

ECONOMIES OF SCALE IN RELATION TO LOCAL GOVERNMENTS
AND SERVICES COMMONLY PRODUCED BY THEM

by

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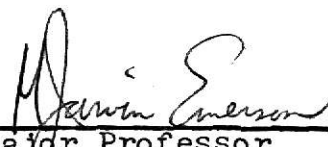
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CHAPTER I

INTRODUCTION

In recent years, the costs of providing public goods and services at the local level have continued to rise at an ever increasing rate. Police and fire protection, highways and streets, sanitary services, recreation, education, health services, and administrative service costs have all risen. Among the causes of increased costs in the provision of these services at the local level are: increases in per capita incomes, urbanization pressures, and the development of new public services, programs and facilities to improve the lot of the aged and the poor.

Schools are of special interest among the locally produced public services because of their magnitude among local government expenditures. In 1967, 37 percent of all state and local spending was for education. Of the \$40 billion spent on education that year, 60 percent was financed at the local level.¹

Among all of the local services, the cost of health services have increased most significantly. The more recent major cause of this phenomenon was the enactment of Medicare

¹James M. Buchanan. The Public Finances (Homewood, Illinois: Richard D. Irwin, Inc., 1970), pp. 342-344.

and Medicaid in the mid-sixties. "The result has been a substantial addition to the total demand for medical care services... Since nothing was done to expand supply, prices for medical care services at all levels increased dramatically in the late 1960's... prices will continue to increase rapidly in the 1970's."² A system of hospitals that had appeared to be nearly adequate for the needs of the society, quickly became inadequate.

Not only has the burden of increasing costs caused increasing pressure on revenue sources in urban areas, but also some effects have occurred in rural areas. The outmigration from rural areas that fed the urbanization trend has resulted in a declining tax base. This declining tax base has caused an increase in the burden of financing public services for those people who did not migrate to the cities.

THE PROBLEM

Can anything be done about these high and rising costs at the local government level? One approach, would be to determine if there is any significant relationship between constituents served and per capita or per unit costs, as indicated in the production function for a particular service, i.e. determine if economies of scale occur.

If economies of scale occur, and the quality is not hampered, perhaps some services should be produced by a form

²Ibid., pp. 355-356.

of consolidated government. If diseconomies of scale occur in the production of some services, perhaps larger jurisdictions might be divided into more nearly optimal units. By taking the production functions for a number of locally produced services into consideration, some efficient size of governmental unit might be determined.

The purpose of this report is to determine if economies and/or diseconomies of scale occur in the production of services at the local level. If economies and diseconomies do occur, then an optimum sized production unit exists for that local public service or groups of services. When possible, numerical conclusions will be indicated as to an optimum size of production unit.

"Economic theory since the time of Adam Smith has recognized the influence of size upon unit costs. In theory, unit costs are relatively high for a small volume of outputs, but as an enterprise increases in size, its production costs per unit of output declines. This phenomenon is called 'economy of scale.' Economies of scale are expected to occur when a larger investment of inputs results in a lower cost per unit of output.

In theory there is some optimum size for all enterprises. The optimum is defined as that size where unit costs are minimized. If the size of the enterprise exceeds this point, a 'diseconomy of scale' arises because unit costs begin to climb."³

THE PLAN

Chapter II begins with a review of the methodologies used in estimating public service production functions. This

³Nels W. Hanson, "Economy of Scale as a Cost Factor in Financing Public Schools," National Tax Journal, XVII (March, 1966), 92.

chapter is important because, in the comparison of studies of scalar economies, their conclusions vary in importance according to the quality of the methodology used. The proxy variables included, the nature of the sample, the sample size, and the statistical tools used are among those factors which affect the quality of a study.

Chapter III is a discussion of the conclusions of these studies. First, the studies which discuss efficiency in the production of particular services are compared, service by service. Then, the over-all conclusions on the possibility of a relationship between municipality size and efficiency in production for all of the services in their aggregate are discussed.

In Chapter IV the results of all the studies are summarized and, where possible, numerical optimum size local government units are indicated. Following the conclusions, a final note in Chapter IV discusses one possible direction that studies of efficiency in local governments might take in the future.

CHAPTER II

METHODOLOGIES USED IN THE STUDY OF ECONOMIES OF SCALE IN LOCAL GOVERNMENTS

A great diversity exists in the methodologies used to study economies of scale in the production of public goods and services at the local level. A logical framework for the presentation of the methodologies was obtained from the statistical tools employed in estimating public service production functions. Although these tools varied in complexity from a comparative index concept to a system of simultaneous equations, some form of regression analysis was most common.

COMPARATIVE INDEX STUDIES

Two of the studies reviewed used rather simple comparative index concepts as their tools. Neutze studied the possibility of economies or diseconomies of scale in administrative costs, a classic theoretical economic consideration, by using comparative percentages.¹ His methodology was merely a determination of the percentage of local government expenditures that were used up in administrative costs. His data were gathered from the local governments of the state of New South Wales in Australia for 1957. The data were unique compared to data

¹G. M. Neutze, Economic Policy and the Size of Cities (New York: Augustus M. Kelley, 1967), pp. 68-69.

that would be gathered in the United States, because of the classes in his study. The smallest of the seven classes were municipalities with population of less than 25,000, and the largest class included all municipalities with a population greater than 150,000. The only city in this largest class was Sidney.

Shapiro investigated the concept of economies of scale in local governments also, using a rather simple comparative index methodology.² He used 1957 data gathered by the United States Bureau of the Census concerning local government financing and an estimation of the population of all 3,100 counties in the United States for that year.³ No attempt was made to study the possibility of economies of scale for locally produced goods and services. His viewpoint was in terms of the pure financial health and wealth of local governments. The expenditure and revenue data of local governments within each county was analyzed according to states. The counties with the highest and lowest revenue and expenditure items of each state were analyzed according to county population class to determine if any significant relationship existed between county population and per capita revenue and/or expenditures.

²Harvey Shapiro, "Economies of Scale and Local Government Finance," Land Economics, XXXIX (May, 1963), 175-186.

³United States Bureau of the Census, Local Government Finances and Employment in Relation to Population in 1957 (Washington, D.C.: State and Local Government Special Studies Number 45, 1961).

SIMULTANEOUS-EQUATION ANALYSIS

A more rigorous approach has been the implementation of simultaneous equations for estimating public service production function. Such a model was developed by Morris and Tweeten⁴ in relating crime control costs and city size. The model, consisting of a simultaneous system of recursive equations, was unique in that the police department service output was measured in terms of crime controlling effectiveness.

Since it is impossible to measure the social disutility of variations in crime rates, Morris and Tweeten held the crime rate constant over the range of city sizes. Assuming that crime can be controlled, their basic empirical procedure was to compare the costs of holding crime at that level in different sized cities, by varying the police numbers.

RANK CORRELATION ANALYSIS

Simple rank order correlation also was used in studying the relationship between city size and the cost of public services. An example is a study by Schmandt and Stephens of the municipalities within Milwaukee County with respect to economies of scale in the production of public services.⁵ Schmandt and Stephens included five separate rank correlation matrices in

⁴Douglas Morris and Luther Tweeten, "The Cost of Controlling Crime: A Study in Economies of City Life," Annals of Regional Science, V (June, 1971), 33-49.

⁵H. J. Schmandt and G. Ross Stephens, "Measuring Municipal Output," National Tax Journal, XIII (December, 1960), 369-375.

their study. A matrix for total municipal expenditures, one each for police, fire, and sanitation services, as well as a matrix for the schools in Milwaukee County. In their study of the municipalities within Milwaukee County, their goal was "to test the assumption that population size is unrelated to per capita municipal expenditures even when service levels are considered."⁶

Although, the inclusion of a service quality index in a study of local government scale economies was an innovation of Hirsch, Schmandt and Stephens included such an index in their study. Their "quality of service" indicator was less complex than the indicator used by Hirsch in his St. Louis study. Schmandt and Stephens felt that the development of a quality index was important because it was necessary to determine the extent to which the variations in municipal outlays could be attributed to variations in the quality of a particular service, rather than the scale of plant. Their "service output index" consisted of an enumeration of the sub-functions performed by a service producing unit, such as the police department. A police department that provides a greater number of sub-functions is considered a higher quality police department. Schmandt and Stephens felt that their index was superior because it measured service output, while the Hirsch index measured input resources for the production of a service.

⁶Ibid., p. 370.

Although the primary statistical tool used by Hirsch was multiple regression analysis, in his analysis of some Isard and Coughlin data concerning sewerage disposal plants he used rank correlation analysis.⁷ Hirsch used the Isard and Coughlin study as an example for his concept of a vertically integrated public service.⁸

REGRESSION ANALYSIS

Among the studies that implemented regression analysis, 2 used linear regression analysis, 6 used curvilinear regression, and 2 did not indicate what type of regression analysis they used. Within the articles which did not specify the type of multiple regression analysis used, no formula or list of variables was included to help indicate which of the analysis types was used.

One such study was done by Gabler⁹ who, "attempts to assess the effects of three population factors--size, density, and rate of change-on the provision of certain urban public services."¹⁰ The expenditures per capita were studied for the

⁷Werner Z. Hirsch, "Implications of Metropolitan Growth and Consolidation," Review of Economics and Statistics, XLII (August, 1959), 232-241.

⁸In the case of a vertically integrated service, more than one stage of the production service process is under the jurisdiction of a governmental unit.

⁹L. R. Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," Land Economics, XLV (November, 1969) 425-434.

¹⁰Ibid., p. 425.

states of New Jersey, Ohio and Texas. For the study of a municipal service associated with the cities in a particular state, two separate analysis were made, one for the per capita employment associated with that service, and another for the per capita expenditures on that service. The additional dependent variable, employment per capita in the production of a particular service, was added to the study because such an addition tends to decrease the differences in costs among cities due to variations in price and salary levels. In each state, the cities studied were divided into two groups, those cities with 25,000 to 250,000 population, and a second group containing those cities in the state with greater than 250,000 population.

Hanson used a significantly different method of analysis, which included regression analysis, to compare data associated with 577 school districts from nine states.¹¹ The districts ranged in size from 1,500 to 846,616 pupils. This data for the 1958-1959 school year included grades one through twelve for the districts studied.

Hanson's system of analysis consisted of gathering information of two types. School district size information as measured in average daily attendance, as well as unit cost residual information for each district. This latter information was gathered

¹¹Hanson, "Economies of Scale as a Cost Factor in Financing Public Schools," pp. 92-95.

by using James' determinants of educational expenditure.¹² James' determinants of education expenditures are a group of eight economic and social characteristics that correlate highly with educational expenditures. The results from the James' regression equation were compared with actual expenditures for each district, and the residual per pupil costs were compared according to district size to determine if a significant relationship existed between school district size and per pupil costs.

Linear Regression

As was already mentioned, a linear form of multiple regression analysis was used in 2 studies for estimating scale economies in public services. One study was a multiple service study, and one study was a single service study.

The multiple service study was done by Brazer.¹³ The city government functions in his study, that are reviewed in this report are: police and fire protection, highways, recreation, general control, sanitation, and educational services.

Brazer's study was made up of 5 sub-studies. First, 462 of the 481 cities with populations of more than 25,000 were analyzed. Three other samples studied all of the cities in California, Massachusetts, and Ohio with 1950 populations

¹²H. Thomas James et al., Wealth, Expenditure, and Decision-Making for Education (Stanford: Stanford University Press, 1963), pp. 69-100.

¹³Harvey E. Brazer, City Expenditures in the United States (New York: National Bureau of Economic Research, 1959), Occasional Paper 66.

greater than 25,000. Finally, the 41 largest cities in the United States (less Washington, D.C.) were studied separately.

Kong Kyun Ro, with linear multiple regression and some data from a group of short-term¹⁴ hospitals in Western Pennsylvania, attempted to estimate the basic relationships of costs for the hospital industry.¹⁵ In order to minimize the variations related to factors other than size, Ro picked a sample of hospitals that was similar in general characteristics, with a wide range through which various independent variables could change. Sixty-eight of the 102 hospitals in Western Pennsylvania made up Ro's sample. The data was gathered for the eleven years between 1952 and 1963, less 1956. The hospitals in the sample varied in size from 36 to 794 beds.

Twenty-two independent variables to express such concepts as: size-volume, capacity utilization, scope of services and technology were included in the study, as well as three exogenous variables referring to community characteristics, and some dummy variables to indicate educational levels of the hospital staff. Two expressions of average costs, adjusted inpatient expenses per admission, were used as dependent variables. A number of regressions were run using only a few variables at a time to avoid colinearity. Just two of the regressions were included

¹⁴A short term hospital is one with an average patient stay of less than 30 days.

¹⁵Kong Kyun Ro, "Determinants of Hospital Costs," Yale Economic Essays, VIII (Fall, 1968), 187-259.

in the paper Ro had published. The other regressions were inconsistent. Both cross sectional and time series data were used in the study, and data were combined through covariance analysis.

Curvilinear Regression

Curvilinear regression was the most popular of the statistical tools used in studying economies of scale in the production of services at the local level. This statistical tool was used in 6 studies.

Hirsch used primarily curvilinear multiple regression and correlation in his study of the St. Louis city-county area. Included in the article was a study of the potential for scale economies with respect to police, fire, refuse collection, and education, as well as a reference to a previously mentioned Isard and Coughlin study of economies of scale in sewerage plants.¹⁶ Hirsch included an innovative quality index in his calculations. His service level index was computed, using factors which presumably affected the quality of the services produced.¹⁷

In his theoretical framework, Hirsch divided the municipally produced goods and services into the categories of horizontally, vertically, and circularly integrated goods and

¹⁶Walter Isard and Robert Coughlin, Municipal Costs and Revenues (Wellesly, Mass: Chandler-Davis, 1957), pp. 75-76.

¹⁷Werner Z. Hirsch, "Implications of Metropolitan Growth and Consolidation, Review of Economics and Statistics, XLII (August, 1959), 232-241.

services. Horizontal integration referred to a number of service producing units, under the jurisdiction of the same government, turning out the same service, such as police services. Vertical integration was the operation, by a government, on more than one level in a production-service process, such as water services. Circular integration referred to the simultaneous operation of a number of services at one location, such as the administrative services performed at a city hall.

Hirsch hypothesized that the short run per capita expenditure function for horizontally integrated service would be U-shaped with a flat bottom. He proposed that the short run per capita expenditure function for circularly integrated services would be U-shaped with the lowest section associated with medium sized cities. Hirsch predicted that, at least in the case of the vertically integrated services he discussed in the article (i.e. sewerage), economies of scale will continue to occur for larger plants, and although some diseconomies of scale will begin to occur in large plant sizes, they will not overcome the economies of scale.¹⁸

In a single service study published in 1965, Hirsch explored the possibility of economies of scale in refuse collection.¹⁹ As in his previous article he used St. Louis

¹⁸Ibid., pp. 233-235.

¹⁹Werner Z. Hirsch, "Cost Functions of an Urban Government Service: Refuse Collection," Review of Economics and Statistics, XLVII (February, 1965), 87-92.

area data. The 1960 data for 24 St. Louis city-county municipalities made up the sample. He again used multiple regression and correlation techniques in the analysis of the data.

Four other single service studies are examples of curvilinear multiple regression analysis, 2 of which were concerned with schools, one with hospitals, and one with fire protection. The possibility of economies of scale in high school operations were studied by John Riew in data gathered about the Wisconsin school system.²⁰ One hundred nine of the 430 high schools of Wisconsin were included in the sample. To minimize the variations in quality within the sample, 321 high schools were eliminated. The quality and expenditure data were subjected to multiple regression analysis, to determine if any relationship existed between high school size and operating expenditure per pupil.

In a study of economies of scale associated with school districts, Donald Osburn used 1966 data from 433 school districts in Missouri. Only those districts which had high schools were included. Osburn also used curvilinear multiple regression as his statistical tool.²¹

²⁰ John Riew, "Economies of Scale in High School Operation," Review of Economics and Statistics, XLVIII (August, 1966), 280-287.

²¹ Donald D. Osburn, "Economies of Size Associated With Public High Schools," The Review of Economics and Statistics, LII (February, 1970), 113-115.

Cohen, with curvilinear regression analysis, studied 53 short-term hospitals in six northeastern states.²² Twenty-three hospitals in the New York City area were used to develop a measure for service output. Service output was measured in dollar costs per services performed. The service standard was developed with the help of functional data gathered from the 23 New York City area hospitals by the United Hospital Fund.

After the service index was devised, two regressions were developed from the data of the 12 short-term New York City area hospitals from the study's sample of 53 hospitals. Information for 1962 was used for one regression, and information for 1963 and 1964 was used for the other regression.

Another study of hospitals, among the sample of 53, was carried out for those 41 hospitals outside of the New York City area. Among the adjustments in the data necessary, for this second regression, was a compensation for wage differences outside New York City.

The statistical tool used by Robert Will was also curvilinear regression. In the application of his model to fire protection services, the relationship between his independent and dependent variables could best be expressed by a hyperbolic function.

Will's model was innovative in local government scalar

²²Harold A. Cohen, "Variations in Cost Among Hospitals of Different Sizes," Southern Economic Journal, XXXIII (January, 1967), 355-366.

economic studies.²³ In his methodology, he used professional standards to determine the amount of urban services required. This was a departure from all of the previous studies in which comparisons between cities were expressed in terms of expenditures on the municipally produced services. His methodology began by defining a physical unit of resource by its characteristics and its ability to satisfy need. The basis of the physical unit should be the professional recommendations or standards developed by experts in the production of the service under study. After the professional standards were analyzed for adequacy, the physical unit was to be applied to total city need, to determine the number of units required for the service under study.

If such an index was made for a number of cities of different sizes, the comparison of these indexes would be helpful in the determination of economies or diseconomies of scale in the production of the municipal service under study. However, to follow Will's procedure would not be a direct analysis of the possibility of scalar economies, as in the other studies reviewed. His optimum sized city was only in terms of the index developed from the service requirement standard, and not in relation to any municipal expenditure data.

²³Robert E. Will, "Scalar Economies and Urban Service Requirements," Yale Economic Essays, V (Spring, 1965), 3-61.

SUMMARY

In summation, a number of varying approaches and statistical tools were used to study scalar economies in the production of services by local governments. Two studies used a comparative index concept as their tool of analysis. One of the studies was a multiple service study and the other a single service study.

A highly sophisticated econometric model consisting of a set of simultaneous equations was used as a tool in one other single service study.

In one article, a simple quality indicator was developed and rank correlation was used as a statistical tool.

Some form of multiple regression analysis was used as a primary statistical tool in 10 of the studies. Linear regression was used in 2 papers, curvilinear regression was used in 6 papers, and 2 papers did not indicate which form of multiple regression (linear or curvilinear) they used.

The methodologies of a number of the studies that used regression analysis differed in some significant way. In one study a pioneering attempt was made to separate the variations in the service quality from the effects of plant size on the costs of locally produced services, i.e. a service quality indicator was developed. In another regression study quality variations were partially neutralized by a second regression equation for which, employment in the given service per capita was used as the dependent variable. Another paper was of great

interest because it studied the idea of using professional standards to determine the need for services by a local government.

Samples of widely varying sizes have been used. In some of the studies, quality has been ignored as a variable, in others a painstaking effort was made to isolate the quality variable to make the association between plant size and cost more meaningful. The conclusions vary as greatly as do the methodologies, as will be seen in the next chapter. Since most of the studies analyzed one or more of the services produced at the local level, the conclusions will be reviewed service by service. Finally, the over-all conclusions of each of the studies will be compared.

CHAPTER III

ECONOMIES OF SCALE IN THE SERVICES PRODUCED BY LOCAL GOVERNMENTS

In the first part of this chapter, the possibility of economies of scale in the production of particular public services will be discussed. Among the services included are: police and fire protection, highways and streets, sanitation, recreation, education, health and administration. In the final section of this chapter, the general conclusions on economies of scale in local governmental units of the various authors are compared.

POLICE PROTECTION

Police protection is quite common among studies of scalar economies in municipally produced goods and services. Brazer, with the use of multiple regression analysis, concluded that economies of scale do exist in the production of this service.¹ The five samples studied included:

- (1) 462 of the 481 cities with a population greater than 25,000;
- (2) the 35 cities in California with a population greater than 25,000;
- (3) the 30 cities in Massachusetts with a population greater than 25,000;
- (4) the 32 cities in Ohio with a population greater than 25,000;

¹Brazer, City Expenditures, p. 66.

- (5) all cities in the United States with a population greater than 250,000 (less Washington, D.C.).²

The conclusions of four of the five samples were that population was a significant factor in determining per capita expenditure levels on police services.³ In the 40 largest cities in the United States no significant relationship existed between population level and per capita expenditure on police protection. The four samples that showed a significant relationship between city size and per capita expenditure on police protection, indicated that only diseconomies of scale occurred.

Hirsch, after studying 64 St. Louis police departments for communities ranging in size from 200 to 865,000 inhabitants, concluded that no significant economies of scale existed.⁴

In Gabler's study of scale economies, he also included police protection. Using multiple regression, he concluded that no significant scale economies existed for cities from 25,000 to 250,000 in any of the three states studied. For cities with populations greater than 250,000, diseconomies were indicated in one state studied.⁵

²Ibid., p. 16.

³Ibid., pp. 26, 37, 40, 43, 56.

⁴Hirsch, "Implications of Metropolitan Growth and Consolidation," pp. 237-238.

⁵Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," pp. 428-434.

From the study of 19 municipalities in Milwaukee County, ranging in size from 1,200 to 750,000 people, Schmandt and Stephens concluded that significant economies of scale in police protection might exist.⁶ According to their rank order study, there was a high positive correlation between population and service level, a significant negative correlation between per capita, per activity expenditures and service level, as well as a significant negative relationship between per capita per activity expenditures and population.

The most recent and sophisticated study of economies of scale in police protection was done by Morris and Tweeten.⁷ Included in the study were 754 cities with populations ranging from 25,000 to over one million people. The conclusions of this sophisticated study were that: "sizeable economies and diseconomies of scale exist with regard to a given quality of police protection."⁸ According to the study, crime control costs were minimized between 250,000 and 500,000. Cities with a population greater than one million experience extensive diseconomies of scale.

According to these five studies of scalar economies in

⁶Schmandt and Stephens, "Measuring Municipal Output," pp. 373-374.

⁷Morris and Tweeten, "The Cost of Controlling Crime: A Study in Economies of City Life," pp. 33-49.

⁸Ibid., p. 48.

the production of the municipal service of police protection, two concluded that economies of scale do exist, one indicated a possibility of scalar economies, and two concluded that economies of scale do not exist. Only one study determined an actual minimum cost range of 250,000 to 500,000 population.

FIRE PROTECTION

With respect to the study of economies or diseconomies of scale in fire protection service, Brazer generally concluded that no significant statistical relationship existed.⁹ From the sample of 462 cities of the California sample, he concluded that no significant relationship existed. A significant relationship was indicated according to his Ohio and Massachusetts samples. The conclusion from the sample of 40 largest cities was that there was no significant relationship between population and per capita expenditures with respect to this municipal service.

Thirty-two city fire departments and fire districts of the St. Louis area serving from 800 to 865,000 people, comprised the sample for Hirsch.¹⁰ A graph of the short-run per capita expenditure function for fire protection in this study was parabolic. On the Hirsch graph, the economies of scale were

⁹Brazer, City Expenditures, pp. 26, 37, 40, 43, 56.

¹⁰Hirsch, "Implications of Metropolitan Growth and Consolidation," 238.

relatively insignificant between 1,000 and 110,000 people served. The minimum point on the curve was at 110,000 people served. Beyond that point, significant diseconomies of scale occurred although variations in cost occurred in this study, the factor which caused their variations was other than the population of the municipality or fire district. Hirsch felt that the cause was variations in land area served.

Schmandt and Stephens indicated that their study might show a possibility of economies of scale in fire protection.¹¹ According to their study, there was a significant positive relationship between population and service level, and a significant negative correlation between per capita, per activity expenditures and service level.

According to Will, who used the study of fire protection as a test for a model he built to determine the efficiency of plants associated with urban public services, economies of scale existed in the production of this public service but significant diseconomies did not exist.¹² A graph of the function, as it was related to fire protection, was a hyperbola which becomes asymptotic to the horizontal axis at high population levels.

In one of the three sample states used by Gabler, to study the cities with populations from 25,000 to 250,000, significant

¹¹Schmandt and Stephens, "Measuring Municipal Output," pp. 373-374.

¹²Will, "Scalar Economies and Urban Service Requirements," pp. 36-61.

diseconomies were found with respect to fire protection services.¹³ In the other two sample states, no significant scalar economies were found within the study of cities varying in size from 25,000 to 250,000. However, in the study of larger cities (greater than 250,000) within these two sample states, significant diseconomies were found.

Two studies indicated that no significant relationship existed between population and expenditures on fire protection. One study suggested that there was a possibility of scalar economies. One other study concluded that economies of scale did exist, and one concluded that, although scalar economies do not exist, diseconomies of scale in the production of fire protection services do exist.

HIGHWAYS AND STREETS

Brazer and Gabler included highways in their study of scalar economies. Although the Beta coefficients in Brazer's multiple regression analysis indicated that there was no significant relationship between population and expenditures on highways, a significant negative relationship existed between population density and expenditures on highways.¹⁴ This indicated that as density increased, the expenditure per capita

¹³Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," pp. 428-434.

¹⁴Brazer, City Expenditures, pp. 26, 37, 40, 43, 56.

on highways and streets declined. These relationships occurred in all five samples studied by Brazer.

R. L. Gabler also included highways in his study of scalar economies. Of the three sample states examined, two states indicated that scalar economies existed.¹⁵ The conclusions of these two samples differed however. Upon analysis of the Ohio cities with populations greater than 250,000, he concluded that significant scalar diseconomies began occurring about 471,000. According to the New Jersey study, a general pattern of economies of scale occurred throughout the larger cities of the state.

Again, the conclusions of the studies vary from no economies to significant economies in relation to the production and maintenance of highways and streets.

SANITATION SERVICES

Garbage collection and sewerage service are two other services that are often produced by local governments and therefore, are often included in studies of scalar economies of local governments. Two of the state samples in Brazer's study showed a significant relationship between sanitation service (includes sewerage disposal and garbage) and city size, but over-all the conclusion of Brazer was that no significant relationship existed

¹⁵Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," pp. 428-434.

between city size and costs of sanitation services.¹⁶

Hirsch, in his early article, quoted a study of sewerage disposal units which was done by Walter Isard and Robert E. Coughlin.¹⁷ Hirsch studied the data of these two men and observed that: "there is a rapid decline, (in treatment) up to a daily sewage flow of 1.5 million gallons. From there the decline, while steady, proceeds at a slow pace."¹⁸ The conclusions were that as long as the proper size plant was available, scalar economies would continue to occur in the treatment of sewerage.

In a study of garbage collection costs that was included in Hirsch's earlier article,¹⁹ he concluded that no significant scalar economies existed. In his later study of garbage collection, costs were found to vary from \$9.12 to \$22.51 per pickup unit among 24 municipalities in the St. Louis city-county area.²⁰ No significant relationship was found between average annual

¹⁶Brazer, City Expenditures, pp. 26, 37, 40, 43, 56.

¹⁷Isard and Coughlin, Municipal Costs and Revenues, pp. 75-76.

¹⁸Hirsch, "Implications of Metropolitan Growth and Consolidation," p. 240.

¹⁹Ibid., pp. 238-239.

²⁰Hirsch, "Cost Functions of Urban Government Service: Refuse Collection," pp. 87-92.

residential collection and disposal costs, and the number of pickup units. Most of the variations in cost were attributed to such quality factors as collection frequency, pickup density and garbage can location.

Schmandt and Stephens concluded that there was a possibility of economies of scale between city size and per capita expenditure on garbage and refuse collection.²¹ According to their rank correlation study, a significant negative relationship also existed between per capita, per activity expenditure and service level, as well as per capita, per activity expenditures on population.

Gabler, like Brazer, lumps sanitation and sewerage into one category for purpose of study.²² He found no significant relationship for those cities between 25,000 and 250,000 population, in his sample. However, in two of the three states studied, a significant relationship was reported in the study of cities greater than 250,000 population. In Ohio and New Jersey, significant diseconomies of scale were found. However, it should be noted here that, in this category of city size, New Jersey has only two municipalities.

Of the five articles that included garbage collection, three concluded that no scalar economies existed. One, concluded that scalar economies might exist and one concluded that such

²¹Schmandt and Stephens, "Measuring Municipal Output," pp. 373-374.

²²Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," pp. 428-434.

economies did exist. Of the articles in which scalar economies for sewerage disposal were studied, two concluded that they existed and one concluded that economies of scale did not exist.

RECREATION

The relationships between population and per capita expenditures on recreation varied among the samples studied by Brazer.²³ No significant relationship was found in the large sample of 462 cities, nor in the sample of 40 large cities. In two of the samples which included all the cities with populations greater than 25,000 people within a particular state, a significant relationship was found. Over-all, Brazer concluded that no significant relationship existed between per capita expenditures on recreation and city size.

Again, as in the study of expenditures on highways, the two sample states in Gabler's analysis which showed a significant relationship between population and per capita expenditures, resulted in differing conclusions.²⁴ In the sample of Ohio cities with populations greater than 250,000, significant diseconomies began to occur beyond 471,000. In the New Jersey study, economies of scale seemed to exist within the sample of larger cities in the state. However, again in the New Jersey

²³Brazer, City Expenditures, pp. 26, 37, 40, 43, 56.

²⁴Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," pp. 428-434.

sample, there were only two cities. This sample size discounts any conclusions one might make about the New Jersey sample.

EDUCATION

Brazer studied schools with his 1953 data collected concerning the 40 cities in the United States with 1950 populations greater than 250,000. Per capita expenditures on education, as was the case with all the other eight functions analyzed in his study of larger cities in the United States, was not significantly affected by the population variable.²⁵ One might conclude that, according to Brazer's data, if any scalar economies in education do exist, they are associated with cities smaller than 250,000 population.

Hirsch studied 1951-52 and 1954-55 data for 27 St. Louis area school districts. Average daily attendance in the districts varied from 500 to 84,000. Hirsch concluded that no significant net relationship existed between expenditure levels and school district size.²⁶

Schmandt and Stephens studied the possibility of scalar economies with a sample of 18 school districts in Milwaukee County.²⁷ The districts varied in size from 380 to 80,485

²⁵Brazer, City Expenditures, p. 53.

²⁶Hirsch, "Implications of Metropolitan Growth and Consolidation," p. 239.

²⁷Schmandt and Stephens, "Measuring Municipal Output," pp. 374-375.

pupils in average daily attendance. The quality index in this study is similar to the index used in the analysis of other governmental services by the same authors. It consists of an enumeration of school activities. Since there was no relationship between service output and expenditures per pupil, while the relationship between expenditures per pupil and school population is significantly negative, add to this the significant negative relationship between per pupil spending per activity and the number of students in average daily attendance, and the suggestion is that economies of scale exist with the sample of school districts within Milwaukee County.²⁸

In Hanson's study of education, the sample was separated and analyzed state by state. The optimum sized school district varied in size from 20,000 students in Nebraska to 160,000 students in New York. The median optimum size district was 50,000 students. Hanson computed the saving per pupil in average daily attendance that accrued to the school district operating the optimum sized school district in each state, with respect to the per pupil cost of operating a school district of 1,500 students. He expressed this saving as the "economy of scale." The annual per student economy of scale varied from \$15 in Nebraska to \$96 in New York, with a median scalar economy of \$27. In three of the nine states, the optimum was

²⁸Ibid., p. 375.

determined to be the largest school district.²⁹ This implies that more economies were possible if larger districts had existed in the state. In the other six states, the optimum was some intermediate size districts. For the six states where an intermediate optimum was calculated, it was discovered that the diseconomies varied from \$4 to \$114 and averaged \$10 per pupil in average daily attendance.³⁰

Upon analyzing the raw data in Riew's study of economies of scale in high schools, economies of scale seem to be indicated from the smallest size school (143-200) pupils to the (701-900) pupil class.³¹ This conclusion is made merely by comparing the pupils in average daily attendance with operating expenditures. Quality variables are allowed to vary at will.

Riew also attempted to isolate the influence of size on costs, by subjecting the raw data, including the quality indicators, to multiple regression analysis. With the other independent variables held constant, when only high school size is varied, a savings of over 200 dollars per pupil in average daily attendance is accrued. Economies of scale occurred from a high school size of 200 to, what Riew determines to be, the optimum size high school of 1,675 students.

²⁹Hanson, "Economies of Scale as a Cost Factor in Financing Public Schools," p. 94.

³⁰Ibid., p. 95.

³¹Riew, "Economies of Scale in High School Operation," p. 282.

Holding all other variables constant and varying the size of the high school, it is determined that 18.3 percent of the changes in costs associated with the high schools in the sample, are due to variations in the size of plant.³²

The general conclusions of Riew are, that this "study of Wisconsin high schools suggests that economies of scale at this level of public education are very significant."³³

Osburn found that, in the Missouri sample of school districts, economies of scale occurred between 200 and 2,244 students. The economies per student over that range were \$47. Most of the economies occurred for school districts between 200 and 1500 students in size.³⁴

Dissenting views on the possibilities of scalar economies, with respect to public schools, are indicated in the studies reviewed. Two studies indicated that no economies of scale existed in school district size, as expressed in pupils average daily attendance. One study concluded that economies of scale are possible. With respect to the concept of an optimum sized school district, one study concluded that such an optimum was 50,000 students and another concluded that it was 2,244 students. It was concluded in one study, that a high school should have

³²Ibid., p. 285.

³³Ibid., p. 287.

³⁴Osburn, "Economies of Size Associated With Public High Schools," p. 115.

about 1,675 students to operate at its optimum scale of plant. Of the studies reviewed, four out of six concluded that, economies of scale do exist in the production of educational services.

HEALTH

With respect to hospitals, Kong Kyun Ro found in analyzing his data that some of the variations in costs according to size, 44 percent, could be accounted for by differences in service-mix. Using costs per day as a dependent variable, nine variables and two dummy variables were found to be related to this dependent variable. The three most important variables were: the ratio of patient care expenses to inpatient operating expenditures, the number of usages of laboratory, and x-ray per 100 patient days.³⁵

Since labor is such a big part of the total costs of operating a hospital, Ro studied its implications and found that: "the factors associated with labor inputs such as its productivity, its prices, its proportionate share of the total input, etc..go a long way in explaining cost differences."³⁶

When analyzing costs in relation to the output of hospital industry, Ro discovered that a built in bias for the possibility

³⁵Ro, "Determinants of Hospital Costs," p. 253.

³⁶Ibid., p. 255.

of scalar diseconomies existed. Larger hospitals tend to be located in larger cities where input costs are higher. Yet, in studying the relationship between input costs and output, with respect to plant size, economies of scale were implied. If economies of scale were implied in spite of the bias that existed toward diseconomies, then the argument that economies of scale existed was strengthened.³⁷ Ro concludes that scalar economies do exist according to his data, and since they tend to continue throughout the range of hospital sizes in his sample, he concludes that, at least in this case, diseconomies of scale do not occur.

According to Cohen's regressions on the New York City areas hospitals, there was a slow rising straight line marginal cost curve, and a U-shaped average cost curve. The lowest average cost per patient day was \$24.08 for a hospital of 290 to 295 beds. There was a relatively large low cost area on the associated average cost curve. A hospital with between 250 and 350 beds was found to have an average cost per patient day of less than \$24.20.³⁸

The study of the 41 hospitals outside of the New York City area revealed results similar to the New York City study. The marginal cost curve was found to be a straight line sloping

³⁷Ibid., p. 245

³⁸Cohen, "Variations in Cost Among Hospitals of Different Sizes," p. 365.

upward to the right, and the minimum point on the average cost curve was found to be at a cost of \$21.25 per patient day, and to be associated with a plant size of from 160 to 170 beds. However, a large portion of the curve was found to be nearly horizontal near that minimum point. The average cost was less than \$21.35 for hospitals with between 125 and 235 beds.³⁹

Cohen's conclusions, taking his two studies into consideration are: "while the evidence is insufficient to make any further narrowing down possible, it appears that hospitals between 150 and 350 beds are most efficient for ordinary patient care. Larger hospitals might be needed for special care."⁴⁰ In concluding remarks after the New York City area study, Cohen adds an important point. "Smaller hospitals (under 100 beds at least) are preferable only when the increased travel cost to the patient is greater than the increased operating cost to the hospital, i.e., in sparsely populated areas."⁴¹

The studies on economies of scale in hospitals by Ro and Cohen agree on one primary point. They both have concluded that economies of scale did occur. However, only Cohen found diseconomies of scale with the hospital sizes he studied. Ro did say that diseconomies may occur above the upper limit of the

³⁹Ibid., p. 365.

⁴⁰Ibid., p. 365.

⁴¹Ibid., p. 362.

largest plant size in his sample.⁴² Ro said that scalar economies continue to occur from a 36 to 794 bed plant size. Cohen's general conclusion was, that costs are minimized when the plant size is between 150 and 350 beds.⁴³ So, according to Cohen's study, possibly significant economies occur up to 150 beds, and significant diseconomies occur beyond 350 beds.

ADMINISTRATION

Although this particular category has been given a number of names, here it will be called, administration. In his study, Brazer entitled an administrative category, general control.⁴⁴ General control has been defined as, "the legislative and judicial branches of the government, office of the chief executive, auxilliary agencies and staff services for finance, law, recording, general public reporting, personal administration, and other general administration."⁴⁵ In four of the five samples studied by Brazer, no significance was found between population and general control expenditure.⁴⁶

⁴²Ro, "Determinants of Hospital Costs," p. 245.

⁴³Cohen, "Variations in Cost Among Hospitals of Different Sizes," p. 366.

⁴⁴Brazer, City Expenditures, p. 71.

⁴⁵U. S. Department of Commerce, Bureau of Census, Compendium of City Government Finance in 1951. Washington, D.C.: Government Printing Office, 1952.

⁴⁶Brazer, City Expenditures, pp. 26, 37, 40, 43, 56.

G. M. Neutze studied what appears to be a similar concept.⁴⁷ He determined the relationship between percentage of budgets paid out for administrative costs, and the city size. Since his sample included only one city over 150,000, the conclusions drawn from the study will be limited. Neutze did show that, according to his sample, economies of scale in administrative costs do exist for cities between 25,000 and 150,000.

Gabler's study of the general control category of expenditures indicated scale diseconomies in one of the three samples of cities with populations greater than 250,000.⁴⁸ No significant relationships existed in any of the other five samples.

Hirsch included in his St. Louis study an analysis of possible scale economies in administration.⁴⁹ He selected the administration of 27 school districts for his sample. His conclusion was "the cost function is U-shaped and its trough is at an average daily attendance of about 44,000 pupils."⁵⁰ However, it is difficult to relate this conclusion with our other studies of general control category government expenditures.

⁴⁷Neutze, Economic Policy and the Size of Cities, pp. 68-69.

⁴⁸Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," pp. 428-434.

⁴⁹Hirsch, "Implications of Metropolitan Growth and Consolidation," pp. 239-240.

⁵⁰Ibid., pp. 239-240.

For the two studies that looked at the possibilities of economies of scale in the general control category, the conclusions was that very little evidence for scalar economies existed.

COMPARISON OF THE GENERAL CONCLUSIONS

What are the general conclusions from scalar economic studies about the production of locally produced goods and services? Brazer says, "there is little, if any, demonstrable positive relationship between the population size of cities and their levels of expenditure per capita when other independent variables are taken into account and the sample studied is a large one."⁵¹ In his study, the only category of service production in which he felt that a highly significant relationship between city size and per capita expenditures existed, was in the production of police services.

Hirsch, who divided the services into three categories, said, in the case of horizontally integrated services such as: "fire protection, police protection, refuse collection...growth and consolidation appear to have little, if any, significant effect on per capita expenditures for these services."⁵²

In circularly integrated plants, where central administra-

⁵¹Brazer, City Expenditures, p. 66.

⁵²Hirsch, "Implications of Metropolitan Growth and Consolidation," p. 240.

tion services are performed, economies of scale occur from small to medium sized production units. Beyond medium sized units, diseconomies begin to occur.⁵³ In the case of circularly integrated services, such as sewerage plants, he said: "Growth and consolidation will lead to a decline in per capita expenditures until a very large scale is reached, so large that few city and metropolitan areas have achieved it."⁵⁴

Summarizing the conclusions of Hirsch, those services produced by a number of similar production units under the jurisdiction of one government, horizontally integrated services, do not tend to develop scale economies. Circularly integrated services, where there is duplicity in some of the phases of production, tend to develop first economies and then diseconomies, if the administrative procedures become too complex and/or too large. Vertically integrated services occur if more than one phase of the production cycle is under the jurisdiction of the local government. In the production of vertically integrated services, if the proper size plant is assumed, economies of scale continue to occur up to very large plants.

All functions considered, Hirsch concluded that "economic efficiency may be highest in...communities of 50,000-100,000

⁵³Ibid., p. 240.

⁵⁴Ibid., p. 240.

residents."⁵⁵

Schmandt and Stephens felt that their study indicated: "the distinct possibility that economies of scale exist for at least some municipal functions when service levels are considered."⁵⁶ Even with their simple service level indicator, they separated, to some degree, the causes of variations in costs between population changes and quality changes in the production of municipal services.

Harvey Shapiro, who studied scalar economies in local government from a public finance viewpoint, rather than a service by service survey, reported that: "local governments in the smallest and largest county areas within the different states tend to have the highest per capita revenues and expenditure. Yet,...these are the units that are experiencing the greatest financial problems."⁵⁷

He suggested that small local governments experienced diseconomies of scale in their production unit. Maybe a better way to put it would be to say, that they were unable to take advantage of scalar economies. With respect to those local governments at the other end of the spectrum, he concluded that their financial problems were due to the greater quality

⁵⁵Ibid., p. 240.

⁵⁶Schmandt and Stephens, "Measuring Municipal Output," p. 375.

⁵⁷Shapiro, "Economies of Scale and Local Government Finance," p. 180.

and quantity of services demanded by people living in those more heavily populated areas.

In studying the data from Australian cities and separating it by state, Neutze observed that: "when we look at the crude relationship between size of centre and expenditure in each state we find very little evidence of any trends."⁵⁸

Gabler's general conclusion was that: "the evidence suggests that for certain expenditure or employment classifications in certain states, larger cities do experience diseconomies of scale."⁵⁹

⁵⁸Neutze, Economic Policy and the Size of Cities, p. 68.

⁵⁹Gabler, "Economies and Diseconomies of Scale in Urban Public Sectors," p. 434.

CHAPTER IV

SUMMARY AND CONCLUSIONS

SUMMARY

Do economies of scale occur in the production processes of goods and services traditionally associated with local governments? Do diseconomies of scale occur? Does an optimum level of output for such services exist? Can some results in the form of numbers be ascertained? What direction should future scalar economic studies take? These questions will be asked of the studies included in this report.

The methodologies varied extensively among the studies. A significant variation in sample sizes was present. Quality indicators were included in some studies. A wide variation in theoretical bases was found among the studies. Among the studies, several different statistical tools were utilized. Two studies used a comparative index concept, a sophisticated set of simultaneous equations was employed in another, rank correlation was used in one study, and in 10 studies some form of multiple regression analysis was utilized.

Two studies seemed most convinced, with one exception each, that no significant relationship existed between municipal output and population. The conclusions of two other studies were that a significant relationship existed in the case of some services produced at the local level. One found that, although no significant relationship was found in the case of

those services which require the greatest portion of the local government budget, economies did occur in such services as water, sewer, and public administration. Diseconomies also occurred in public administration, with an optimum size somewhere between 50,000 and 100,000 constituents served. The conclusions of the other study were less clear, as to which services might experience a relationship between service level and population, because the conclusions that were drawn from the study of different samples were often unrelated. However, in studying one sample, it was concluded that an optimum sized city might be near 471,000 people.

In studying the finances of local governments, it was concluded that a significant relationship does exist between the population under the jurisdiction of a local government and the costs of operation for that government. For small governments, the cost of providing the basic services is higher than is the case for medium sized local government. However, the increased cost of operation for large local governments is due to the demand for more and better services. To put it another way, economies of scale occur, some optimum size local government exists, and much of what appears to be diseconomies, is a result of the demand for increased quality and quantity.

Two specialized articles concluded that a significant relationship between the size of the city and costs of the service existed. However, both of them refused to speculate on whether such a relationship existed for all services produced

by city government.

Of the three articles which reviewed the possibility of scalar economies in education, the two which were studies of school districts, concluded that a significant relationship does exist between district size and per pupil costs. Since they both arrived at an optimum sized plant, one 50,000 and the other 2,244, it is obvious that they would agree that both economies and diseconomies exist.

The study of the production of educational units associated with high schools found that the optimum sized plant was at 1,675 students. This implies that economies and diseconomies of scale do occur in the production of educational units.

Both studies of health services, concluded that economies of scale in hospitals do exist. One simulated diseconomies of scale in his study, the other suggested that diseconomies of scale might exist above the upper limit of the largest hospital (794 beds) in his sample. One concluded that the optimum sized hospital would be somewhere between 150 and 350 beds. The other concluded that economies of scale occurred from the smallest to the largest (36 to 794 beds) hospitals in his sample.

CONCLUSIONS

It appears that a significant amount of evidence exists to indicate that economies and diseconomies of scale do exist in relation to the production functions of local governments. Sweeping conclusions about what the optimum size of such institutions might be, are not so readily available. In the

case of municipalities, the studies that indicate a particular size, range vary extensively. The studies on school districts vary extensively also. In the articles on hospitals reviewed here, no conclusions on optimum size were common to both studies.

In reference to the question, what direction might scalar economic studies of municipalities and other local governments take in the future, mention should be made of an unpublished paper by Alonso.¹ He suggests that studies of economies of scale in municipal governments, and the services they provide, tend to be too microscopic. Rather than studying only the public sector, cities should be studied as a production unit. Any decisions about their efficiency or inefficiency should not be made until the city is studied as a complete unit. Until the costs of producing the output of that city are compared with the value of the output produced, no conclusions can be made about the city's efficiency. He suggests that in a dynamic city, the residual between the costs of producing and the value of the total product might continue to increase if the city continues to grow. He suggests that: "even the largest cities have not yet reached excessive sizes from the point of view of growth and productivity."² Perhaps one direction that research

¹W. Alonso, "The Question of Urban Size," (unpublished material, University of California, Berkeley, 1970).

²Ibid., p. 2.

about economies of scale in cities might take, would be to study this concept of Alonso's for cities in the United States. Is there a significant relationship between city size and a city's aggregate efficiency?

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ECONOMIES OF SCALE IN RELATION TO LOCAL GOVERNMENTS
AND SERVICES COMMONLY PRODUCED BY THEM

by

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Economies of scale in the production of public goods and services have experienced only modest popularity in economic literature in recent years. This is true even though there could be great practical value in such studies. The primary reason for the lack of work in this area is the difficulty of developing a relatively inexpensive methodology that would provide conclusions that could be used as a basis for policy decisions on optimum size production units, if such production units exist. Studies that are relatively inexpensive only indicate whether economies of scale and/or diseconomies of scale exist. The few studies that used complex methodologies included only a small number of the services produced at the local level by the public sector. This may be because the studies they performed were excessively expensive. For those services they studied, however, they usually ascertained a numerical indication of an optimum sized unit, if it existed.

Upon reviewing the studies of a number of authors concerning economies of scale in the production of police and fire protection, highways and streets, sanitary services, recreation, education, health and administrative services the only conclusions that can be drawn are that, with the results of the particular studies varying as much as they did, no consensus was indicated with respect to particular public services produced at the local level.

Comparing the overall conclusions of those authors that ventured conclusions on the possibility of economies and/or

diseconomies of scale with respect to local governments in the aggregate, the results seem to indicate that economies of scale and diseconomies of scale might exist. The few studies that indicated an optimum size local governmental unit were not similar enough to indicate any significant numerical relationship.