 43, 46.

TABLE A-3

CRIME RATES AND THEIR CORRESPONDING CLEARANCE RATES[a]

FOR THE 33 LARGEST KANSAS CITIES, 1970

City	Total Crime Rate	Percent Cleared	Violent Crime Rate	Percent Cleared	Property Crime Rate	Percent Cleared	Murder, Rape Agg. Assault Rate	Percent Cleared
Wichita	65.5	37.21	3.5	65.07	62.0	35.73	1.76	78.58
Kansas City	71.3	16.92	7.0	52.21	64.3	13.00	3.61	74.34
Topeka	59.6	12.72	4.2	41.89	55.4	9.93	2.71	52.84
Overland Park	28.9	13.56	1.0	46.06	27.9	12.46	0.78	55.46
Lawrence	55.4	14.78	2.1	46.60	53.3	13.40	1.29	59.59
Salina	45.1	35.60	0.6	80.39	44.5	35.02	0.37	89.47
Hutchinson	63.6	18.38	0.8	51.35	62.8	17.82	0.30	72.22
Prairie Village	24.6	13.47	1.1	64.86	23.5	10.73	0.96	68.66
Manhattan	62.3	13.13	2.4	24.03	59.9	12.70	1.02	31.67
Leavenworth	22.7	26.24	4.7	62.72	18.0	16.73	3.70	68.20
Emporia	43.3	29.59	0.6	58.33	42.7	29.07	0.30	80.95
Shawnee	24.3	20.26	0.8	56.25	23.5	19.16	0.49	66.67
Pittsburg	42.5	11.40	0.5	85.71	42.0	10.50	0.55	88.89
Junction City	85.6	25.75	14.0	43.92	71.6	22.01	9.46	54.06
Olathe	26.2	19.96	1.0	82.35	25.2	16.78	0.84	78.26
Great Bend	33.8	49.75	0.6	66.67	33.2	49.45	0.43	92.31
Newton	39.6	16.34	0.3	60.00	39.3	15.82	0.26	77.78
Hays	42.0	16.11	0.8	72.22	41.2	15.31	0.71	76.47
Coffeyville	51.6	18.19	2.1	56.06	49.5	15.55	1.59	50.00
Garden City	37.3	24.57	1.3	62.22	36.0	22.97	1.08	68.42
Dodge City	23.1	24.00	0.1	50.00	23.0	23.86	0.07	100.00
Liberal	45.1	9.65	1.0	77.78	44.1	8.71	0.74	92.31
Arkansas City	50.4	16.72	1.8	36.84	48.6	16.11	1.44	39.79
Parsons	38.7	6.35	0.5	75.00	38.2	5.80	0.31	83.33

Sources: Crime rates computed from Crime in Kansas, 1970, pp. 48–57; clearance rates derived from unpublished 1970 and 1971 data compiled by the Kansas Bureau of Investigation.

[a]The clearance rates used in this study were based on a two year average (1970 and 1971).

TABLE A-3 - Continued

City	Robbery Rate	Percent Cleared	Burglary Rate	Percent Cleared	Larceny Rate	Percent Cleared	Auto Theft Rate	Percent Cleared
Wichita	1.75	50.00	16.07	38.36	40.03	33.82	5.86	41.41
Kansas City	3.42	24.11	22.57	13.74	30.38	13.54	11.32	9.88
Topeka	1.50	18.56	12.65	9.29	39.70	9.45	3.06	18.42
Overland Park	0.18	21.74	5.14	12.49	21.54	11.92	1.30	20.16
Lawrence	0.79	15.00	6.54	9.77	43.35	13.62	3.46	18.18
Salina	0.24	53.85	9.25	34.94	33.73	34.50	1.51	47.37
Hutchinson	0.54	31.58	13.39	14.03	47.80	18.42	1.55	27.93
Prairie Village	0.11	28.57	4.98	15.76	17.98	8.74	0.60	14.55
Manhattan	1.38	17.39	20.05	5.69	36.63	16.83	3.19	20.00
Leavenworth	0.95	35.42	5.21	14.84	11.17	17.19	1.63	18.89
Emporia	0.26	26.67	5.44	38.87	35.80	26.93	1.46	43.06
Shawnee	0.29	36.36	7.91	16.91	14.45	19.79	1.17	26.53
Pittsburg	0.00	66.67	17.90	5.56	22.11	13.82	1.98	31.25
Junction City	4.52	23.74	17.30	15.63	46.17	25.78	8.15	18.28
Olathe	0.17	100.00	4.52	17.26	19.37	15.63	1.28	30.51
Great Bend	0.19	0.00	8.24	37.96	23.68	52.19	1.30	85.71
Newton	0.06	33.33	7.12	23.05	31.67	13.07	0.45	31.43
Hays	0.06	0.00	4.87	14.71	35.40	15.23	0.97	21.43
Coffeyville	0.53	75.00	21.70	15.03	26.13	16.58	1.65	22.86
Garden City	0.20	28.57	6.90	21.00	28.19	23.52	0.95	31.03
Dodge City	0.07	0.00	4.32	24.14	17.84	22.79	0.85	42.86
Liberal	0.22	40.00	8.02	11.46	34.30	7.64	1.86	16.00
Arkansas City	0.38	30.00	11.12	18.12	35.49	14.02	1.97	37.93
Parsons	0.08	50.00	10.45	4.76	26.82	5.84	1.00	13.79

TABLE A-3 - Continued

City	Total Crime Rate	Percent Cleared	Violent Crime Rate	Percent Cleared	Property Crime Rate	Percent Cleared	Murder, Rape, Agg. Assault Rate	Percent Cleared
Atchison	30.2	14.65	0.6	50.00	29.6	13.93	0.48	64.29
El Dorado	44.0	23.31	2.8	63.55	41.2	18.92	2.68	64.71
Winfield	17.4	23.06	0.1	66.67	17.3	22.76	0.09	66.67
Ottawa	14.9	18.98	0.1	100.00	14.8	18.14	0.00	100.00
Merriam	30.2	16.50	0.7	63.16	29.5	13.81	0.46	69.70
McPherson	12.8	23.08	0.1	100.00	12.7	22.69	0.09	100.00
Leawood	15.9	11.86	0.4	50.00	15.5	10.29	0.39	53.85
Independence	40.0	13.00	0.9	60.00	39.1	10.84	0.39	69.57
Chanute	32.7	33.72	1.0	92.31	31.6	32.43	0.77	100.00

City	Robbery Rate	Percent Cleared	Burglary Rate	Percent Cleared	Larceny Rate	Percent Cleared	Auto Theft Rate	Percent Cleared
Atchison	0.16	0.00	5.33	5.76	23.48	16.42	0.72	9.52
El Dorado	0.16	40.00	12.67	17.75	26.97	18.50	1.54	38.71
Winfield	0.00	0.00	3.42	34.51	12.98	16.45	0.61	55.56
Ottawa	0.09	100.00	3.08	8.49	11.24	19.65	0.45	52.94
Merriam	0.28	20.00	11.34	9.79	16.22	15.14	1.94	24.39
McPherson	0.00	50.00	0.65	18.37	11.89	23.40	0.18	25.00
Leawood	0.00	0.00	2.32	9.43	11.98	7.98	1.26	37.50
Independence	0.48	41.67	11.79	10.57	26.29	9.96	1.06	29.63
Chanute	0.19	50.00	4.74	33.85	25.92	30.18	1.06	94.12

TABLE B-1

DATA USED IN FIRE PROTECTION EXPENDITURE ANALYSIS

FOR 78 KANSAS CITIES OVER 2,500 POPULATION

City	Total Public[a] Fire Prot. Expend. 1970	Per Capita Fire Prot. Expend. 1970	Population[i] 1970	Density[j] 1960	Per Capita[k] Real Estate and Personal Prop. 1970
Abilene	102,966	15.46	6,661	3066	5722
Anthony	10,465	3.94	2,653	1960	6213
Arkansas City	165,670	12.54	13,216	4075	4870
Atchison	205,048	16.32	12,565	4042	4609
Baxter Springs	10,539	2.35	4,489	3460	4313
Belleville	5,876	1.92	3,063	2262	5337
Beloit	11,721	2.84	4,121	2257	4962
Bonner Springs	5,682	1.55	3,662	3523	5637
Chanute	86,783	8.39	10,341	3875	5114
Cherryvale	12,799	4.91	2,609	1988	2937
Clay Center	38,339	7.72	4,963	2563	6460
Coffeyville	184,709	12.22	15,116	3343	4088
Colby	27,959	6.00	4,658	3239	6534
Columbus	14,048	4.19	3,356	2425	4601
Concordia	73,857	10.23	7,221	3511	4853
Derby	8,281	1.04	7,947	5871	4767
Dodge City	177,178	12.54	14,127	4097	6211
El Dorado	112,212[b]	9.12	12,308	4473	5098
Emporia	190,132	8.15	23,327	5350	5498
Eureka	21,084	5.90	3,576	3379	4158
Fairway	56,277[c]	10.96	5,133	4498	10652
Fort Scott	118,382	13.20	8,967	2091	5333
Fredonia	6,531	2.12	3,080	2694	5035
Galena	9,192	2.48	3,712	981	3681
Garden City	14,859	1.00	14,790	3937	6152
Garnett	8,229	2.60	3,169	1785	6027
Goodland	7,610	1.38	5,510	2973	6502
Great Bend	180,243	11.17	16,133	2526	7386
Hays	74,383	4.83	15,396	4425	6667
Haysville	20,142[d]	3.11	6,483	6484	3823
Herington	28,907	9.13	3,165	2848	4603
Hiawatha	7,040	2.09	3,365	3391	6142
Hoisington	6,201	1.67	3,710	4248	4948
Holton	31,700	10.35	3,063	2753	5418
Hutchinson	658,911	17.86	36,885	3648	6550
Independence	85,954	8.31	10,347	3507	4650
Iola	84,263	12.98	6,493	3825	3896
Junction City	178,100	9.36	19,018	5667	5158
Kansas City	3,739,648	22.23	168,213	6005	7126
Kingman	7,607	2.10	3,622	1557	5429
Larned	27,741	6.07	4,567	2942	6014

TABLE B-1 - Continued

City	Per Capita[l] Retail and Service Receipts 1967	City Fire[n] Defense Class. 1972	% Dwellings[o] Built 1939 or Earlier 1970	Fire Fighting[p] Personnel Full time=1 Other=0	Mixture=1 Other=0
Abilene	2,944	6	70.71	0	1
Anthony	3,069	7	71.88	0	0
Arkansas City	2,302	5	72.99	1	0
Atchison	1,912	4	75.52	1	0
Baxter Springs	2,086	8	77.02	0	1
Belleville	2,813	7	67.78	0	0
Beloit	3,406	6	64.74	0	0
Bonner Springs	2,936	7	44.07	0	0
Chanute	2,432	7	74.03	1	0
Cherryvale	1,102	7	80.55	0	1
Clay Center	3,158	6	66.49	0	1
Coffeyville	2,390	5	70.40	1	0
Colby	3,290	6	45.48	0	1
Columbus	2,569	7	74.74	0	1
Concordia	2,410	6	67.41	0	1
Derby	1,402	8	3.30	0	0
Dodge City	3,476	5	52.90	1	0
El Dorado	1,903	6	56.52	1	0
Emporia	2,340	6	56.43	1	0
Eureka	2,593	7	73.85	0	1
Fairway	N.A.	6	17.80	1	0
Fort Scott	2,949	6	78.89	1	0
Fredonia	3,074	7	78.90	0	0
Galena	885	8	77.44	0	1
Garden City	3,141	7	35.08	0	0
Garnett	2,871	7	66.09	0	0
Goodland	3,389[m]	7	51.59	0	0
Great Bend	3,247	6	39.80	0	1
Hays	2,432	6	28.20	0	1
Haysville	620	7	1.98	1	0
Herington	2,455	6	83.48	0	1
Hiawatha	2,904	7	75.37	0	0
Hoisington	1,916	7	64.32	0	0
Holton	3,359	7	70.01	1	0
Hutchinson	2,657	4	59.15	1	0
Independence	2,702	6	75.80	1	0
Iola	3,075	6	80.27	0	1
Junction City	1,964	6	38.90	1	0
Kansas City	1,529	4	47.42	1	0
Kingman	2,764	6	56.55	0	0
Larned	2,975	7	61.14	0	0

TABLE B-1 - Continued

City	Total Public Fire Prot. Expend. 1970	Per Capita Fire Prot. Expend. 1970	Population 1970	Density 1960	Per Capita Real Estate and Personal Prop. 1970
Lawrence	385,557[e]	8.44	45,698	4267	5888
Leavenworth	279,647	11.12	25,147	3021	5085
Leawood	105,726	10.22	10,349	2575	14741
Liberal	74,254	5.39	13,789	6006	5685
Lindsborg	5,649	2.04	2,764	2007	4170
Lyons	20,807	4.78	4,355	2187	5333
Manhattan	221,061	8.02	27,575	6051	6817
Marysville	7,792	2.17	3,588	3187	4743
McPherson	110,779	10.21	10,851	3845	6369
Medicine Lodge	2,964	1.16	2,545	3840	4395
Merriam	39,019	3.60	10,851	2034	9061
Mission	23,258[f]	2.78	8,376	5140	12409
Mission Hills	92,394[c]	22.12	4,177	1811	22334
Neodesha	38,153	11.58	3,295	3594	4126
Newton	235,648	15.26	15,439	3460	5699
Norton	5,346	1.47	3,627	2389	5876
Olathe	167,030	9.32	17,917	2113	7678
Osawatomie	28,694	6.68	4,294	3301	4487
Ottawa	127,756	11.58	11,036	3049	5786
Overland Park	516,598[g]	6.54	79,034	4060	9188
Paola	8,150	1.76	4,622	2990	5796
Parsons	202,504	15.56	13,015	3239	4469
Phillipsburg	20,328	6.27	3,241	3233	5341
Pittsburg	265,324	13.15	20,171	3736	5912
Plainville	10,788	4.11	2,627	4434	3815
Prairie Village	297,770[c]	10.58	28,138	4226	10314
Pratt	21,584	3.20	6,736	3262	6009
Roeland Park	23,096[h]	2.32	9,974	5966	7285
Russell	13,422	2.50	5,371	1852	5825
Salina	559,586	14.84	37,714	5024	6594
Scott City	4,862	1.22	4,001	3555	6403
Shawnee	62,256	3.04	20,482	3240	7214
Topeka	1,926,078	15.41	125,011	3453	6578
Valley Center	6,861	2.69	2,551	3671	4623
Wellington	115,756	14.34	8,072	3388	4801
Wichita	4,186,561	15.14	276,554	5024	6780
Winfield	152,797	13.40	11,405	3706	4570

TABLE B-1 - Continued

City	Per Capita Retail and Service Receipts 1967	City Fire Defense Class. 1972	% Dwellings Built 1939 or Earlier 1970	Fire Fighting Personnel	
				Full time=1 Other=0	Mixture=1 Other=0
Lawrence	1,716	5	35.30	1	0
Leavenworth	1,695	5	58.66	1	0
Leawood	850	6	2.23	0	1
Liberal	2,747	7	28.76	0	1
Lindsborg	1,882	7	69.73	0	0
Lyons	2,449	7	63.22	0	0
Manhattan	1,909	6	39.36	1	0
Marysville	3,994	7	71.25	0	0
McPherson	2,409	5	50.49	0	1
Medicine Lodge	2,796	8	52.27	0	0
Merriam	1,618	6	14.56	0	1
Mission	6,795	7	14.83	0	0
Mission Hills	N.A.	6	27.89	1	0
Neodesha	1,999	6	79.59	0	1
Newton	1,972	5	56.68	1	0
Norton	3,891	7	66.62	0	0
Olathe	1,858	5	20.80	0	1
Osawatomie	2,122	6	70.72	0	1
Ottawa	2,790	7	69.58	1	0
Overland Park	1,499	7	4.48	0	1
Paola	2,076	7	67.70	0	0
Parsons	2,330	5	67.94	1	0
Phillipsburg	3,475	7	54.85	0	0
Pittsburg	1,848	5	75.21	1	0
Plainville	2,766	7	40.96	0	0
Prairie Village	1,303	6	2.10	1	0
Pratt	3,336	7	61.61	0	0
Roeland Park	Inc.	7	14.52	0	1
Russell	2,388	7	50.88	0	1
Salina	2,356	5	40.46	1	0
Scott City	2,787	7	36.52	0	0
Shawnee	542	7	8.49	0	0
Topeka	2,134	3	41.52	1	0
Valley Center	1,407	7	15.75	0	0
Wellington	2,513	6	68.59	1	0
Wichita	2,266	3	29.04	1	0
Winfield	2,243	5	71.41	1	0

Footnotes to TABLE B-1

Notes:

[a]Unless another source is specified, all expenditure figures used were obtained from the city budgets filed with the Department of Post-Audits of the State Auditor's Office. Footnotes b, c, d, e, g and h refer to methods used to compute expenditures for cities listing only partial or no cost figures under the fire expenditure category in their budget.

[b]While El Dorado had police and fire expenditure funds listed in its 1970 budget, the majority of the cost of these two services was aggregated in a Department of Public Safety Fund. The Public Safety figure was $286,927, the police fund was $21,583, and the fire fund listed $9,837 in expenditures. The El Dorado Director of Safety indicated that 15 of the city's 42 Public Safety Officers were firemen, with the remainder being policemen. From this information it was arbitrarily decided to allocate the Public Safety Department expenses between the two categories in that ratio; 15/42 of the $286,927 was assumed to be fire protection expenses, with the rest allocated to police.

[c]A phone visit with the chief of Johnson County Consolidated Fire Districts 2 and 3 revealed that several cities received protection from that consolidated unit - all of Prairie Village, Fairway, Mission Hills, Mission Woods, Westwood, and Westwood Hills, and parts (approximately 12.5% of each) of Overland Park and Roeland Park. Total expenses of the unit were $639,750 in 1970, with a mill levy of 4.6679 on all tangible property in the districts used for financing. Therefore, each city's fire protection costs was determined by multiplying one-tenth of one percent of the mill levy by the total assessed value of tangible personal property in that city.

[d]Haysville's city clerk stated that Haysville has no city fire department; fire protection service is received from a county fire district, which Haysville residents support by payment of a 3 mill levy on tangible property. Using the specified mill levy and the 1970 assessed property valuation figure, costs of fire protection for the city were calculated.

[e]Lawrence had 62 full-time firemen, 64 full-time policemen, and 16 Public Safety officers in 1971 (figures for 1970 not available). Cost figures for 1970 were $145,103 for the Public Safety Department, $419,014 for police, and $371,046 for the fire department. A Lawrence city official indicated that approximately 90% of the Public Safety expenditures should be allocated to the police function with the remaining 10% placed in the fire account. In its inception the Lawrence Department of Public Safety had trained its personnel to serve as dual firemen-policemen, subject to call for either duty; now most of these officers serve strictly as police patrolmen. Therefore, only 10% of Public Safety Department expenditures were allocated to the fire protection function.

[f]Mission receives fire protection from Mission Fire District #1, which provides service to all of the city of Mission and all but about 12.5% of Roeland Park.

Footnotes to TABLE B-1 - Continued

[g]A visit with the chief of Overland Park Fire District #1 via the telephone revealed that approximately 87.5% of Overland Park is served by Fire District #1, with the remainder of the city protected by Johnson County Consolidated Fire Districts 2 and 3. The 1970 budget for the Overland Park Fire District was $420,000. Multiplying 12.5% of the total assessed tangible property valuation for the city by one-tenth of one percent of the mill levy (4.6679) for consolidated districts 2 and 3 gave a total of $96,598. Summing these two figures provided a close approximation of total public fire protection expenditures for the city.

[h]Roeland Park receives fire protection from Mission Fire District #1 (covers roughly 87.5% of the city) and Johnson County Consolidated Fire Districts 2 and 3 (about 12.5%). The city paid $13,224 to the Mission Fire District in 1970, while costs of the consolidated fire district were determined on the basis of an assessed tangible property mill levy of 4.6679 for that part of Roeland Park which it covered. Calculations indicated that in 1970 $9,872 was paid to Johnson County Consolidated Fire Districts 2 and 3 by the Roeland Park residents living in that district.

[i]U.S. Department of Commerce, Bureau of the Census, U.S. Census of Population: 1970, General Population Characteristics - Kansas, PC(1) - B18 Kansas (Washington, D.C.: U.S. Government Printing Office, 1971), pp. 55-56.

[j]U.S. Bureau of the Census, County and City Data Book, 1967 (Washington, D.C.: U.S. Government Printing Office, 1967), p. 588.

[k]Data from unpublished reports of taxible tangible property valuation by city on file at the Kansas Property Valuation Department. Refer to footnote j, Table A-1 for procedure used in deriving real estate and personal property valuations.

[l]U.S. Bureau of the Census, Census of Business, 1967, Retail Trade: Kansas BC 67 - RA 18 (Washington, D.C.: U.S. Government Printing Office, 1969, pp. 8-15; and U.S. Bureau of the Census, Census of Business, 1967, Selected Services: Kansas, BC 67 - SA 18 (Washington, D.C.: U.S. Government Printing Office, 1969), pp. 8-11.

[m]Value for selected services receipts was interpolated from county total based on the ratio of city service establishments to total county service establishments.

[n]Insurance Services Office, "Rate Publications Index: (Town Index) Listing," Topeka, Kansas, effective July 21, 1972. (Mimeographed.)

Footnotes to TABLE B-1 - Continued

[o]U.S. Department of Commerce, Bureau of the Census, 1970 Census of Housing, Housing Characteristics for States, Cities, and Counties: part 18 - Kansas, Vol, I (Washington, D.C.: U.S. Government Printing Office, 1972), pp. 87, 104-106, 116-120.

[p]The League of Kansas Municipalities, Directory of Kansas Public Officials 1971-72 (Topeka, Kansas: League of Kansas Municipalities, pp. c-2 to c-84; and The League of Kansas Municipalities, Directory of Kansas Public Officials 1972-73: Cities, Schools, Buyer's Guide (Topeka, Kansas: League of Kansas Municipalities), pp. c-2 to c-84.

TABLE B-2

MISCELLANEOUS INFORMATION RELATING TO THE PROVISION OF FIRE PROTECTION IN 78 KANSAS CITIES

City	Year	Full time Fire chief	Fire Fighting Personnel: No. Volunteers	Fire Fighting Personnel: No. Full Time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Abilene	1970	Yes	8	9	$4	5	Ind. contract for rural fire prot. @$100 yr. + $100 per run
Anthony	1971	No	24	--	$2-3	3	Twps. contract for rural fire prot. @$200-350 a yr.
Arkansas City	1971	Yes	--	17	--	5	Twps. contract for rural fire prot. @$80 1st hr., $50 add. hrs.
Atchison	1970	Yes	--	19	--	7	Ind. contract for rural fire prot. @$15 per residence & schools, $20 retail stores, $50 mfg., plus $100 1st hr., $50 2nd hr.
Baxter Springs	1970	N.A.	22	1	$3-4	6	Twps. contract for rural fire prot.
Belleville	1970	No	20	--	$3-5	2	---------
Beloit	1970	N.A.	20	--	$5	2	Inds. contract for rural fire prot. @$75 per run
Bonner Springs	1970	N.A.	23	--	$2.50	2	Dists. contract with city for rural fire prot. @$2.50 a call
Chanute	1971	Yes	--	35	--	4	---------
Cherryvale	1970	Yes	12	2	$2.25-$3.75	2	---------

TABLE B-2 - Continued

City	Year	Full time Fire chief	Fire Fighting Personnel No. Volunteers	Fire Fighting Personnel No. Full time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Clay Center	1970	Yes	13	5	$3	3	---------
Coffeyville	1970	Yes	--	22	--	7	---------
Colby	1970	Yes	20	3	$3	3	Have 1 rural fire dist. truck
Columbus	1971	No	25	1	$3-5	4	Inds. contract for rural fire prot. @$100 per run
Concordia	1970	Yes	10	6	$2.50	3	---------
Derby	1970	N.A.	33	--	$1.00-$1.50	5	---------
Dodge City	1970	Yes	--	26	--	6	Twps. & fire dist. contract for rural fire prot @1 mill levy
El Dorado	1970	Dir. Saf.	--	15	--	9	Twps. contract for rural fire prot.
Emporia	1970	Yes	--	24	--	7	4 Twps. contract for rural fire protection
Eureka	1970	No	21	1	$4	3	City mutual aid with county rural fire district
Fairway	1970	Yes	--	N.A.	--	N.A.	City in Johnson C. Consolidated Fire Districts #2 and 3
Fort Scott	1970	Yes	--	15	--	5	---------

TABLE B-2 - Continued

City	Year	Full time Fire chief	Fire Fighting Personnel No. Volunteers	Fire Fighting Personnel No. Full time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Fredonia	1970	No	16	--	$4	3	---------
Galena	1971	N.A.	25	1	--	6	Twps. contract for rural fire prot.
Garden City	1970	No	15	--	$6-10	6	Twps. contract for rural fire prot. @$1,200 per yr.
Garnett	1970	No	25	--	$3.50	2	---------
Goodland	1970	No	14	--	$6	3	---------
Great Bend	1970	Yes	10	23	$20/mo.	5	Twps. contract for rural fire protection
Hays	1970	Yes	8	10	$3-5	4	---------
Haysville	1970	Yes	--	N.A.	--	N.A.	City is in a county fire protection district
Herington	1967	Yes	15	3	$4-5	3	Contract with townships for rural fire protection
Hiawatha	1970	No	16	--	$5	4	Twps. contract for rural fire prot. @$20 per run, firemen $5/run
Hoisington	1971	N.A.	16	--	$5-7	4	Twps. contract for rural fire prot. @$100/run

TABLE B-2 - Continued

City	Year	Full time Fire chief	Fire Fighting Personnel: No. Volunteers	Fire Fighting Personnel: No. Full time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Holton	1970	Dir. Saf.	--	7PS	--	4	Twps. contract for rural fire prot. @$480 yr.
Hutchinson	1970	Yes	--	73	--	8	Fire dists. contract for fire prot., dists. #1 & 5 annual fee 10 mill levy
Independence	1970	Yes	--	14	--	5	Ind. contract for rural fire prot. @$100 run; 3 mile limit if Fire Dept. clause in policy
Iola	NG	Yes	26	14	--	3	City operates fire dist. #2
Junction City	1970	Yes	--	18	--	5	---------
Kansas City	1971	Yes	--	367	--	37	---------
Kingman	1970	N.A.	32	--	$3-6	5	Twps. contract for rural fire protection
Larned	1970	N.A.	15	--	$3-10	6	Twps. contract for rural fire protection
Lawrence	1970	Yes	--	47 + 16PS	--	11	Grant twp. contracts with city for rural fire protection
Leavenworth	1970	Yes	--	38	--	7	Provides for rural fire prot. by contract

TABLE B-2 - Continued

City	Year	Full time Fire chief	Fire Fighting Personnel: No. Volunteers	Fire Fighting Personnel: No. Full time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Leawood	1971	Yes	13	13	--	2	---------
Liberal	1970	Yes	14	11	$4	7	Twp. contract for rural fire prot. @$500 annually
Lindsborg	1970	No	18	--	$5	3	---------
Lyons	1970	No	24	--	$5	2	Fire dists. contract for rural fire prot. @$35/mo + $35/call
Manhattan	1970	Yes	--	37	--	7	Manhattan twp. contracts for rural fire prot. @.5 mill levy
Marysville	1970	No	28	--	$5	4	---------
McPherson	1970	Yes	12	8	$1-10	3	4 twps. contract for rural fire prot. @$720-1380 per yr.
Medicine Lodge	1971	N.A.	15	--	$5	2	---------
Merriam	1970	No	25	3	--	4	---------
Mission	1970	Yes	25	--	--	4	City in Mission Fire District #1
Mission Hills	1970	Yes	--	N.A.	--	N.A.	City in Johnson County Consolidated Districts 2 and 3
Neodesha	1971	Yes	N.A.	6	$1.50-3	3	City contracts with twps. for rural fire prot. @$1,400 yr.
Newton	1970	Yes	--	22	--	13	Twps. contract for rural fire prot., per mill levy

TABLE B-2 - Continued

City	Year	Full time Fire chief	Fire Fighting Personnel: No. Volunteers	Fire Fighting Personnel: No. Full time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Norton	1971	No	20	--	$3-4	20	Twps. contract with city for rural fire prot. @$5/call, $1/mile traveled; city has contract with state sanitorium @$50/yr.
Olathe	1970	Yes	11	16	$5	4	---------
Osawatomie	1970	No	23	4	$5-7.50	3	---------
Ottawa	1970	Yes	--	14	--	4	---------
Overland Park	1970	Yes	30	32	$0	N.A.	Part in Overland Park Fire Dist. #1; part in Johnson Co. Consolidated Fire Districts #2 and 3
Paola	1971	N.A.	13	--	$10	3	---------
Parsons	1970	Yes	--	22	--	7	Inds. contract for rural fire prot. @$500/run; industries $500/run
Phillipsburg	1970	N.A.	N.A.	--	$35-50/run	2	---------
Pittsburg	1970	Yes	--	29	--	8	---------
Plainville	1970	N.A.	30	--	$3 city $4 rural	3	Twps & inds. contract for rural fire prot. @$500-1,000 annually

TABLE B-2 - Continued

City	Year	Full time Fire chief	Fire Fighting Personnel No. Volunteers	No. Full time	Payment to Volunteers ($ per run)	Number Pieces of Motor Fire Apparatus	Other Fire Information
Prairie Village	1970	Yes	--	N.A.	--	N.A.	City in Johnson County Consolidated Fire Districts #2 and 3
Pratt	1970	No	16	--	$7.50	3	---------
Roeland Park	1970	Yes	Yes (Mission)	Yes (John. Co.)	--	N.A.	Part in Johnson Co. Consolidated Fire Dists. #2 and 3; part in Mission Fire Dist. #1
Russell	1970	Yes	22	1	$5	3	---------
Salina	1970	Yes	--	69 + 6PS	--	13	Inds. contract for rural fire protection
Scott City	1970	N.A.	22	--	$3-5	3	Fire dist. #1 contracts for rural fire protection
Shawnee	1970	Yes	82	--	$1	9	---------
Topeka	1970	Yes	--	202	--	35	---------
Valley Center	1970	No	25	--	$5	7	3 twps. contract for rural fire protection @$100/yr.
Wellington	1970	Yes	--	15	--	9	---------
Wichita	1970	Yes	--	426	--	69	---------
Winfield	1970	Yes	--	18	--	11	Inds. contract for fire protection

Footnotes to TABLE B-2

Source:

The League of Kansas Municipalities, Directory of Kansas Public Officials, 1971-72 (Topeka, Kansas: The League of Kansas Municipalities), pp. c-2 to c-84; and The League of Kansas Municipalities, Directory of Kansas Public Officials, 1972-73: Cities, Schools, Buyer's Guide (Topeka, Kansas: The League of Kansas Municipalities), pp. c-2 to c-84.

Notes:

N.A. = not available in source from which material was taken.

NG = not given

PS = Public Safety Officer (has dual responsibility with police and fire departments)

Dir. Saf. = Director of Safety

TABLE B-3

SUMMARY OF CITY FIRE LOSSES

IN KANSAS BY CLASSES, 1965-70

Class	1965-70 Total Fires	Ave. Fires Per Year	1965-70 Total Fire Loss ($)	Average Loss Per Year ($)	1965-70 % of Total Fire Loss
Dwellings	9,450	1,575	16,804,524	2,800,754	37.09
Retail Trade	1,321	220	9,285,709	1,547,618	20.50
Selected Services	435	72	2,258,156	376,359	4.98
Personal Property	5,321	887	1,504,082	250,680	3.32
Public and Public Regulated Services	97	16	415,895	69,316	0.92
Wholesale Trade	554	92	5,013,206	835,534	11.07
Manufacturing	336	56	4,474,753	745,792	9.87
Other	650	108	5,549,264	924,877	12.25
Total	18,164		45,305,589		

There were 428 deaths from fires in Kansas 1965-70.

Source: State Fire Marshal Department, "Fire Losses in Kansas," annual reports 1965-70 (Topeka, Kansas: State Fire Marshal Dept.). (Mimeographed.)

Note: Refer to Table B-4 for a more detailed report of the city fire losses in Kansas.

TABLE B-4

CITY FIRE LOSSES FOR KANSAS 1965-70

Class	1965 Total Fires	1965 Total Loss	1966 Total Fires	1966 Total Loss	1967 Total Fires	1967 Total Loss
Dwellings						
Boarding and Rooming Houses - Fraternity and Sorority Houses	3	60	2	500	3	8,26[illegible]
Dwellings - same and separate policy	1,213	1,448,392	1,540	2,369,292	1,822	2,469,68[illegible]
Apartments	61	246,805	85	131,005	90	
Trailers	1	15	7	1,690	16	6,57[illegible]
Stores and Dwellings (not more than 4 families)	9	37,180	3	36,500	3	20,40[illegible]
Total	1,287	1,732,452	1,637	2,538,987	1,934	2,681,52[illegible]
Retail Trade						
Mercantile buildings	165	667,936	147	796,066	72	830,74[illegible]
Restaurants and Bars	47	83,533	38	65,735	44	129,06[illegible]
Automobile Garages, Service and Filling Stations	29	40,173	40	253,913	38	211,34[illegible]
Lumber Yards, Coal and Wood Yards, Building Material Yards	3	930	6	103,560	6	176,74[illegible]
Food Products & Beverages	17	110,245	22	474,412	16	79,60[illegible]
Apartments (with mercantile occupancy)	--	------	1	500	2	2,50[illegible]
Wearing Apparel and Textiles	--	------	2	35	14	15,14[illegible]
Total	192	1,455,143	256	1,667,221	261	902,81[illegible]
Selected Services						
Seasonal Dwellings, Camps Auto Courts, Tourist Cabins	13	14,632	4	2,000	--	------
Hotels, Clubs, YMCA	9	5,547	32	24,913	43	604,46[illegible]
Theatres and Auditoriums	5	3,180	4	53,150	8	9,25[illegible]
Places of Amusement, Sports, Public Assembly	3	205	11	26,777	15	17,04[illegible]
Laundries and Cry Cleaning Establishments	28	74,885	19	62,952	25	38,82[illegible]
Total	58	98,449	70	169,792	91	669,60[illegible]

TABLE B-4 - Continued

Class	1965 Total Fires	1965 Total Loss	1966 Total Fires	1966 Total Loss	1967 Total Fires	1967 Total Loss
Personal Property						
Household Contents	3	6,350	26	9,847	50	15,05
Passenger Automobiles	671	105,469	699	106,915	733	99,87
Trucks	50	41,926	65	26,978	69	20,58
Tractors	1	50	4	8,435	8	4,87
Cycles	5	715	9	2,975	8	1,46
Busses	1	10	5	2,500	2	42
Boats	1	500	3	680	3	4,06
Planes	--	---	--	---	--	---
Electric Traction Property including Trackless Trolleys	--	---	--	---	1	1,50
Barns other than Farm - Private Garages	147	72,896	193	138,247	--	---
Scooters	2	110	1	10	--	---
Total	881	228,026	1,005	296,587	874	147,83
Public and Public Regulated Services						
Electric Generating Stations and Auxiliary Risks	4	75,625	1	15	2	75,02
Water Works, Pumping Stations, Filtration and Sewage Plants, etc.	1	21,000	1	127	3	9,36
Scheduled Railroad Property	6	3,325	12	27,360	10	10,27
Oil and Gas Well Lease Properties	--	---	1	1,525	--	---
Total	11	99,950	15	29,027	15	94,66
Wholesale Trade						
Heavy Stocks, Including Machinery	22	70,528	30	83,006	19	26,09
Light Merchandise including mixed stocks	54	892,702	68	464,919	63	673,82
Extra Hazardous Stocks	2	228	2	45,100	2	7,50
Warehouses - General, Merchandise, Wool	3	15,495	8	6,305	17	163,01
Warehouses - Waste paper, Rags, Junk	3	8,997	3	3,700	2	70
Oil Distribution and Tank Wagon Stations	2	475	1	9,184	1	1,00
Warehouses - Cold Storage	1	16,000	2	7,200	1	75,00

TABLE B-4 - Continued

Class	1965 Total Fires	1965 Total Loss	1966 Total Fires	1966 Total Loss	1967 Total Fires	1967 Total Loss
Printing, Newspapers, Periodicals, etc.	3	125	2	418	4	2,616
Warehouses - Household Furniture	1	500	1	7,500	1	302
Warehouses - Grains, Beans, Seeds, Peanuts and Rice	2	2,055	--	---	1	10,010
Grain Elevators, Tanks and Warehouses - Terminal	7	154,641	1	2,000	4	175,875
Grain Elevators, Tanks and Warehouses - Country	--	---	--	---	1	1,500
Total	100	1,161,746	118	629,332	116	1,137,429
Manufacturing						
Dairy Products, Ice Cream Mfg. and Ice Factories	3	5,750	2	125	1	6,433
Grain Milling, Feed Mills, Stock, Food and Starch Factories	5	50,922	5	9,372	7	39,868
Bakeries and Confectionary Products	3	23,475	3	57,675	2	6,600
Canning, Preserving and Processing of foods, etc.	1	125	--	---	3	700
Clothing Factories	--	---	--	---	--	---
Woodworking, including Furniture Factories, Shop & Cabinet Work	3	6,135	2	3,000	2	1,290
Chemical Works-Hazardous	1	25,000	3	49,500	6	60,592
Plastic, Bone, Celluloid and Shell Products	1	50	2	100,050	1	200
Stone Crushing, Cutting, Quarrying, etc.	--	---	2	1,020	--	---
Heavy Metalworkers, Foundries, etc.	7	81,000	10	61,465	1	700
Oil Refining - Mineral and Petroleum	--	---	1	200	4	45,350
Meat Products - Packing Plants and Stockyards	3	1,600	5	2,907	--	---
Cloth Products including Mattress Factories and Sewing Risks	3	10,700	4	10,740	--	---

TABLE B-4 - Continued

Class	1965 Total Fires	1965 Total Loss	1966 Total Fires	1966 Total Loss	1967 Total Fires	1967 Total Loss
Precision Products - Watch, Instruments, Radio Parts, Jewelry Manf.	--	---	1	100	--	---
Sawmills and Planning Mills, Shingle, Lath and Stave Mills	1	1,905	--	---	1	7,900
Cotton Gins including Auxiliary buildings	--	---	--	---	1	5
Paper and Pulp Manf.	2	7,099	--	---	1	1,403
Brick, Tile and Clay Products	--	---	1	130	--	---
Industrial Belting and Heavy Leather Goods	1	20,000	--	---	--	---
Glass Factories	2	8,400	--	---	--	---
Total	49	285,630	46	296,650	38	209,391
Other						
Farm Property	--	---	--	---	5	16,547
Office and Bank Risks	28	260,728	15	20,700	24	37,257
Hospitals, Sanatoriums, Orphanages, Homes for Aged	9	1,600	5	1,032	9	4,661
Churches and Chapels	13	75,466	9	55,750	14	55,934
Airplane Hangars	--	---	1	12	1	200
Educational Institutions (Public and Private)	22	378,840	18	221,765	18	55,788
Other	--	---	--	---	--	---
Bridges, Piers, Wharves and Docks	--	---	1	10	1	35
Builders Risks	6	345,325	5	14,700	1	6
Penal Institutions, including Instit, where inmates restrained	1	22	3	235	11	---
Total	79	1,061,981	57	314,204	73	170,428
Aggregate total	2,726	5,571,051	3,204	5941,800	3,333	6,556,021
Total Deaths by fire	63		88		76	

TABLE B- 4 - Continued

Class	1968 Total Fires	1968 Total Loss	1969 Total Fires	1969 Total Loss	1970 Total Fires	1970 Total Loss
Dwellings						
Boarding and Rooming Houses - Fraternity and Sorority Houses	10	8,391	10	18,537	19	373,246
Dwellings - same and separate policy	1475	2,200,104	1133	2,596,536	1433	3,046,451
Apartments	149	357,108	166	485,506	170	721,439
Trailers	6	3,750	8	30,025	13	10,470
Stores and Dwellings (not more than 4 families)	--	---	--	---	--	---
Total	1640	2,569,353	1317	3,130,604	1635	4,151,606
Retail Trade						
Mercantile buildings	132	1,805,032	88	1,027,380	115	1,098,314
Restaurants and Bars	45	119,338	36	102,559	54	211,432
Automobile Garages, Service and Filling Stations	37	207,865	31	86,298	45	281,011
Lumber Yards, Coal and Wood Yards, Building Material Yards	14	54,086	5	53,500	9	219,713
Food Products & Beverages	1	4,000	--	---	--	---
Wearing Apparel and Textiles	--	---	--	---	--	----
Total	229	2,190,321	160	1,269,737	223	1,810,470
Selected Services						
Seasonal Dwellings, Camps Auto Courts, Tourist Cabins	20	13,142	11	19,607	15	39,700
Hotels, Clubs, Y.M.C.A.	24	43,651	20	534,403	31	79,047
Theatres and Auditoriums	--	---	1	48,000	--	---
Places of Amusement, Sports, Public Assembly	20	147,748	9	82,500	12	210,612
Laundries and Dry Cleaning Establishments	21	28,135	17	23,858	15	49,910
Total	85	232,676	58	708,368	73	379,269

TABLE B-4 - Continued

Class	1968 Total Fires	1968 Total Loss	1969 Total Fires	1969 Total Loss	1970 Total Fires	1970 Total Loss
Personal Property						
Household Contents	167	18,416	107	17,537	107	18,577
Passenger Automobiles	834	138,564	520	135,445	554	135,810
Trucks	73	29,260	47	33,048	69	64,409
Tractors	9	24,525	8	3,475	21	43,775
Cycles	8	1,200	10	3,085	15	2,450
Busses	--	---	3	900	2	8,180
Boats	3	1,300	2	875	1	800
Planes	1	150,000	--	---	--	---
Total	1095	363,265	697	194,365	769	274,001
Public and Public Regulated Services						
Electric Generating Stations and Auxiliary Risks	4	50,310	1	2,140	4	5,310
Water Works, Pumping Stations, Filtration and Sewage Plants, Etc.	--	---	3	430	2	5,650
Scheduled Railroad Property	12	11,360	18	16,755	10	58,745
Oil and Gas Well Lease Properties	1	50	1	41,500	--	---
Total	17	61,720	23	60,825	16	69,705
Wholesale Trade						
Heavy Stocks including Machinery	5	58,087	9	2,900	4	11,250
Light Merchandise including mixed stocks	3	13,200	4	920,942	--	---
Extra Hazardous Stocks	5	3,975	2	2,050	1	8,000
Warehouses - General, Merchandise, Wool	54	288,157	43	218,661	51	362,172
Warehouses - Wastepaper, Rags, Junk	6	840	3	1,150	3	770
Oil Distribution and Tank Wagon Stations	4	98,550	3	14,490	6	20,980
Warehouses - Cold Storage	1	6,000	--	---	--	---
Printing Newspapers, Periodicals, etc.	7	6,086	--	---	6	46,439
Total	85	474,895	64	1,160,193	71	449,611

TABLE B-4 - Continued

Class	1968 Total Fires	1968 Total Loss	1969 Total Fires	1969 Total Loss	1970 Total Fires	1970 Total Loss
Manufacturing						
Dairy products, Ice Cream Mfg. and Ice Factories	7	11,845	1	50	3	5,434
Grain Milling, Feed Mills, Stock Food & Starch Factories	10	261,520	11	143,609	20	206,718
Bakeries and Confectionary Products	--	---	1	1,750	2	5,250
Canning, Preserving and Processing of foods etc.	10	7,255	11	39,130	17	289,849
Clothing Factories	1	838	1	24,000	1	500
Woodworking, including Furniture Factories, Shops & Cabinet Work	1	100	4	75,350	1	250
Chemical Works - Hazardous	1	50	4	15,850	7	3,293
Plastic, Bone, Celluloid and Shell Products	2	8,391	3	580,700	2	15,900
Stone Crushing, Cutting, Quarrying, etc.	1	1,500	1	3,600	--	---
Heavy Metalworkers, Foundries, etc.	9	180,051	16	155,507	22	146,924
Light Metalworkers - Machine Shops, Metal Specialties, Etc.	5	1,089,325	6	260,710	4	28,108
Oil Refining - Mineral and Petroleum	3	11,200	1	500	2	800
Meat Products - Packing Plants and Stockyards	3	1,450	--	---	1	17,000
Cloth Products including Mattress Factories and Sewing Risks	2	3,250	--	---	1	5,300
Precision Products - Watch, Instruments, Radio Parts, Jewelry Manf.	5	80,225	--	---	--	---
Total	60	1,657,000	60	1,300,756	83	725,326

TABLE B-4 - Continued

Class	1968 Total Fires	1968 Total Loss	1969 Total Fires	1969 Total Loss	1970 Total Fires	1970 Total Loss
Other						
Farm Property	11	29,213	130	146,595	42	145,417
Office and Bank Risks	40	288,145	19	104,305	20	95,471
Hospitals, Sanatoriums, Orphanages, Homes for Aged	8	111,138	8	18,900	11	24,700
Churches and Chapels	13	196,475	11	164,789	8	67,950
Airplane Hangars	4	66,785	3	27,300	4	3,700
Educational Institutions (public and private)	21	1,345,250	16	55,491	30	1,102,496
Other	19	2,302	8	2,924	6	2,065
Bridges, Piers, Wharves and Docks	3	250	--	---	--	---
Builders Risks	6	990	--	---	--	---
Total	125	2,040,548	195	520,304	121	1,441,799
Aggregate total	3336	9,589,778	2574	8,345,152	2991	9,301,787
Total Deaths by fire	62		73		66	

Source: State Fire Marshal Department, "Fire Losses in Kansas," annual reports 1965-70 (Topeka, Kansas: State Fire Marshal Dept.). (Mimeographed.)

TABLE B-5

HOW FIRE DEPARTMENTS ARE RATED BY FIRE INSURANCE INDUSTRY

Rating	City Populations 10,000-24,999	25,000-49,999	50,000-99,999	Over 100,000	Total
1	2	-	3	4	9
2	-	1	6	19	26
3	10	19	40	35	104
4	33	58	42	14	147
5	87	57	11	1	156
6	96	35	3	-	134
7	26	12	2	-	40
8	9	2	2	-	13
9	3	1	-	-	4
10	2	1	-	-	3

Source: Raymond L. Bancroft, Municipal Fire Service Trends: 1972, National League of Cities Research Report (Washington, D.C.: National League of Cities, 1972), p. 39.

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AN ECONOMIC ANALYSIS OF POLICE AND FIRE PROTECTION IN KANSAS CITIES

by

ROBERT CLAYTON MUNSON

B. S., Kansas State University, 1971

AN ABSTRACT OF A MASTER'S THESIS

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Police and fire protection are two public services which all Kansas cities except the very smallest supply. Marginal returns from additional expenditures on these two services are generally unknown. Consequently, cities tend to expend money for these services on the basis of perceived problems with little information as to the problem solving effectiveness of additional expenditures.

Using an expenditure determinants approach, this study attempted to account for the variation in per capita expenditures among Kansas cities for police and fire protection. An inherent part of the analysis for both services was the inclusion of a measure reflecting service quality. Because cities differ in the magnitude of the crime problem that they have, a model was also developed to account for the variation in crime rates. In addition, attempts were made to determine whether there are economies or diseconomies of scale for these two services.

The main factors influencing the level of crime in Kansas cities were population size, income, and a special demographic measure reflecting the propensity to commit crime of a city's population. Population size was the most important factor accounting for crime rate variation; holding income, demographic characteristics, and density constant at their mean values, the estimated crime rate was calculated to rise from a rate of 33.5 for a city of 10,000 up to 61.5 for a city of 280,000. Per capita police expenditures had little affect on the crime rate for the cities studied.

Two measures of police force quality were tested: (1) deterrence effectiveness, as measured by the difference between a city's actual crime rate and its "expected" crime rate; and (2) apprehension ability, as measured by the percentage of crimes solved. However, neither measure was felt to be an adequate indicator of the overall quality of a police force. Further research is needed to devise a comprehensive police quality index.

A cost output model was developed to account for the variation in per capita police expenditures among cities based on population, density, income, crime rate, crime clearance rate, demographic characteristics, and street mileage. The crime rate was the only variable that accounted for a significant amount of the expenditure variation.

Lack of an adequate quality measure precluded any attempt to determine whether economies of scale exist for the provision of police protection in Kansas cities, but evidence pointed toward diseconomies; i.e., greater per capita expenditures as population size increased.

The fire protection model developed included seven independent variables--population, density, the city fire defense classification, per capita property valuation, per capita sales receipts, percent of dwelling units built in 1939 or earlier, and the fire department manpower arrangements. The city classification, property valuation, age of dwellings and manpower variables were all highly significant in accounting for expenditure variation among cities for fire protection, with the city classification the most important.

Definite economies of scale for the fire protection service were evident when the cities analyzed were compared at an equal quality level. This implies that consolidation of fire departments, when feasible, may be a means of reducing per capita costs.