A SPATIAL APPROACH TO GOVERNMENT

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CHAPTER I

INTRODUCTION AND SUMMARY

Federalism in the United States is an established fact. City governments provide goods and services to city residents and county governments provide goods and services to city and county residents. The same is true for special districts, school districts, states and the federal government. Space is divided into a network of governments. The federal government operates over the entire country. States subdivide the country into 50 parts. Counties subdivide the States. Cities exist as separate government areas in the counties of Oklahoma and most other states. Each individual is a resident of several governmental jurisdictions. The problems involved with allocation of goods and services in a federal system have been the source of much discussion and study. This dissertation is a contribution to the discussion.

Purpose

The purpose of this dissertation is to examine the causes of expenditure changes in the overlay of public sector expenditures. Previous efforts have been made by others to determine the efficient level of government to provide a particular public service as well as the efficient degree of federalism. Generally, these studies agree that certain goods with certain characteristics should be allocated by certain orders of government. Breton develops a utility function where spillover benefits are spatially distributed and determines the size and number of orders of government.[1] Oates and Tullock consider political and decision costs.[2] Tiebout manufactures a Loschian-type hierarchy based on two aspects of cost minimization: output and area.[3] Borukhov adds population density to Tiebout's analysis.[4] Their theoretical arguments imply a public sector overlay, analogous to the Loschian private sector, where utility is maximized for the median voter in each government.

This dissertation first develops a model of utility maximization for the median voter in the context of a spatial system of government. This model is then integrated with the hierarchial overlay of governments. This discussion provides the theoretical basis for the empirical tests performed. Then instead of testing empirically for deviations from the efficient system of federalism in Oklahoma, this dissertation examines the causes of expenditure changes in the public sector for Oklahoma as it presently exists. This does not assume any efficiency criteria. Individuals in the private sector maximize utility by purchasing a certain bundle of goods given relative prices, individual income and individual preferences. A change in relative price, for example, causes

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[1] Albert Breton, "A Theory of Government Grants," Canadian Journal of Economics and Political Science, XXXI, May 1965, pp. 173-187.

[2] Gordon Tullock, "Federalism: Problems of Scale," Public Choice, VI (Spring 1969), pp. 19-29. Wallace Oates, Fiscal Federalism (New York: Harcourt, Brace, Jovanovich, Inc. 1972), pp. 31-53.

[3] Charles M. Tiebout, "An Economic Theory of Fiscal Decentralization," Public Finance: Needs, Sources and Utilization, Ed. National Bureau of Economic Research (Princeton: Princeton University Press, 1961), pp. 78-96.

[4] Eli Borukhov, "Optimal Service Areas for Provision and Finance of Local Goods," Public Finance, XXVII (Spring 1972), pp. 267-282.

an adjustment in quantity demanded so that a new position of maximum utility can be reached. Likewise, in the public sector of the economy changes in the area over which a good is allocated, or changes in population density in a jurisdiction cause the individual to adjust the equilibrium quantity of a public good to change so that an individual can reach a new position of maximum utility. Thus, by fitting public expenditures to various independent variables developed from the theory and available data sources, it is possible to examine how these variables affect movements in the pattern of expenditure in the Oklahoma hierarchy of governments. Most cross sectional studies of state and local finance have lumped the state, county and city government expenditure data together. By narrowing the scope of the empirical work to the city and county governments and by separating city expenditures from county expenditures, it becomes possible to examine how independent variables affect city expenditures relative to county expenditures. It is stressed that this study is intended to show the factors influencing spending patterns in the Oklahoma system of governments and that these factors are of importance in governmental planning.

Scope of The Study

This dissertation has three tasks: (1) a discussion of the expenditure pattern that results from a federal system; (2) the development of a conceptual model for maximizing utility in the public sector; (3) an examination of the causes of expenditure changes in Oklahoma using the variables from the model as independent variables in a regression analysis.

Chapter II argues that the pattern of government that results from a federal system is a hierarchial overlay analogous to a Loschian system. A presentation of the Loschian system is given for the private sector. The groundwork is laid for viewing several models of public sector hierarchies.

Chapter III presents a utility maximization model for the median voter in separate voting jurisdictions. This model results in a pattern of government similar to the public sector hierarchy described in Chapter II.

Chapter IV is the presentation of the empirical work. The independent variables in chapter are proxies for the variables in equation (9) from Chapter III. The dependent variables are per capita expenditures, dollar expenditures and expenditure ratios. Regression equations are estimated to determine the effect of the independent variables on expenditures in the hierarchy of government responsibility in Oklahoma.

Chapter V presents the conclusion and policy implication.

Findings of the Study

The following list summarizes the pertinent findings of the empirical study.

(1) Per capita expenditure shows a positive and generally elastic response to median family income by county area. Per capita expenditure is defined as expenditure in dollars by government unit divided by population in the same government unit. Higher elasticities for individual city categories indicates that increased median family income would result in higher per capita expenditure for city residents relative to county residents. This conclusion is for public expenditure only.

It does not measure the private expenditure response to median family income for individuals providing some of their own services. For example, a family could provide water and sewerage services for themselves. This expenditure is not measured in the equations.

(2) When urbanization is defined as the percent of population in county i that lives in municipal areas, the estimated equations reveal several important conclusions about urbanization: A) increased urbanization of the population may increase per capita expenditures for both city and county residents; B) per capita county highway expenditures increase with urbanization indicating that increased urbanization imposes costs on nonurban residents; C) city per capita expenditure for sanitation, sewerage, and perhaps for parks and recreation, highways and financial administration go up with increased urbanization; and D) aggregating data into a total expenditure category can hide these results.

(3) The area variable is defined as the percent of the total county area for county i that is legally contained in municipal areas. The results for the area variable with respect to spatial dimension suggest the following: A) per capita county expenditures, particularly those with a spatial dimension fall with decreased relative urban area; B) per capita city expenditure increase for fire protection and public buildings with increased relative urban area; C) some categories such as police protection which would be expected to have a spatial dimension apparently do not.

(4) The number of elected officials in county i, elected for k city and county governments reduces total per capita expenditures at the county level. The coefficients do have the expected positive sign for city per capita expenditures with significantly high F-values. The

number of elected officials is used as a proxy for the administrative costs of additional governments.

(5) A variable was constructed showing the sum of incorporated city distance for city j from the nearest city at least twice as large or at least 2,500 population for each town in county i divided by the number of cities, n, in county i. Selected county expenditure categories like highways and financial administration showed higher per capita expenditure as this distance variable for cities increases.

(6) A one percent increase in urbanization results in a greater than one percent increase in urban dollar expenditures for all major categories. The percentage increase is relatively lower for those categories of expenditure that are shared with the county. Thus, county expenditures are substituted for city expenditure to a small degree.

(7) Dollar expenditure shows a highly elastic response to median family income for both city and county governments. Furthermore, the elasticities are higher for luxury services like parks, recreation and libraries.

(8) As the distance between cities increases, county expenditures increase, but city dollar expenditures do not.

(9) The coefficients for the number of elected officials is positive for both city and county governments. The elasticities are generally higher for city than for county governments showing a relative shift to city government. This result is stronger when per capita expenditures are used.

(10) An increase in the percent of the county area urbanized implies an increase in dollar expenditures for both city and county governments. Elasticities are higher for city than county expenditure categories.

Urbanized areas are likely to have a fringe of nonurbanized population which requires the county to increase its allocation of services. People surrounding a city require more services from the county government than their more rural counterparts. This result does not show up when per capita expenditure data are used.

CHAPTER II

LOSCH AND THE PUBLIC SECTOR

Introduction

The purpose of this chapter is to show that economic efficiency criteria are best met in a federal system and that this system's division of functions between levels of government results in a Loschian hierarchy analogous to the one existing in the private sector. The central problem discussed here is the allocation of goods and services between central and sub-central governments. The first two sections of this chapter develop the Loschian system and several research methods on central place hierarchies are sampled. The final section discusses public hierarchies. Several studies on public hierarchies are reviewed and it is shown that a federal system develops along lines similar to those of a Loschian hierarchy.

The Loschian Theory

Introduction

Since it will be shown that the public sector develops along the same spatial hierarchy as a Loschian hierarchy in the private sector, it is necessary to review the Loschian hierarchy for the private sector.

Nourse's Presentation of Losch

The Loschian system begins with the assumption of a homogeneous plain with a uniform distribution of population, resources and income and with transportation costs equal in every direction.[1] Each commodity has a uniform network of markets or trading areas. Furthermore, each commodity or service with the same threshold size will locate in the centers of the same market area. It is assumed that only networks are possible and that they fit together so that each market area includes *s* areas of the next smaller size. If *s* equals three, three of the smallest trading areas will fit into the next largest market. Each central place with the same number of market centers will have the same commodities and services. Although population has been assumed to be equally distributed, there are central places of different importance generated on the plain. The smallest central places will provide services to the same number of rural people *r*, and will have the same population. The population of each of these smallest places will be some proportion, *k*, of the rural and central place population served. The next larger place will include *s* number of the smallest places and its population will be the same proportion *k* of the population served. The population served includes the *s* smaller central places and the *r* rural populations served by each plus the population of this higher central place. The smallest are first-order places. The next largest will be second-order places and so on.

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[1]Hugh O. Nourse, Regional Economics (New York: McGraw-Hill Book Co., 1968), pp. 32-62.

Beckmann

The relationship between trading areas and systems of cities has been formalized by Beckmann.[2] If

m = order of a place

P_m = population served by a place of the mth order

C_m = population of places of the mth order

k = proportion of population served located in central place

s = number of places in the m-1 order served by places in the mth order

r = rural population served by 1st order place

then (1) $C_m = kP_m$

(2) $P_m = C_m + sP_{m-1}$

therefore

(3) $P_m = kP_m + sP_{m-1}$

and solving for P_m so $P_m - kP_m = sP_{m-1}$, then

(4) $P_m = (s/1-k)P_{m-1}$ and solved

(5) $P_m = P_1(s/1-k)$.

Also

(6) $P_m = rs^{m-1}/(1-k)^m$ because we know

(7) $P_1 = r + C_1$ and

(8) $C_1 = k(P_1) = k(r + C_1) = kr/1-k$ and

(9) $P_1 = r + kr/1-k = r/1-k$, which can be substituted into (5) to get (6). Further substitution of (6) into (1) gives

(10) $C_m = ks^{m-1}r/(1-k)^m$.

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[2] M. J. Beckmann, "City Hierarchies and the Distribution of City Size," Economic Development and Cultural Change, VI (April, 1958), pp. 243-248.

There are six factors governing the proportions in the hierarchy. They are; r, k, s, P, N, and T. The first three factors are as noted above. The fourth, total population (P), is derived when m reaches its largest value, which is the fifth factor, N. Therefore (6) becomes

(11) $P = P_n = s^{N-1}r/(1-k)^N$.

This can be rearranged by dividing out to get

(12) $r = (1-k)^N P/s^{N-1}$ and

(13) $N = \log(Ps/r)/\log(s/1-k)$.

The sixth factor is the total number of cities (T). It is derieved by forming a series from s and N:

(14) $T = 1 + s + s^2 + . . . + s^N = s^{N+1} - 1/s-1$.

Thus, a general system with six variables results. If four are known or given the other two can be calculated. Suppose k = 1/2, s = 3, r = 1,000, and N = 6 are known, then T and P can be found. It can be shown that the system in Table I is determined.

TABLE I

A LOSCHIAN SYSTEM

Order	Population of Centers	Population served by each Center	Rank
1	1,000	2,000	243
2	6,000	12,000	81
3	36,000	72,000	27
4	216,000	432,000	9
5	1,296,000	2,592,000	3
6	7,776,000	15,552,000	1

Source: H. O. Nourse, Regional Economics (New York: McGraw Hill Book Co., 1971), p. 41.

This system can explain location, geographic size and the spacing of economic activity. It also can explain the range of goods and services offered to consumers in towns of different size. Lower-order cities supply a smaller range of goods and services to a smaller area. Higher-order centers are more complex, offering a greater range of goods, services and retail activities.

Emperical Studies of Loschian Systems

Introduction

Several methods used in empirical research on central place hierarchies will be surveyed in this section. No attempt is made to cover the entire literature on the subject, since a complete listing is available in a periodically updated bibliography of central place studies.[3] The purpose here is to present a few studies using different empirical methods which provide an appreciation of the Loschian hierarchy essential in understanding the public hierarchy to be developed later in this chapter and Chapter III.

Rank-size Rule

According to the Beckmann formulation presented above, the rank of a city increases by multiples of s as city size increases by multiples of s/1-k. Thus, if k is close to zero the rank multiplied by the city size approaches a constant. More formally, Beckmann shows that the city

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[3]Brian J. L. Berry and Allen Pred, Central Place Studies, A Bibliography of Theory and Applications, Bibliography Series No. 1 with supplement (Philadelphia: Regional Science Research Institute, 1965), pp. 1-68.

halfway in the nth size class is $1 + s + \ldots + s^{n-1} = s^n - 1/s-1 + n^2/2$ which is approximately given as $s^n(1/2 + 1/s-1)$. Therefore size is;

$$(15)\ P_{N-n} = kr/s/(1-k)^{N-n}.$$

The product of rank and size is;

$$(16)\ kr/s(1/2 + 1/s-1)(s/1-k)^N(1-k)^n = C(1-k)^n.$$

Thus C depends on k, r, s, and N. As k approaches zero, then $(1-k)^n$ approximates the product of the rank and size.

Now the general equation for the rank size rule is:

$$(17)\ rs^a = C$$

where

r = city rank

s = population of city

a = a constant

C = a constant approximately equal to the population of the largest place.[4]

Logarithms of both sides of the equation can be taken, allowing estimation by ordinary least-squares procedures. If the rank size rule holds, _a_ should be approximately equal to one. A value of _a_ that is approximately equal to one would indicate a hierarchial system of cities, assuming no statistical problems. However, a value that deviates from one is not sufficient evidence to conclude against the validity of the hierarchy since the rule is contingent on _k_ being close to zero. It is quite possible to have _k_ equal to 1/2 and still have a perfect system of central places. Indeed, the earlier example of Nourse is such a case. Thus, the rank-size method of verification of the hierarchy is limited.

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[4]M. J. Beckmann, "City Hierarchies and the Distribution of City Size," Economic Development and Cultural Change, VI (April, 1958), pp. 243-248.

Distance Measurement Studies

Losch focused his empirical efforts on Iowa.[5] He concluded that central places did in fact correspond to a case of the general framework. Losch set s = 4 by grouping equal sized cities into classes. His theoretical distribution of cities was based on actual distances between settlements in the lowest size class. Trading places the same distance apart would have the same number and type of trading activities. The distance apart is based on the formula:

$$(17) \quad b = a\,(n)^{\frac{1}{2}}$$

where,

b = distance between central places of the same size

a = distance between smallest settlements

n = number of smallest settlements served by the central place.

With the exception that no sixth order or first ranking city exists, prediction and reality were close for distance, population and numbers of cities in Iowa.

A recent attempt has been made by Flood and Schreiner to apply a similar method to Oklahoma to determine if a clear differentiation of towns based upon the range of goods and services provided existed and, if the differentiation existed, the effect of distance from larger towns in the region on the differentiation.[6] A multi-county planning region was selected for study. A table was constructed where towns less than

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[5]August Losch, The Economics of Location, (New Haven, Conn.: Yale Univ. Press, 1954), pp. 105-120.

[6]J. Flood and Dean Schreiner, "Availability of Retail and Business Services to Rural Populations: Application to South Central Oklahoma," Research Application in Economic Development and Planning, Research Report P-665 (July, 1972), pp. 164-176.

5,000 population were ranked by number of establishments from highest to lowest in a horizontal direction. In a vertical direction the 35 types of establishments were ranked from the lowest to the highest threshold level.[7] The hierarchial system depicted in Table II resulted, where an X means that such service exists and A has more services than B and B more than C. Thus the smallest centers supplied only limited types of goods while larger centers supply a wider variety of services. For example, gas stations begin to appear in towns of very low population, while jewelry stores do not appear until the towns are much larger.

TABLE II

RANGE OF GOODS AND SERVICES

Towns Estab.	A_1	A_2	B_1	B_2	C_1	C_2
Gas Station	X	X	X	X	X	X
Grocery	X	X	X	X	X	X
Drug Store	X	X	X			
Farm Equip.	X	X	X			
Household Appliances	X					
Jewelry	X					

Source: K. Flood and Dean Schreiner, "Availability of Retail and Business Services to Rural Populations: Application to South Central Oklahoma," Research Application in Economic Development and Planning, Research Report P-665 (July 1972), p. 169.

[7] Ibid., p. 169.

This analysis was applied to 47 centers classified as before. Generally, they found three classes of activities. Class one activities were found in all sizes of centers and included, gas stations, grocery stores, beauty salons and churches. Class two activities were found in A and B centers and included, drug stores, auto repair shops, laundromats, farm equipment, auto parts, auto dealers and physicians. Class three activities were found only in the largest centers and included nursing homes, clothing stores, legal services, novelty stores and jewelry stores. They chose as the threshold level of an activity the lowest population after the first appearance of the activity such that in any sequence of four towns at least two establishments were found. The results, summarized in Table III, indicate a Loschian relationship, although there are several exceptions. For example, if there is a class B town located on a major highway or a major recreation spot, hotels and motels may appear. Also, there may be some overlapping of population ranges by classes of town. The authors note this may be due to an uneven distribution of resources. Centers in sparsely populated areas may offer a greater array of services for a given population base than do centers in more densely populated regions. In general, however, a Loschian hierarchy seemed to exist in southern Oklahoma.

Studies Using Time and Population

A further hypothesis of Flood and Schreiner relates population and distance factors. Generally the larger cities were expected to be farther from urban centers relative to the smaller B and C order centers. B centers might be located somewhat nearer the urban centers. C centers may be grouped around A centers or B centers that are around A centers

TABLE III

CLASSIFICATION OF ACTIVITIES BY THRESHOLD POPULATION AND TOWN CLASS

Activities	Threshold Population	Range of Number of Establish-ments by Town Class	Range of Population by Town Class	Number of Centers
Class 1 Activities: Class C Towns		1-24	121-1,271	23
Gas Service Station	121			
Grocery Stores	123			
Churches	129			
Agric. Services & Supplies	129			
Beauty Salons	165			
Eating Places	165			
Class 2 Activities: Class B Towns		30-73	611-1,640	19
Bottled Gas	228			
Drug Stores	228			
Auto Repair	424			
Lumber Yard	434			
Insurance Agency	439			
Repair Services	439			
Laundry & Laundromats	492			
Drinking Places	587			
Package Liquor	611			
Variety, Dept., Ben. Merch.	611			
Florists	611			
Hardware & Paint	611			
Farm Equipment	618			
Furniture & Appliances	636			
Auto Parts	706			
Auto & Boat Dealers	706			
Physician's Office	706			
Hotels & Motels	722			
Class 3 Activities: Class A Towns		80-113	1,723-3,995	5
Nursing Homes	840			
Real Estate Agency	840			
Clothing Stores	950			
Sporting Goods	1,271			
Specialty Retail	1,354			
Legal Services	1,524			
Dentist Office	1,524			
Specialized Health	1,640			
Gift & Novelty	1,640			
Jewelry Store	1,862			
Accounting Services	2,611			

Source: J. Flood and Dean Schreiner, "Availability of Retail and Business Services to Rural Populations: Application to South Central Oklahoma," Research Application in Economic Development and Planning, Research Report P-665 (July 1972), pp. 164-176.

and so on. To test such a hypothesis the average distances between centers was computed. It was determined class A towns averaged 19 miles from the nearest urban center. Class B towns grouped around urban centers averaged 19 miles from the larger center, whereas those grouped around class A towns averaged 26 miles from the center. C centers grouped around urban centers averaged 12 miles from the larger center versus 36 miles for those class C towns grouped around a B center which were grouped around an A center. Class C towns grouped around class B and class A towns which were directly grouped around the urban center averaged 19 and 26 miles respectively and had the expected relative proportions. Thus, the general conclusion is that proximity to larger urban centers imposes constraints on the potential service functions of a small trade center. This influence existed for almost 20 miles. Further, it was determined that class C centers are of two types. First, population in class C centers around metropolitan areas may increase rapidly with little or no effect on the number of services provided. Second, class C centers farther from metropolitan areas may lose population without losing their functions.

A basic problem with all of the empirical efforts presented so far is that none are addressed to the changes that occur over time. Hodge studied the spatial changes in the great plains over a twenty year period and found dramatic changes.[8] Hodge's analysis is divided into two sections. One is deductive the other is inductive. The deductive analysis concerns the validity of a number of hypothesis on trade center

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[8]G. Hodge, "The Prediction of Trade Center Viability in the Great Plains," Regional Science Association Papers, XV (1965), pp. 87-115.

change. For example, he suggested that trade centers ranking low in the retail service hierarchy at the beginning would lose rank more rapidly than higher ranking centers. His general empirical method is to classify centers into a system of seven types of trade centers. Then the number of each type of center is matched with the median population, average number of establishments and an index of sales volume. Next, he examined changes in the system at intervals over the period 1941-61. His findings indicate that low-ranking centers lost rank more rapidly than higher ranking centers. Also, smaller trade centers were farther apart in 1961 than 1941. The opposite was true for larger centers. The empirical method was simply to measure distance apart for the seven classes of centers. Finally, the adjacent center may compete enough to result in the decline of one or both. Of the 190 pairs of similar trade centers spaced less than the mean apart for their class, 79 percent experienced relative decline.[9]

The problem with this method is that it cannot predict which centers will grow and which will not. Nor is it able to predict which traits, except size and location, are more conducive to the growth or decline of centers. Hodge utilized principal-axis factor analysis of 35 community environment variables for 473 trade centers in Saskatchewan to provide an approach to answer such questions.[10] The community environment variables include such things as: population, measures of density and age stratifications, local manufacturing, services and education. Using the technique of principal axis factor analysis, the 35 community

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[9] Ibid., p. 100.

[10] Ibid., p. 103.

environment factors were condensed mathematically into three factors. The first he denoted as urban size. This is due to high positive loadings on population and investment in utilities, retail services and manufacturing employment. The factor loading is a measure of the degree of closeness between the variables and the factor. Each factor is made up of a linear combination of all variables in which the factor loadings are analogous to regression coefficients in a multiple regression equation. The second and third variables he named were farm size and urban density, respectively. Each of the three factors was regressed against an index of change in number of retail and service establishments in the center from 1941-61. Using least-squares, only the urban density scale was significant. This scale was dominated by gross population density at the center and assessed valuation of private physical investment per acre. In addition to population size and location, therefore, urban density was conducive to changes in the hierarchy.

Thus, two methods have been applied to better understand the causes of trade center change. Such changes in the private sector may result in readjustment in the public sphere to be discussed in the next section.

Summary

This section and the preceding section have reviewed the content of the Loschian hierarchy and sampled some of the more widely used empirical techniques for testing it. The Loschian system was defined in difference equation form. An example, where $k = 1/2$, $s = 3$, $r = 100$ and $N = 6$, was taken from Nourse. Three empirical methods were presented: the rank-size rule, distance measurement and time and population studies.

In general, a central place hierarchy is evident in the private sector of a market economy. The neatness of the hypothetical framework proposed by Losch and others is obscured by the failure of the strict assumptions of geographical uniformity to be realized in any country. For the purposes of this study four observations are pertinent. First, the existence of a hierarchy in the private sector, however obscured, indicates that an efficient organization of public output might result in a similar hierarchy because public output is likely to be needed where private activity is greatest. Second, in addition to the geographical irregularities, political considerations will result in additional irregularities in the public hierarchy. Consequently, a test for deviations from a perfect hierarchy in the public sector is unnecessary. Third, the strong indications of a private hierarchy in the midwestern United States, for instance, Iowa and Oklahoma, suggest that a midwestern state such as Oklahoma would be a good state in which to conduct a case study of a public hierarchy. Fourth, and finally, the most useful studies of the private hierarchy examine its determinants over time and space. Thus, the empirical study of the public hierarchy conducted in Chapter IV takes a similar approach.

Federalism and Efficiency

Introduction

This section reviews and critically discusses previous work on public hierarchies. The purpose is to develop the argument that the allocation of the functions among governments in a federal system forms a public hierarchy. Furthermore, this section develops the cost variables used in Chapter III to analyze the behavior of the median voter.

Allocation is the only question discussed. Stabilization and distribution are assumed to be functions of the central government. Full employment, stable prices and a proper distribution of income are also assumed.

Breton

Breton's analysis assumes a static order of public goods that can be ranked from large to small on the basis of space.[11] This means there would be clusters of national goods, regional goods, provincial goods and so on. Further he assumes that government functions are economic in nature, that only allocation takes place and that preferences are revealed. Each individual has a utility function with positive marginal utilities for each good. In addition a transformation function exists that defines the real resource cost of producing one type of good expressed in terms of the amount foregone of the other goods. Maximizing this function subject to the constraint yields a set of equilibrium conditions giving the amount produced and consumed and its costs in terms of a numeraire. From this operation Breton analyzes two possible outcomes: a perfect mapping and an imperfect mapping.[12] The perfect mapping is defined as one in which all the benefits of local goods are exhausted within the boundaries of the local jurisdiction; benefits of the provincial goods within the provincial goods jurisdiction and so on. If these goods are paid for by benefit taxes and if the prices of private goods are set by a mechanism which correctly reflects the preferences of

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[11] Albert Breton, "A Theory of Government Grants," Canadian Journal of Economics and Political Science, XXXI (May 1965), pp. 173-187.

[12] Ibid., p. 180.

members of society, then a constitution which has as many governments as it has different public goods gives an allocation of resources that is Pareto optimal.

Although Breton makes the point later in his discussion, it should be noted that benefits-received taxation does not bring about Pareto optimality unless it is assumed there are equal preference functions, a unanimity voting rule or compensation payments. Assuming any or all of these, Pareto optimality results from his analysis.

An imperfect mapping results when benefits cannot be clearly defined and spillovers exist. Breton shows, however, that with an imperfect mapping efficiency can be achieved by using conditional grants.

Breton's analysis results in a hierarchial system of government. In the perfect mapping he describes, first-order governments of the Loschian hierarchy would produce a subset of all public expenditures defined as local goods. Second-order governments will not only be responsible for first-order functions but also contain a second-order government responsible for second-order functions. If first-order governments were cities and second-order governments were counties, then second-order cities would be county seats responsible for administration of its own county expenditure and a city government responsible for its city public expenditure. Analogously, third-order cities would be state capitals which were also county seats as well as cities. These third-order cities would contain the administrative apparatus for public expenditures in three governments, city, county and state, with each government extending over a wider area. Given the assumption of a homogeneous plain with equal population distribution, income and demand, each citizen would be a member of <u>the</u> nth or highest order government and a member of one of each of the lower order governments. All space would be filled by each order if all the lower order governments are counted. Thus, within this framework of the federal system cities exist in a hierarchy of responsibility. Higher-order cities contain higher-order governments which extend over a subset of lower-order governments. The highest-order city is the federal government which extends over the entire country.

Breton's hierarchy does not consider the administrative cost of adding more governments. The next three analyses attempt to include some of the additional costs of adding more governments.

Tullock

Tullock begins by indicating two factors traditionally considered in discussions on the size of governmental units.[13] The first is externality and the second is the optimal scale of production. Figure 1 shows these two relationships. Absolute geographic or physical size is placed on the horizontal axis and cost of chosing a governmental unit is on the vertical axis. Costs are total dollar costs for a given level of service. Size means the physical area of the governmental unit. Externalities (E) decrease asymptotically while operating costs (C) are U-shaped. Only two things vary: costs for a given level of service and physical size. Vertical summation yields TC, with OS indicating the optimal-size government unit for a particular public good. Tullock then shows that economies of scale are relevant only if the government unit must produce the service. If it is able to purchase it from a specialized

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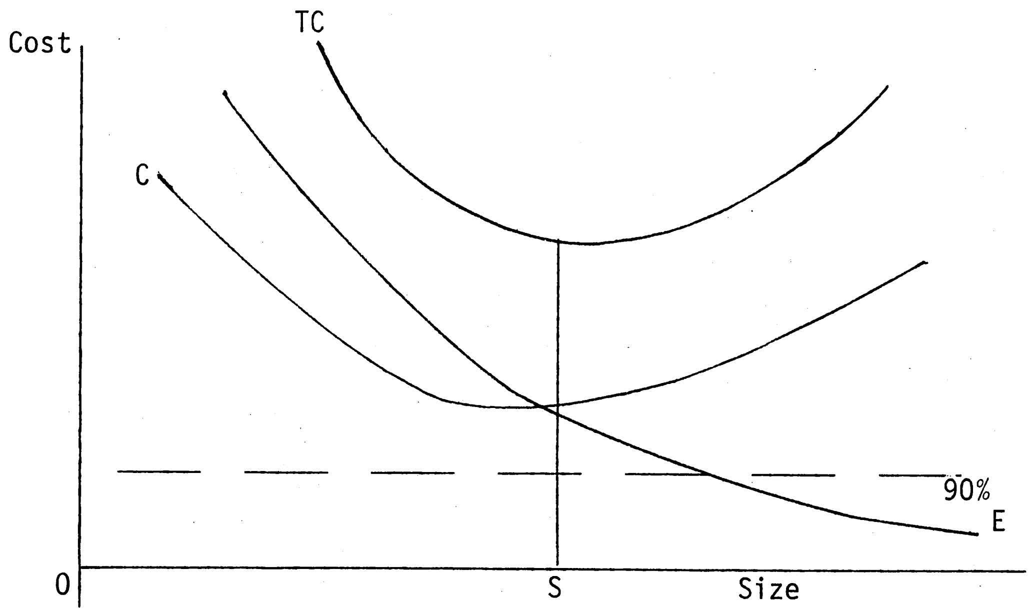
[13] Gordon Tullock, "Federalism: Problems of Scale," Public Choice, VI (Spring 1969), pp. 19-29.



Source: Gordon Tullock, "Federalism: Problems of Scale," Public Choice, VI (Spring 1969), pp. 19-29.

Figure 1. Cost in Relation to Size

producer, then economies of scale are not a relevant variable in determining the size of the government unit. Only externalities are left for consideration. Here, he argues that all externalities cannot be entirely internalized because total internalization would normally require boundaries which run along some very impressive natural barrier. Such a minor matter as street cleaning might require a national governmental unit to totally internalize its effects.[14] Therefore, he chooses 90 percent, an arbitrary number, as the amount of internalization which would determine the optimal size government.

At this point, Tullock introduces three political costs into the analysis. The first is the cost of activities to an individual of which he disapproves. These costs increase as the size of the group increases. As the voting population is broken into smaller units, the average level of adjustment of government to the preferences of its citizens increases.

The second is the cost of satisfaction lost as the unit of choice is raised. The unit of choice is the number and size of the goods and services offered. Using Tullock's example, suppose all restaurants present menus in an a-la-carte fashion so individual choice is allowed.[15] Then, suppose that only fixed meals are presented. If all possible combinations of the previous a-la-carte menu were presented, a book instead of a page or two would be required for the fixed meal menu. Therefore, only a dozen or so fixed menus are presented. Freedom of choice exists, but the choice is restricted. Obviously, it is harder to provide as wide a range of choice if the unit of choice is large.

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[14] _Ibid_., p. 19.

[15] _Ibid_., p. 23.

The third cost is due to increased bureaucracy. The smaller the size of governmental units, the more governments there are and therefore the higher the costs of increased bureaucracy. Figure 2 combines all costs into one graph to determine the optimal size government. Cost for a given service level is measured on the vertical axis. The horizontal axis measures the degree of dispersion of government activities. Movement to the right means the government is halved and then halved again and so on. S represents the first of the costs presented above, i.e. the loss of satisfaction to those voters who did not win. T represents both the second and third costs mentioned above. Costs fall as combinations are increased and then rise as costs of bureaucracy take over. S + T is the vertical summation. The minimum point is the optimum degree of differentiation for governments. Tullock states:

> We have now what appears to be a theoretical structure for deciding the degree to which the government should be federalized. A society actually applying our solution would require a good deal of empirical research which has not yet been done. If I may be permitted to offer a guess, I would imagine that it would end up with each individual being a member of somewhere between five and eight separate governmental units.[16]

Tullock has created a federal hierarchy. Movement to the right on Figure 2 increases the degree of federalism. Suppose the minimum point on S + T in Figure 2 is 1/8. Then, the four levels of the hierarchy are: one federal government, two state governments, four county governments and eight city governments. These governments provide public output in a hierarchy of jurisdictions. In a private good hierarchy a minimum threshold consumption level is necessary for demand to call forth local production. As demand increases, the central

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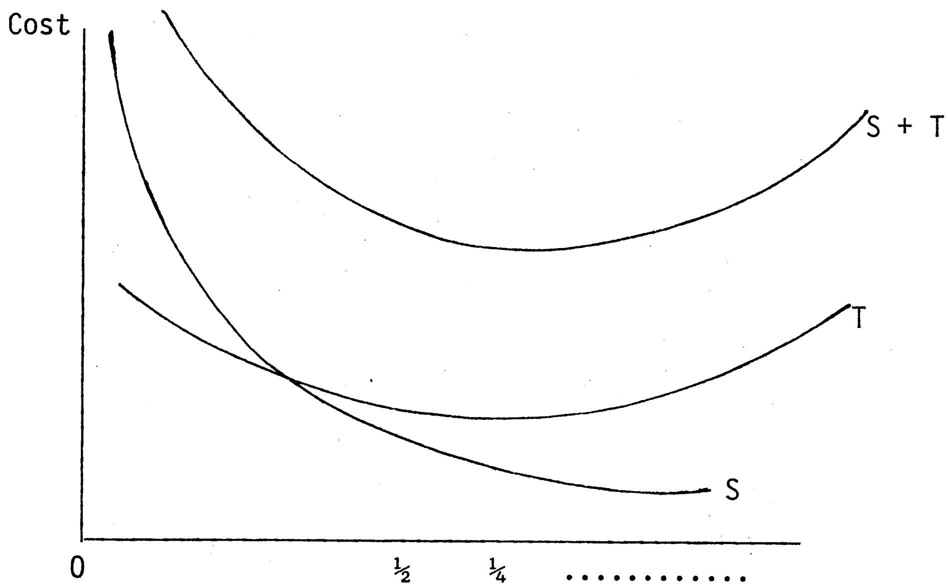
[16] Ibid., p. 28.



Source: Adopted from Gordon Tullock, "Federalism: Problems of Scale," VI (Spring 1969), p. 27.

Figure 2. Cost Related to the Degree of Dispersion

places in the hierarchy are ranked according to their relative importance within the region. The lower-order centers supply only those goods which require frequent purchase. Higher-order centers are more complex and offer a greater range of goods over a larger area than lower order cities. An efficient system of public allocation might result in a public hierarchy through the same type of process. A federal government operates over the entire country. States subdivide the country into 50 parts. Counties subdivide the states and cities subdivide the counties. In the private sector, the hierarchy changes with changes in demand and changes in technology that alter cost factors. In the public sector, institutional factors prevent change in the size of the orders of government in the hierarchy. However, they do not prevent adjustments in expenditure patterns within this institutionally constant-sized hierarchy. These adjustments are analyzed in Chapter IV.

Oates

Oates reviews the Breton analysis and concludes;

> In particular, if we no longer have a pure public good whose consumption is rigidly defined over precise geographical subsets of the population, the selection of the proper level of government to provide the good involves weighing the potential welfare gains from a greater decentralization of decision making against the possible gains from increased centralization.[17]

He goes on to determine the optimal-sized jurisdiction by fixing population and reducing decision costs to zero. He uses an impure public good whose consumption is not confined to any precise subset of geographical units. Figure 3 is from Oates and shows the cost in dollars on

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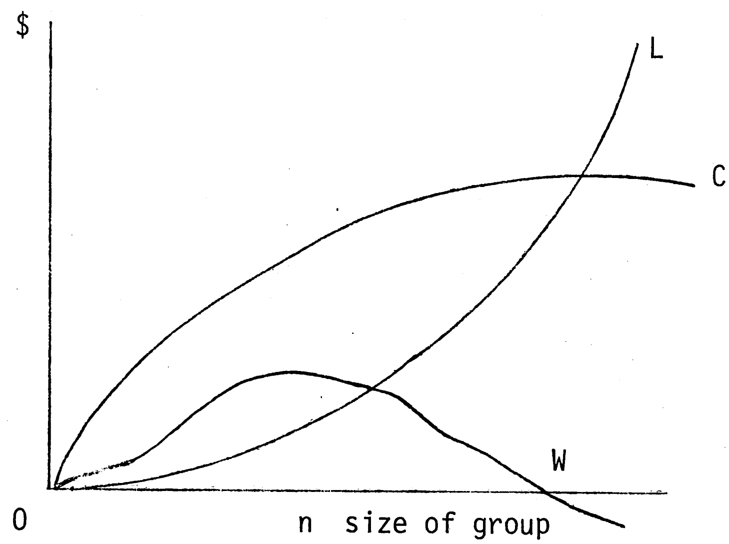
[17] Wallace Oates, Fiscal Federalism, (New York: Harcourt, Brace, Jovanovich, Inc. 1972), p. 108.



Source: Wallace Oates, Fiscal Federalism, (New York: Harcourt, Brace, Jovanovich, Inc. 1972), p. 39.

Figure 3. Optimum Group Size

the vertical axis and size of group on the horizontal axis.[18] OC is the aggregate cost savings from increasing the number of persons consuming the good jointly. It increases at a decreasing rate because more people are sharing the same cost for the output as the group gets larger. The cost of this joint consumption is OL. It is a loss in consumer surplus to each individual consumer due to consuming a fixed level of a public good. This loss can be shown very easily using the Edgworth box in Figure 4.[19] A and B are persons while x and y are private and public goods respectively. If y is constrained to be equal for both, then consumption must take place on yy'. $0_A 0_B$ is the contract curve for unrestrained consumption. Fix B on indifference curve B_1, then A would go to A_2 and tangency is at D. However y is a public good so y is consumed jointly. Now, if B is constrained to B_1, A will be on A_1 which is below indifference curve A_2. Thus, the welfare loss to consuming in large groups is the difference between A being on indifference curves A_1 and A_2. Under plausible assumptions as the group gets larger the loss gets larger as shown by OL in Figure 3. Subtracting OL from OC in Figure 3 gives OW. The maximum point on OW is n* which gives the optimal group size.

Spillovers can be added to the analysis by showing the gain from internalizing spillovers by enlarging group size. Adding this to OC enlarges the optimal group size and internalizes spillovers.

Decision costs are taken into account by a curve measuring loss and subtracting it from OC. This results in a smaller optimal group size.

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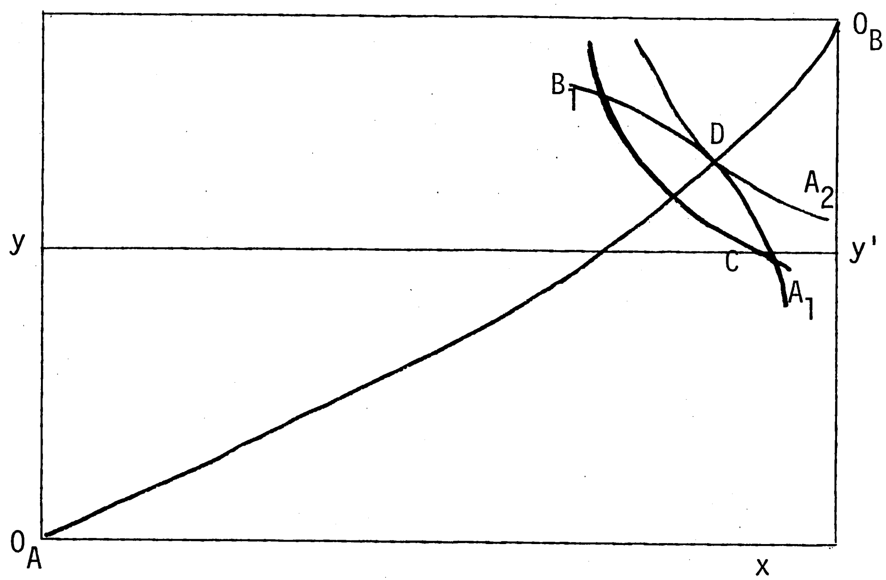
[18] Ibid., p. 108.

[19] Ibid., p. 54.



Source: Wallace Oates, <u>Fiscal Federalism</u>, (New York: Harcourt, Brace, Jovanovich, Inc., 1972), p. 57.

Figure 4. Edgeworth Box in a Public Economy

Oates' analysis is very similar to Tullock's. He cites Tullock frequently and generally considers the same political and governmental costs when determining the optimal group size. The difference is that Tullock uses a group of public goods and determines the optimal degree of federalism all at once, while Oates considers only one good at a time when developing the case for impure public goods. Both develop a hierarchy of government responsibility. One type of public output is assigned to one level of government, another type of public output is produced and allocated more efficiently over a different government jurisdiction. In both analyses each citizen is a member of each order of government in the same way that each consumer in the private hierarchy is a member of each order in the system of central places.

Tiebout

Tiebout provides a more comprehensive economic model of cost-minimization where economies of scale are more carefully considered.[20] He does not discuss political costs. However, he does introduce distance from the point of allocation of public output.

He assumes a 100 square mile city where population, and demand for police protection are uniform. Police protection is a pure public good within the precinct patrolled. In this way total output is $X_p = x_1 = x_2 = \ldots x_n$, where n is the number of consumers. A unit of protection is an index number indicating some relative amount of protection like the number of times a police car passes each house.

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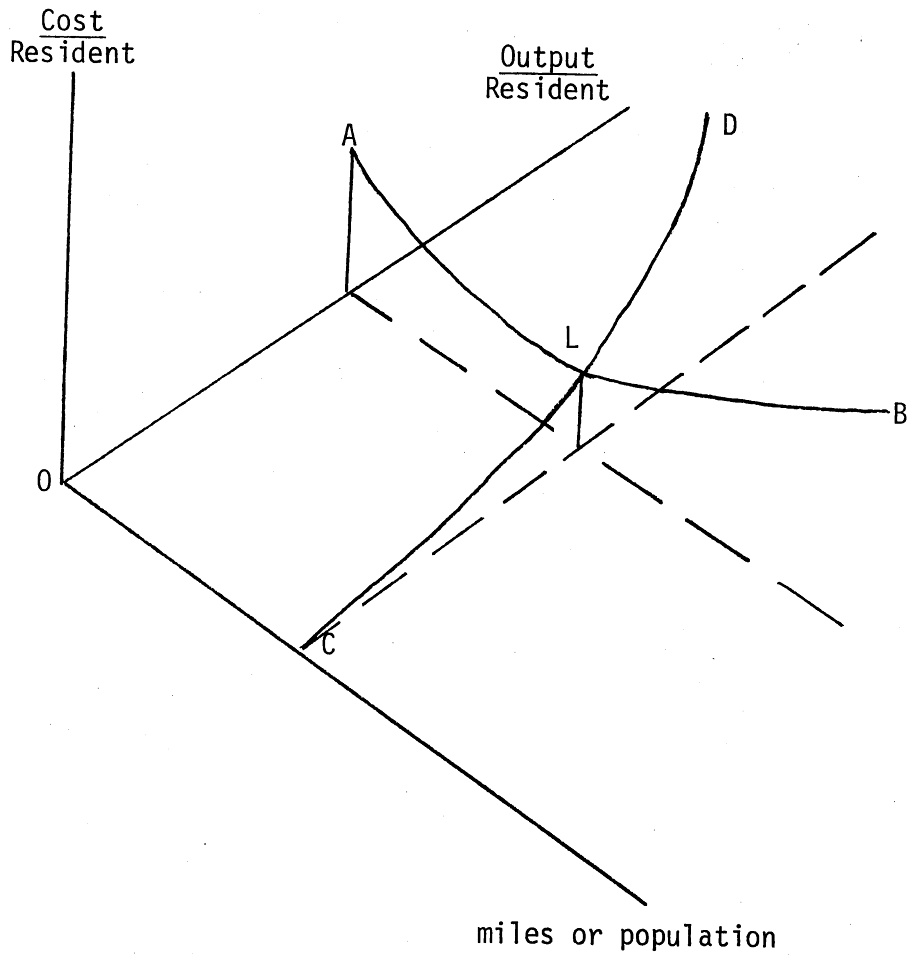
[20]Charles M. Tiebout, "An Economic Theory of Fiscal Decentralization," Public Finances: Needs, Sources and Utilization, Ed. National Bureau of Economic Research (Princeton: Princeton University Press, 1961), pp. 78-96.

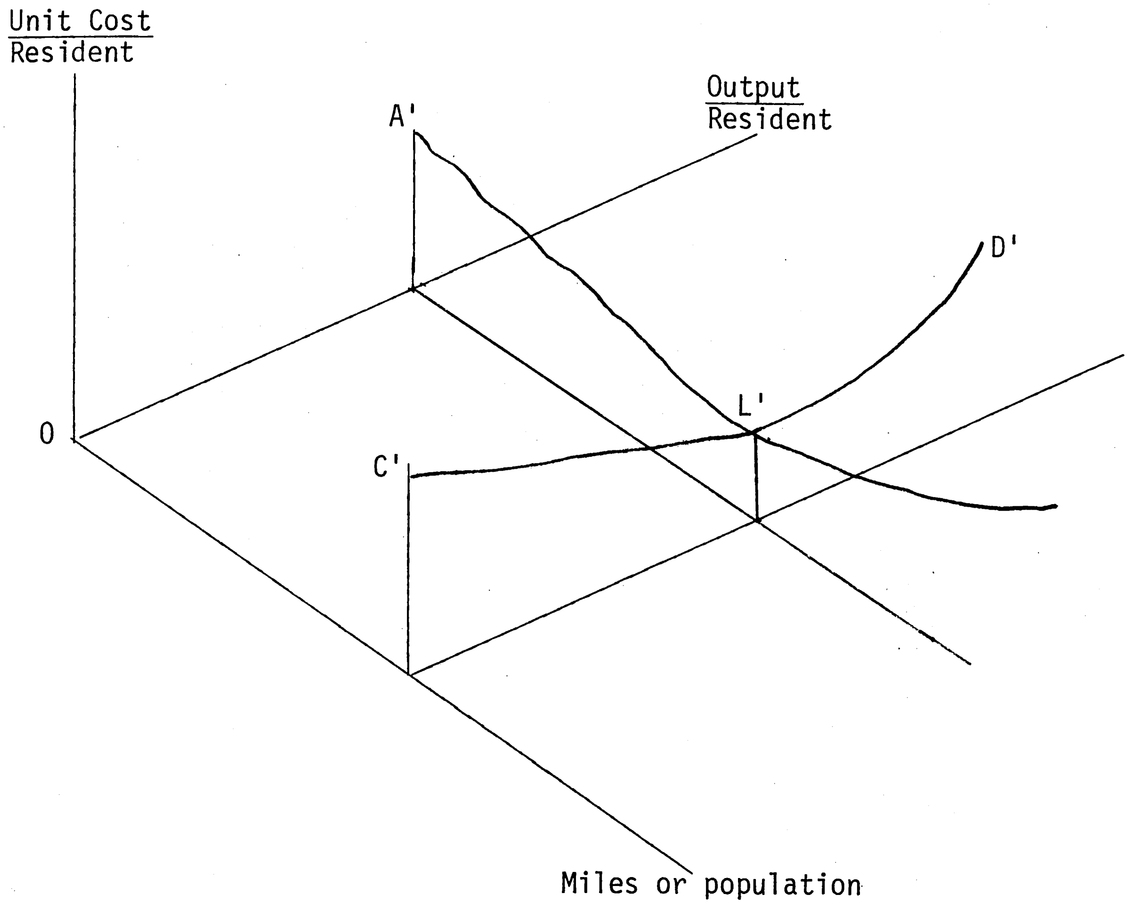
Given these assumptions the problem is to divide space into the optimum number of districts. The optimum will be the one where costs are minimum. Total costs are assumed to increase for two reasons; (1) given spatial size, total costs will rise with the level of protection and (2) total cost increases, given the level of output, as spatial size increases. Figure 5 shows the variables which affect cost per resident. Cost per resident is on the Z axis, output per resident on the y axis and miles or population on the x axis. The x axis is interpreted to mean that population increases in some proportion k as distance increases. Since police protection is assumed to be a pure public good, benefits are independent of population size. Area, of course, increases as distance increases. As output increases, given miles and population, cost per resident increases along CLD. Holding output per resident constant and increasing distance means cost per resident decreases and then increases along ALB. Changing the x axis to unit costs per resident results in a solution analogous to that presented in Figure 6. Since demand is the same, economies of scale determine the radius of the circle which is to be the size of each individual precinct and the level of output necessary for cost-minimization.

The analysis is altered slightly if the benefits of a service such as fire protection, air raid sirens or hospitals diminish as a function of distance from the site of production. Assume that fire protection is a pure public good whose benefits diminish as distance increases. No additional costs are incurred by including additional area. The only difference is that benefits fall for those living farther away from fire protection. Thus, benefit taxation requires a tax in proportion to the share of total benefits. These taxes are allocated in two possible ways



Source: Charles M. Tiebout, "An Economic Theory of Fiscal Decentralization," Public Finances: Needs, Sources and Utilization, Ed. National Bureau of Economic Research (Princeton: Princeton University Press, 1961), p. 80.

Figure 5. Residential Services Cost Surface



Source: Charles M. Tiebout, "An Economic Theory of Fiscal Decentralization," Public Finances: Needs, Sources and Utilization, Ed. National Bureau of Economic Research (Princeton: Princeton University Press, 1961), p. 81.

Figure 6. Residential Services Unit Cost Surface

which result in individual taxes which are unequal. The first makes the individual's tax payment proportional to his utility. The second makes each individual's utility equal. Each person's tax is his total benefits minus the average utility.

As Tiebout himself suggests, this analysis results in a hierarchy like that of the Loschian hierarchy in the private sector. With technology given and uniform demand, <u>each</u> public good will establish as many branch agencies as economies of scale indicate. Assuming uniform demand allows Tiebout to concentrate on determining the optimal sized jurisdiction by finding the minimum point on a cost surface where area and population are variable as well as quantity. Later in Chapter IV it will be argued that demand does not change in any systematic way from one jurisdictional configuration to another and that empirical efforts should concentrate on factors affecting cost.

Borukhov

This last review seeks to define an optimal service area with variable factor substitution and density.[21] Efficiency for a mobile population requires that density should be increased until the disutility from increased density equals the savings in costs. Borukhov assumes that cities are agglomerations of people around one public good provided by the city. The good is produced at constant cost. Benefits of the good decline with distance and therefore individuals prefer to live closer to the center up to the point where congestion costs become as

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[21] Eli Borukhov, "Optimal Service Areas for Provision and Finance of Local Public Goods," Public Finance, XXVII (Spring 1972), pp. 267-282.

large as benefits from nearby consumption. The problem is to find the intensity of land use. Then, it becomes possible to find the city population size N that maximizes the per capita surplus of benefits over costs.

Assume a Cobb-Douglas production function:

(1) $H = AL^{\alpha} K^{\beta} \quad \alpha + \beta = 1$

where: H = the quantity of housing produced

L = the quantity of land

K = the aggregate quantity of other factors of production.

Benefits fall linearly as:

(2) $B = a - bu$, where u is distance from the center.

Equilibrium requires marginal costs to equal marginal benefits so that:

(3) $P' (u) = -b$.

Then:

(4) $H = H(u)$

is the number of households at every ring of distance from the center.

Total people in the city is:

(5) $N = \int_{0}^{\bar{u}} H(u)\, du$.

Total value of the benefits is:

(6) $B^* = \int_{0}^{\bar{u}} H(u)(a - bu)\, du$.

The surplus of benefits over costs is B* minus constant costs (C) and the costs of capital used in constructing houses. If the price of capital is constant and equal to w and the marginal product of capital is K'(u) then total cost will be:

(7) $wK^* = \int_{0}^{\bar{u}} wK'(u)\, du$, where k* is total product of capital

so that

(8) $S = B^* - w^{K^*} - C$

is equal to the surplus, S.

Average surplus is S/N and finding its partial derivative with respect to N is $\partial(S/N)/\partial N$. Setting it equal to zero and solving for N gives the optimal population size. Further substitution gives $\bar{u}^*$ which is the radius of the optimal city. Now the increase in area is no longer assumed proportional to population increase as in the Tiebout model. An increase in marginal costs of distance now effects both density and area as it cannot do in the Tiebout model since density is constant.

Summary

The purpose of this chapter was to present an argument showing that a federal system develops along the lines of a Loschian hierarchy. Losch was reviewed and explained in section one. The type of hierarchy developed and the approach to testing it reviewed in section II both provide clues to an approach which can be taken in a theoretical and empirical analysis of a public sector hierarchy. Section II reviewed the main theoretical work on public sector hierarchies. All of the theories suggested thus far result in a hierarchial overlay of expenditure. Recall for instance that Breton developed a utility function where spill-over benefits were spatially distributed and determined the size and number of orders of government. Oates and Tullock considered political and decision costs. Tiebout manufactured a perfect hierarchy considering two aspects of cost minimization in space. Borukhov added population density to Tiebout's effort. The maximization models of Breton and Borukhov do not allow the development of an empirical specification designed to analyze all of the different types of costs introduced by Oates, Tiebout and Tullock.

This chapter has demonstrated that a simple model which analyzes the spatial aspects of state and local government expenditure should incorporate the following variables: population density, area, political costs and the distance between points of allocation and expenditure in the public hierarchy. Such a model is developed in the chapter which sets up the empirical work which will be undertaken in Chapter IV.

CHAPTER III

A MODEL OF FEDERALISM

Introduction

The purpose of this chapter is to develop a model of government allocation in a federal system. A utility maximization model is used as a first step in the development of a determinant federal system. In Chapter II it was argued this system results in an overlay of expenditure analogous to the Loschian hierarchy in the private sector. In Chapter IV the model will be applied to an empirical analysis of Oklahoma.

A Model

One Public Good

Start with a country that has A square miles of area and Y thousands of people. This means A/Y square miles per person. Since this is a new country it begins with no public goods or government administrative apparatus except a central government that has a constitution and a body of laws. Assume that stabilization and distribution are dealt with by this central government and that the economy is stabilized and distribution is considered "socially" acceptable. Allocation over the A square miles of this country begins one public good at a time with simple majority voting and single peaked preferences.

Suppose allocations begin in this hypothetical country with units of police protection (y) and a private good (x). Equation (1) represents the utility function for the median voter:

(1) $u = f(x,y)$

where u is utility with $\partial u/\partial x > 0$, and $\partial u/\partial y > 0$.[1]

In this model however, police protection is measured in efficiency units. Thus y equals the amount of police protection per policeman (m) times the number of policemen (M). Therefore:

(2) $y = mM$

The efficiency units per policeman, m, depends on: (U_p) the population density of the people being protected, (A) the area over which protection is provided, (D) the distance between points of allocation and, (G) governments per person that exist for allocating goods through the public sector. These factors influence the amount of police protection available because they all affect the ability of a police force to do its job. Therefore the quantity m is represented by the equation (3) below:

(3) $m = m(U_p,A,D,G)$

where $\partial m/\partial U_p < 0$, $\partial m/\partial A < 0$, $\partial m/\partial D < 0$, $\partial m/\partial G < 0$.

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[1]The median voter is used because in a political system where majority rules, the median or fifty-first percentile voter is assumed to decide the outcome of an election. Suppose there is a continuum of individual preferences for a particular public service. Some voters might prefer zero dollar expenditures on a particular public service while others might prefer a little and others a great deal. For those who want a large dollar expenditure on a public service to win support they must compromise their wishes to gain a majority. Those who want little or no public expenditure must agree to accept a little more expenditure in order to obtain a needed majority. The result is that the preferences of the median voter prevail in a simple majority voting system. Since this is the system used in the United States political system, the utility function of the median voter is used to represent allocation in the public hierarchy.

The derivatives for U_p, A, D and G are hypothesized to have negative signs, therefore as the four variables increase they cause a decline in the amount of police protection available. For example, the level of protection from a police department declines as the area over which it operates increases.[2] Therefore, the value of $\partial m/\partial A$ is less than zero. Likewise $\partial m/\partial U_p$ is less than zero because congestion lowers the effectiveness of a police force. More time might be devoted to traffic control as population density increases. Crime prevention is more difficult in densely populated areas. $\partial m/\partial D$ is less than zero also. As distance from the next level of government increases, output of police protection declines because spillover declines for the median voter.

The utility maximizing solution is found by maximizing equation (1):

(1) $u = f(x,y)$

subject to the transformation function which defines the cost to the median voter of a public good, here police protection, expressed in terms of the amount foregone of a private good. The Budget constraint is equation (4):

(4) $T_o y + Px - I = T_o m(U_p,A,D,G)M + Px - I = 0$

where I is income, P is the price of the private good and T_o is the part of the efficiency wage rate paid by the median voter. Suppose the Lagrangian function $Z = f(x,y) + \lambda(T_o m(U_p,A,D,G)M + Px - I)$ applies to the median voter in the entire country. Maximizing Z yields equations:

(5) $Z_M = u_y + \lambda T_o m = 0$

(6) $Z_x = u_x m + \lambda P = 0$

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[2]This assumes a constant level of technology and capital equipment. Without this assumption, the negative derivative might not hold.

(7) $Z_\lambda = T_o mM + Px - I = 0$

where $Z_m = \partial Z/\partial M$ and so on.

Solving these equations simultaneously yields the maximum critical values for M, x and λ. Second order conditions for a maximum require the successive bordered principal minors of the relevant bordered Hession determinant to alternate in sign. We will assume second order conditions are satisfied. The first order conditions give the preference maximizing values, when Z applies to the entire country. For example, the value of M would be the number of policemen which would maximize utility for the entire country. These equations yield a solution similar to that obtained from conventional analysis of the consumer. The ratio of marginal utilities to prices equals each other and λ. If this were not the case, the median voter could make himself better off by changing the allocation of public goods relative to private goods.

Recall that the hypothetical country has A square miles of area. So far Z has been maximized for the median voter for the entire country. Suppose the A square miles of area is divided into equal areas, using the Loschian s coefficient from Chapter II. The s value was three, so the first division is into three areas. This gives three utility functions for three median voters. The maximum critical values of M, x and λ are determined for each of the median voters in the three areas; then the average of the Z values for the median voters is determined. If this average figure is greater than for that of the entire country, then it would be best to have police protection divided into district governments for allocation of three quantities. The same process could be applied to 9 areas, 27 areas or 81 areas so that the efficient sized unit of government is determined. Thus the first order conditions apply to the Z function for different configurations of space. In general, no theoretical reason exists for benefits to change as different orders are tried. Yet by such drastic changes in the group voting size from order to order, it would be expected that a different output maximizes utility from one grouping to another.

The model could be expanded to include more public goods. The problem is slightly more complicated when additional goods are included in the model but the analysis is the same. Instead of maximizing one public good and one private good, maximum critical values for λ, a private good x and each of the public goods would be determined, given the values for U_p, A, D and G. Then it is possible to divide the country into Loschian areas of three governments, nine governments, 27 governments and so on. A Z function could be maximized for the median voter for each area given the new values for U_p, A, D and G. If the average of the Z values is greater than for nine governments than it is for one or three or 27 governments, then this would be the optimum level of federalism. The model not only determines the network of government allocation it also determines a finite number of levels of government. New governments are not created free of costs. There are decision costs because now each individual votes in another set of elections. Also there are administrative costs associated with setting up another government. Therefore, when costs of operating a new level of government are greater than the costs of forcing a public good into the existing government network, no new level of government is created.

The System as a Whole

The model developed operates at a high degree of abstraction. Indeed, it assumes utility comparison and maximization. As well, it is an extension of the theory of economic agents in space. By including area as a variable, the geographical size of governmental area is also determined. The system's division of functions between levels of government result in a public sector Loschian hierarchy analogous to the one existing in the private sector.

By itself, the existence of the hierarchial overlay is devoid of policy content. Therefore, the empirical issues addressed are the factors which affect expenditure distribution throughout the hierarchial overlay. For example, how will increase in median income affect expenditure in the hierarchy? The expectation is that there is a positive income effect so that expenditure would increase at all levels of the hierarchy. The relative shift in expenditure within the hierarchy due to an income change would depend on cost characteristics of the good. A second example would be a shift or change in density. What effect does density have on the hierarchy? The argument will be that the increase in density for a given area will increase congestion and shift expenditure toward those governments where density is greatest. Thus, the effort is to determine how the variables affect expenditure patterns in the existing hierarchy.

Since the purpose of the empirical effort is to examine expenditure relationships in the hierarchy of governments for Oklahoma, it is necessary to convert the first-order conditions into a per capita expenditure equation. Solving equations (5-7) for M, yields equation (8), the demand function for M.

(8) $M(T_o, m, I) = M(T_o, m(U_p, A, D, G), I) = M$

Multiplying equation (8) by $T_o m$ gives equation (9), the per capita expenditure function.

(9) $T_o y = T_o m M(T_o, m(U_p, A, D, G), I)$

where T_o is the part of the efficiency wage paid by the median voter for police protection. Therefore, $T_o y$, is the cost to the median voter. It is a function of I, U_p, A, D and G. Equation (9) is the estimating equation to be used in Chapter IV. The partial derivatives of this equation give the expected signs for the coefficients to be estimated in Chapter IV. Thus, equation (9) is crucial to the empirical work that begins in Chapter IV because I, U_p, A, D and G become the independent variables. Per capita expenditure is used as a proxy for $T_o y$ which is the dependent variable. Depending on the quality of the equations, these estimates could be useful in future planning for state and local governments.

CHAPTER IV

AN EMPIRICAL METHOD FOR OKLAHOMA

Introduction

Chapter III developed a model of utility maximization for the median voter in a federal system of government. In Chapter II it was argued that a federal system of government would develop into a hierarchial overlay of government expenditure that is analogous to the Loschian hierarchy in the private sector. The Loschian theory was presented and several of the important theories on government expenditure hierarchies were presented. The purpose of this chapter is to make this theory operational. No attempt will be made to assign functions to any particular level of government or to argue that one service configuration is best. Instead the effort will be to discover how variables influence expenditure patterns in the hierarchy. The independent and dependent variables developed in the second and third sections of this chapter are implied by the model in Chapter III. The specific relationthip of interest for the empirical study is equation (9) from the model in Chapter III. Equation (9) is $T_o y = T_o m\underline{M}(T_o, m(U_p, A, D, G), I)$. Equation (9) is ideal because per capita expenditure can be used as dependent variables in place of $T_o y$. Thus U_p, A, D, G and I will be independent variables in a linear regression while per capita expenditure will represent $T_o y$ as the dependent variable. Before the regression equations are presented two empirical problems are discussed.

Two Empirical Problems

To date there has been a large outpouring of statistical analysis attempting to explain some part or subset of public sector expenditure relationships. Generally, two problems are evident in previous expenditure studies. First, there is the problem of uncertainty over the use of the study. Second, there is the difficulty in identifying whether the studies measure demand or supply factors.

The problem in the first case results because most early government expenditure studies never made clear whether they were intended to provide an understanding of economic relationships or to predict expenditures. The first efforts seemed to be predictive. Solomon Fabricant in an NBER study of 1952 used three independent variables to explain expenditure variation at the state-local level.[1] They were percent urbanization, population density and per capita income. The R-square was 72 percent. Others followed using much the same technique. Fisher in 1961 and 1964 added several demographic variables.[2,3] Kurnow changed the form of the equation by fitting it in logs.[4] Brazer disaggregated the dependent variable both by region and by function.[5] Finally, Sacks

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[1] Solomon Fabricant, The Trend of Government Activity in United States Since 1900, (Princeton: National Bureau of Economic Research, 1952).

[2] Glenn Fisher, "Determinants of State and Local Government: A Preliminary Analysis," National Tax Journal, XIV (December, 1961), pp. 349-55.

[3] Glenn Fisher, "Interstate Variation in State and Local Government Expenditure," National Tax Journal (March,1964), pp. 55-74.

[4] E. Kurnow, "Determinants of State and Local Expenditures Reexamined," National Tax Journal, XVI (September, 1963), pp. 252-255.

[5] Harvey Brazer, City Expenditures in the United States, (New York: National Bureau of Economic Research, 1959), pp. 1-54.

and Harris added federal grants-in-aid.[6] The uncertainty that arises is because these studies are of a predictive type. Some of the independent variables are themselves components of the dependent variable. It is known, for example, that local governments usually are required to spend all federal grant-in-aid money. Therefore, it does not seem surprising that expenditures are "explained" by federal grants-in-aid. Morss elaborates this point with the following model.[7] Y is state and local expenditure, Z_1 is federal aid payments to states and localities and Z_2 is state and local expenditures other than those financed by federal aid payments. Using 1960 per capita expenditures he found that Y fit to Z_1 gave:

$$Y = 226.96 + \underset{(.27)}{1.25Z_1}, \quad R^2 = .30$$

Although only one variable was fit, the results suggest a significant positive relationship between Z_1 and Y with 30 percent of the variation explained. However, if Z_2 is fit to Z_1 so that the portion of local expenditure that comes from the federal government is removed, then:

$$Z_2 = 227.30 + .25Z_1, \; R^2 = .02.$$

Now the coefficient of the variable is not significant and only two percent of the variation has been explained. The two equations differ because the first contains a portion of an identity between Z_1 and Y. The two move together because Z_1 is a component of the other. There is

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[6]S. Sacks and H. Harris, "The Determinants of State and Local Government Expenditures and Inter-governmental Flows of Funds," National Tax Journal, XVII (March 1964), pp. 75-85.

[7]Elliott R. Morss, "Some Thoughts on the Determinants of State and Local Expenditures," National Tax Journal, XIX (March 1966), pp. 95-103.

nothing wrong with this technique, but it does serve to show the difference between a predictive variable and one that is used to understand some relationship, economic or otherwise. The purpose of the predictive variable is to raise the R^2 so that one can predict with the equation. It is precisely the predictive variable which is avoided in the empirical work that follows. Instead, the equations presented include variables which can help in understanding what factors influence expenditure patterns in the theoretical hierarchy.

The second difficulty is the separation of cost factors from demand factors. Musgrave criticizes much of the research for its inability to disentangle these forces.[8] A better separation, he thinks, is not an insoluble problem. The basic ambiguity arises from demographic variables. Suppose there is a city that has X square miles of area and 1,000 people. With 1,000 people, city services are limited. Say there is only a volunteer fire department, one policeman, a city dump and a small library. City government is conducted at evening meetings in a local school. Now, suppose the city grows suddenly to 10,000 people. City services grow also. The police force is increased to eight. The library doubles. A full-time fire department is hired. Water mains and sewerage lines are put in. A city hall and a park are built. Is the growth of city services due to an increase in demand or a decrease in cost? Is there any reason to suppose that the 1,000 people living together should suddenly change their demand for services because more people moved in? If public output is defined as a unit of service, there

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[8]Richard Musgrave, "Discussion of Part III, the Urban Public Economy," Issues in Urban Economics, Ed. H. Perloff and L. Wingo (Resources for the Future: Johns Hopkins University Press, 1968), pp. 567-574.

seems no a priori reason to believe an individual in a large city necessarily has any different demand for public services than an individual in a small city or even an isolated individual in the county. If police protection is defined as a unit of crime prevention and not numbers of policemen or police cars, then the larger police force in the city with 10,000 people is a result of an effort to maintain the same level of protection as in the city with 1,000 population. If crime is higher per person in the larger city, a higher expenditure per person can be termed a higher cost of crime due to congestion or urbanization. In effect, what is argued is the demand of the median voter does not show any systematic change no matter how space is divided. Why should the isolated individual necessarily have less desire for fire protection, or books or parks or trash pickup than his urban counterpart? He very likely does not get the service, but this is because there are no other individuals to share the cost. If all residents of a county demand equal services no matter where they live, either in a city or in a remote rural area in the county, then each resident gets fire protection where a fire truck can spray X gallons of water on a building or house in Y minutes. Obviously, it costs more to provide this service to an individual living in the remote area than in a city because one fire truck and its crew may have to stand ready to protect one house in the remote area. By living in close proximity the group can share the expense. Increased city expenditure in response to increased urbanization results from a lower cost per person for public goods and services as well as from a higher cost per person in achieving a given service level.

The purpose of this discussion on empirical problems is to clarify two things: (1) the equations to follow are not to be predictive equations but are designed to help understand local government expenditure and (2) it is argued the variables presented, except income, are inherantly cost and not demand related.

Analysis of City and County Per Capita Expenditure

Introduction

The purpose of this section is to develop a regression model using as independent variables those from equation (9) in Chapter III. Per capita expenditure is used as the dependent variable.

Equation

The regression equation below links the analysis of Chapter II and III and provides an approach to the empirical work for Oklahoma. Y_i below represents $T_o y$ from equation (9). The independent variables below represent the variables U_p, A, D, G and I from equation (9). The regression equation is:

$$\ln Y_i = \alpha + \beta \ln U_{pi} + \zeta \ln A_i + \ell \ln E_i + \theta \ln(1/n\Sigma D_{ji})_1 + \mu \ln(1/n\Sigma D_{ji})_2 + \Omega \ln(1/n\Sigma D_{ji})_3 + \pi \ln Y_{mi}, \; n = 77,$$

where:

Y_i = per capita expenditure by category h.

U_{pi} = percent of population in county i that lives in municipal areas.

A_i = the percent of the total county area for county i that is legally contained in municipal areas.

E_i = number of elected officials in county i, elected for k city and county governments.

$(1/n\Sigma D_{ji})_1$ = the sum of incorporated city distance for city j from the county seat of county i by county divided by the number of cities, n, in city i, or the average distance of cities from the county seat.

$(1/n\Sigma D_{ji})_2$ = the sum of incorporated city distance for city j from the nearest city for each city in county i divided by the number of cities, n, in county i, or the average distance between cities.

$(1/n\Sigma D_{ji})_3$ = the sum of incorporated city distance for city j from the nearest city at least twice as large or at least 2,500 population for each town in county i divided by the number of cities, n, in county i, or the average distance from a "large" city,

Y_{mi} = median family income by county i.

Data

The data relied on for these first estimates were taken from the 1967 Area Measurement Reports and the 1967 Census of Governments.[9,10] The second estimates use 1972 data. The Area Measurement Reports are a series of state reports presenting measurements of surface area for selected geographic units. The report was prepared by the Geography Division of the Bureau of the Census. The Census of Governments is a publication of state, county, city and special district government reports. It is published every five years and contains data on expenditure and revenue.

The raw data were combined to form the variables used in the regression analysis. For example, the dependent variable for the per capita equations required that county expenditure categories be divided

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[9]U.S. Bureau of the Census, Area Measurement Reports, Series GE-20, No. 38 (Washington, D.C., 1967).

[10]U.S. Bureau of the Census, Census of Governments, 1967, Vol. 7, State Reports, No. 36 (Washington, D.C., 1970).

by county population. The urbanized population variable used the same population data and expressed it as the ratio of city population for each county area to the total population in each county. The intercensal population estimates were taken from the Census of Governments for 1967 and 1972. The urbanized area variable was constructed from the Area Measurement Reports of 1967. Total area for each county was divided into total urbanized area for each county. The updated area estimates for 1972 were obtained over the telephone from the Bureau of the Census in Suitland, Maryland. The median family income data was chosen over mean family income in order to eliminate any extreme income values which might influence the data for each county. The elected officials data which were used to approximate the G variable in Chapter III were taken directly from the Census of Governments data and were not changed from their published form. The data for the distance variables were taken from a road map and rounded to the nearest mile. Since the distance variables are an attempt to measure the interjurisdictional spillover, it was best to measure distance over well traveled routes. Other possible measures, such as direct distance, do not tell how people get around and possibly use other services.

Rationale

The variables included in the model in Chapter III are used here to examine the extent of their influence on per capita expenditure by individuals in the hierarchy of governments. All of the coefficients are expected to be positive. The rationale for the expected results is given below.

The coefficient of $\ln U_{pi}$ is expected to be positive because an increase in urbanization is associated with an increase in congestion because congestion lowers the effectiveness of a level of public service. Therefore, to maintain the service level more expenditure is required. An increase in urbanization decreases the amount of service available due to increased congestion. The argument is that congestion increases the tax cost of maintaining the desired service level and this increases expenditures.

The coefficient for $\ln A_i$ is expected to be positive for city residents only. Allocation over a wider spatial area decreases the quality of a given output. For example, police protection declines if the same number of policemen serve a wider rather than a smaller area. Therefore, the cost of maintaining a given service level increases as area increases. Expenditure increases making the coefficient positive for city residents. Since A_i is urbanized area, a higher percent of urbanized area should have insignificant results for county categories.

The variable E is a proxy for the costs of government. In Chapter III it was argued public services decline as the number of governments increase. Additional elections, added government officials, and increased administrative costs were given as largely responsible for the decline in service levels. Since expenditure is used as a proxy for T_0y, it is expected that increased government costs resulting from more governments will increase expenditures. The coefficient should be positive.

The distance variables measure the interrelationship between government expenditure. The coefficients should be positive because the larger the value of the distance variable, the greater the distance between cities and therefore the more cities must rely on their own expenditure. For example, as the index of city distance from the county seat increases, city expenditure should increase. This assumes that closeness to the county seat gives expenditure advantages to cities that are reflected in its spending.

Although the equations in Chapter III have only one distance variable, it was decided to use three different specifications in the empirical work because it allows a broader examination of distance factors.

Median family income shows how income changes affect demand for public expenditure. Income effects are almost always positive so that a positive coefficient is expected.

Results

Expenditure figures in Table IV are divided into four classifications. Equations one and two are expenditures allocated only by county governments. Equations three through eight are county expenditures for goods and services also allocated by city governments. Equation nine is for natural resource expenditures allocated exclusively by county governments. Equations 10 through 15 are city expenditures allocated only by the city governments for each county area. Equations 16 through 21 are city expenditures allocated by county governments as well. F-values are in parenthesis. An F-value of 3.98 or better indicates a 95 percent significance. An F-value of 2.79 or better gives a significance reading of 90 percent.

The purpose of the linear regression is to test significance of variables and to compare the size of coefficients for different

TABLE IV

PER CAPITA EXPENDITURE EQUATIONS

	Equations							
Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
County Expenditure by County Only								
(1) Public welfare (PW)								
1967	-.29	.98	1.58					.27
	(7.1)	(5.0)	(8.4)					
1972	-.21	2.80					.41	.42
	(4.8)	(43.3)					(3.3)	
(2) Health (H)								
1967								.00*
1972								.00
County Expenditure for Services Allocated by City and County Government								
(3) Financial administration ($\$_{co}$)								
1967	-.22	.35	.37	-.30			.19	.58
	(22.5)	(4.6)	(3.4)	(9.7)			(4.1)	
1972				-.46			.35	.37
				(20.2)			(11.6)	

* The F level to enter was set at a minimum of 2.0. Thus, no variables were entered if the F statistic was below 2.0. This accounts for the R-squares of zero.

TABLE IV (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	ln$(\Sigma D_{ji}/n)_1$	ln$(\Sigma D_{ji}/n)_2$	ln$(\Sigma D_{ji}/n)_3$	R^2
(4) General Control (G_{co})								
1967	-.24 (24.8)		.89 (18.4)	-.34 (8.5)				.50
1972								.00
(5) Police (P_{co})								
1967	-.25 (10.6)	.65 (7.4)		-.31 (3.4)				.29
1972	-.34 (7.5)							.09
(6) Public Buildings (M_{co})								
1967								.00
1972								.00
(7) Highways (Q_{co})								
1967	-.44 (24.5)	.77 (6.4)					.37 (3.4)	.36
1972	-.35 (26.4)	.39 (4.7)						.26
(8) All Expenditures (Z_{co})								
1967	-.31 (27.9)	.55 (9.1)		-.40 (9.6)				.53
1972	-.27 (18.6)			-.45 (12.8)			.37 (9.9)	.61

TABLE IV (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
			Natural Resources Allocated by County Government					
(9) Natural Resources (NR)								
1967	-.67		3.11					.34
	(29.4)		(25.2)					
1972	-.48		3.20	-.79				.36
	(9.2)		(22.5)	(4.5)				
			City Expenditure Allocated Only by the City Governments					
(10) Fire Protection (F)								
1967	.34	2.00						.54
	(10.8)	(28.2)						
1972	.77	2.40				1.14		.52
	(10.8)	(12.0)				(5.2)		
(11) Sewerage (S_e)								
1967		1.83						.21
		(4.9)						
1972		3.8	2.50					.36
		(18.1)	(4.0)					
(12) Sewerage with no capital (S_{e1})								
1967		2.10						.20
		(8.1)						
1972		3.9	2.20					.40
		(23.3)	(4.0)					

TABLE IV (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
(13) Sanitation (S_a)								
1967		2.77 (16.0)	3.25 (8.2)	1.73 (12.3)				.42
1972	.52 (5.6)	3.64 (17.8)	2.58 (5.6)					.50
(14) Library (B)								
1967			2.60 (6.6)	.83 (4.1)				.39
1972	.51 (5.6)							.10
(15) Parks and Recreation (PR)								
1967			2.86 (8.8)	1.53 (15.3)				.56
1972		3.60 (25.2)		1.50 (8.4)				.34
City Expenditure for Services Allocated by City and County Government								
(16) Financial Administration ($\$_{ci}$)								
1967								.00
1972		2.10 (8.7)						.17
(17) General Control (G_{ci})								
1967		.64 (7.1)		.54 (12.2)				.09
1972								.00

TABLE IV (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
(18) <u>Police</u> (p_{ci})								
1967			.65 (4.8)					.20
1972								.00
(19) <u>Public Buildings</u> (M_{ci})								
1967	.52 (4.9)							.06
1972	.87 (6.3)			1.69 (3.7)				.26
(20) <u>Highways</u> (Q_{ci})								
1967	.11 (3.8)		.89 (10.0)					.24
1972			.73 (6.3)					.05
(21) <u>All Expenditures</u> (Z_{ci})								
1967	.20 (17.1)	.34 (3.2)	.57 (5.7)				.25 (5.7)	.46

Table IV (continued)

where the dependent variables are listed below:

PW = county government per capita expenditure on public welfare

H = county government per capita expenditure on health

$\$_{co}$ = county government per capita expenditure for financial administration

G_{co} = county government per capita expenditure for general control

P_{co} = county government per capita expenditure for police protection

M_{co} = county government per capita expenditure on public buildings

Q_{co} = county government per capita expenditure on highways

Z_{co} = county government per capita expenditure for total expenditures

NR = county government per capita expenditure for natural resources

F = city government per capita expenditure for fire protection

S_e = city government per capita expenditure for sewerage

S_{el} = city government per capita expenditure for sewerage with no capital

S_a = city government per capita expenditure on sanitation

B = city government per capita expenditure on libraries

PR = city government per capita expenditure on parks and recreation

$\$_{ci}$ = city government per capita expenditure on financial administration

G_{ci} = city government per capita expenditure on general control

P_{ci} = city government per capita expenditure on police protection

M_{ci} = city government per capita expenditure on general public buildings

Q_{ci} = city government per capita expenditure on highways

Z_{ci} = city government per capita expenditure on total expenditures expenditure categories. The specific statistical procedures for selecting variables was stepwise regression. Although no single selection technique is necessarily best, a stepwise routine is superior for use here. Stepwise regression provides a judgment on the contribution made by each variable as though it had been the most recent variable entered, without regard to its actual place of entry.[11] Thus, the fact that any variable which provides a non-significant effect is removed leads Draper and Smith to conclude that a stepwise method is the best selection procedure.[12] In presenting results only the final equation in the stepwise procedure is presented.

The percent of variation in the dependent variable explained, the R-square, is not expected to be high. First, R^2's are often low in a cross section analysis. Second, the exclusion of intergovernmental revenue from the explanation of local expenditure, for the reasons discussed above and because the cost of breaking down intergovernmental revenue by category for county and city expenditures is prohibitive, will reduce R^2's. Third, various institutional considerations are ignored.

The procedure followed in this section compares elasticities between the county and city expenditure equations. By comparing these elasticities, it is possible to see how the variables affect per capita expenditure for city and county residents. Given that the equations are specified in a nontypical way, the median income variable is crucial. An a priori restriction that one might place on the coefficeint of median

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[11] N. R. Draper and H. Smith, Applied Regression Analysis, (New York: John Wiley and Sons, Inc., 1966), p. 172.

[12] Ibid., p. 173.

income is that it would be non-negative. Furthermore, it would be expected to be larger for what one might call non-essential services. Since these restrictions were not imposed on the estimating equation, a comparison of these expected results with the estimated coefficients may give some idea of the reasonableness of the estimated equation. Per capita expenditures increase with median income for almost one-half of the equations estimated for the year 1967. However, in 1972 less than one-third of the equations estimated had significant coefficients on median income. However, none of the coefficients are negative. Furthermore, the coefficients, where significant, tend to be larger for such items as parks and recreation and public welfare than for financial administration and general control. Intuitively, the latter categories would be expected to be income inelastic and the former categories income elastic. The reduced importance of income in 1972 compared to 1967 could indicate that more services were financed by the state and federal government in the latter year. In general, the income variable performs as expected lending support to the model. Finally, in 1967, at least, the positive elasticity for the total expenditures per capita category combined with generally high elasticities for the individual city categories indicates that increased median income would result in higher per capita expenditure for city residents relative to county residents.

The first hypothesis with regard to the spatial structure of government to be investigated is that increased congestion, measured by the percent of the county population urbanized, results in a higher cost of providing public services. This higher cost is expected to be restricted to city residents and to be apparent in higher per capita expenditures for city residents. For total expenditures the hypothesis is rejected for 1972 (the coefficients are not significant), and can be supported for 1967 only with modification. In 1967 the coefficents are positive for per capita expenditure for both county residents and city residents. However, the coefficients for county residents (.55) is larger than the coefficient for city residents (.34). This somewhat surprising result, that increased urbanization increases per capita expenditures more for county residents than for city residents, might be clarified by an examination of the individual expenditure categories. The increase in per capita county expenditures attributed to urbanization is due to an increase in public welfare (an exclusive county function), county police protection, county highways and county financial administration. The generally larger elasticity coefficients for city fire protection, sewerage, sanitation and police protection do not offset the large coefficients for county per capita expenditures. For 1972, the urbanization variable is significant only for county per capita expenditures for highways. For cities it is significant for fire protection, sanitation, sewerage, parks and recreation and financial administration. The aggregation of the individual categories hides the significance of the urbanization variation for both city and county for 1972.

The estimated equations reveal several important conclusions about urbanization: 1) increased urbanization of the population may increase per capita expenditures for both city and county residents; 2) per capita county highway expenditures at least increase with urbanization indicating that increased urbanization imposes costs on non-urban residents; 3) city per capita expenditure for sanitation, sewerage and perhaps for parks and recreation, highways and financial administration go up with increased urbanization; and 4) aggregation into a total expenditure category can hide these results.

The next spatial hypothesis with respect to per capita expenditures is that an increased percentage of the county area which is urbanized results in an increase in per capita expenditures for city residents because of a relative increase in the area over which the public output must be allocated. Conversely, the coefficient for county per capita expenditures is expected to be negative. The coefficient, as expected, is negative for total county expenditures in 1967 and 1972. For 1967, the coefficient is negative for all county expenditure categories except health and public buildings. These two categories would probably be concentrated in the county seat; thus, the reduction in the non-urbanized area probably would not be expected to affect them. For 1972, financial administration and general control, in addition to the previously mentioned categories, are insignificant. The categories such as public welfare, police, highways for which a reduced relative area of distribution would be expected to reduce costs do, in fact, have significant, negative coefficients.

The results for city per capita expenditures are not as striking. The total city expenditures per capita increase with a relative increase in urbanized area in 1967 but not in 1972. However, fire protection, the category which might be expected to have the largest cost increase with increased relative area, does have a significant positive coefficient for both years. In addition, highways and public buildings have significant, positive coefficients for 1967 and sanitation, libraries and buildings have the expected coefficients for 1972. Although one can see that relatively larger urbanized areas could lead to additional decentralized building activity, it is difficult to understand why sanitation, sewerage and particularly police protection per capita costs apparently do not increase with an increase in the percent of the total area which is urbanized. Apparently, the marginal cost of an increase in area is equal to the average cost for those categories.

The results with the area variable suggest the following: 1) per capita county expenditures, particularly those with a spatial dimension, fall with decreased relative urban area; 2) per capita city expenditure increase for fire protection and public buildings with increased relative urban area; 3) some categories such as police protection which would be expected to have a spatial dimension apparently do not.

The number of elected officials in a county is expected to measure increased administrative and political costs with more government activity. Somewhat surprisingly, this variable reduces total per capita expenditure at the county level for both 1967 and 1972. It also reduces per capita expenditure for several individual categories in both years. Possibly an increased number of elected officials allows county residents to articulate a desire for reduced per capita county expenditure in return for either increased city expenditure or tax reduction.

The coefficient does have the expected positive sign for such individual city per capita expenditures as sanitation, libraries, parks and recreation and public buildings in one or both of the years studied. Either urban residents with more elected county officials are better able to articulate their desires for such urban services, or more cynically, politicians like to build monuments. However, for 1972 the coefficient for total city expenditure per capita is negative. Although it does not in general perform as expected, the elected officials variable does provide results of interest.

The variables measuring distance between cities perform poorly. For 1967 they have significant positive coefficients for county highways and financial administration; for 1972, the expected results are obtained for public welfare (a county function) and county financial administration and total per capita county expenditures. The hypothesis is that an increased spread of city governments within a county will reduce possible spillover benefits between cities and increase the cost of providing county services to cities. To some extent the hypothesis is supported.

This distance variable performs poorly for the city categories. Total city per capita expenditures for 1967, for instance increase with the distance between cities and, importantly, fire protection costs for 1972 apparently increase with distance between cities. The hypothesis, again, is that a city A near to city B might reduce the cost to city A of providing a given public service (and vice versa) because of spillover benefits. In general, the output of a public service provided by one city does not spill over in any obvious way to another city. Presumably, a resident of one city in Payne county, say Perry, could use the parks of another city, say Stillwater. However, it is not obvious that a citizen of one city could use the sanitation system of another. Fire protection represents a significant exception. A conflagration in Perry might result in the Stillwater fire department providing assistance and vice versa. Thus, the two cities could, and in fact do help insure each other. Obviously, the greater the distance apart, the less likely it is that such spillover benefits could occur.

The significant variable for fire protection is, of course, consistent with this hypothesis.[13]

Summary

This part of the empirical work has performed two major functions. First, it shows that the model of the median voter developed in Chapter III is not inconsistent with the situation in Oklahoma and suggests that the proxies for the costs of supplying public output are reasonable. Second, it provides a rationale for a continuation of an empirical study of the determinants of expenditures in the Oklahoma hierarchy of governments. The next section begins the study of these determinants.

Analysis of City and County Expenditure

Introduction

The purpose of this section is to fit a regression model using the independent variables from equation (9) in Chapter III. The dependent variable will be dollar expenditures instead of the per capita expenditure measure used in the first regression model. The analysis switches to expenditures by government rather than per capita expenditures. The results above suggest that the model of Chapter III has identified relevant factors affecting the cost of providing public services. Now, the dissertation moves to its main focus, the explanation of the determinants of expenditure in a given public hierarchy. The per capita

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[13] I am indebted to Dr. Donald L. Moomaw for his thoughts for this section.

expenditure equations were an application of the median voter model from Chapter III. By multiplying equation (9) from Chapter III by P, population, the model is converted to dollar expenditures.

Equation

The equation is:

$$\ln X_i = \alpha + \beta \ln U_{pi} + \zeta \ln A_i + \ell \ln E_i + \theta \ln(1/n\Sigma D_{ji})_1 + \mu \ln(1/n\Sigma D_{ji})_2 + \Omega \ln(1/n\Sigma D_{ji})_3 + \pi \ln Y_{mi}, \quad n = 77,$$

where:

X_i = dollar expenditure by category h,

U_{pi} = percent of population in county i that lives in municipal areas,

A_i = the percent of the total county area for county i that is legally contained in municipal areas

E_i = number of elected officials in county i, elected for k city and county governments.

$(1/n\Sigma D_{ji})_1$ = the sum of incorporated city distance for city j from the county seat of county i by county divided by the number of cities, n, in county i, or the average distance of cities from the county seat,

$(1/n\Sigma D_{ji})_2$ = the sum of incorporated city distance for city j from the nearest city for each city in county i divided by the number of cities, n, in county i, or the average distance between cities,

$(1/n\Sigma D_{ji})_3$ = the sum of incorporated city distance for city j from the nearest city at least twice as large or at least 2,500 population for each town in county i divided by the number of cities, n, in county i, or the average distance from a "large" city,

Y_{mi} = median family income by county i.

<u>Rationale</u>

As before all of the coefficients of significant variables are expected to be positive. The rationale for the expected result is given below.

The coefficient of the ln U_{pi} is expected to be positive because congestion lowers the quality and effectiveness of a public service. This effect should be strongest for cities and relatively weak or non-existent for counties. However it is possible that increased urbanization could influence county expenditure patterns. If the urbanized portion of the county population uses many of the county services, then the county government could reflect city spending patterns.

The argument is much the same for the coefficient of ln A_i. Allocation over a wider spatial area decreases the quality of public services. For example, police protection declines if the same number of police serve a wider rather than a smaller area. Therefore the tax cost of maintaining a service level increases as area increases. This increases expenditure making the coefficient positive. This effect should be positive for cities and negative for county governments.

The E variable is used again as a proxy for the costs of government. Additional elections, added government officials and increased administrative costs are given as largely responsible for the decline in service levels. Since it is expected that increased government costs resulting from more governments will increase expenditures, the coefficient should be positive.

The coefficients for the distance variables should be positive because the longer the distances between cities, the more cities must rely on their own expenditure. For example, the third distance variable measures summed city distance from cities at least twice as large or

2,500 for all cities in the county weighted by the number of cities. The expectation is that a larger distance index will result in higher city expenditures and therefore a positive coefficient.

The median family income variable shows how income effects influence demand for public expenditure. The coefficient should be positive because higher income levels cause an increase in service levels.

Results

The expenditure figures are divided into the same four classifications as the per capita expenditure figures. Equations one and two are for county government expenditure only. Equations three through eight are county expenditure for goods and services also allocated by city governments. Equation nine is natural resources allocated by county governments. Equations 10 through 15 are city expenditures allocated only by the city governments for each county area. Equations 16 through 21 are city expenditure allocated by county governments as well. F-values are in parenthesis. An F-value of 3.98 or better indicates 95 percent significance. An F-value of 2.79 or better gives significance of 90 percent. Table V presents the equations for both 1967 and 1972.

Dollar expenditure figures provide a clearer indication of governmental fiscal relationships than per capita expenditure figures. The intention is to compare the elasticities between the county and city expenditure equations. By comparing these elasticities it becomes possible to see how the variables change expenditure between city and county governments relative to each other. For example, a high median family income elasticity for city expenditure relative to county expenditure categories would cause a shift in expenditure away from county government toward city government as income increases.

TABLE V

DOLLAR EXPENDITURE EQUATIONS

	Equations							
Dep. Var.	ln A	$\ln U_p$	$\ln Y_m$	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
County Expenditure by County Only								
(1) Public Welfare (PW)								
1967	.484 (11.5)		3.34 (21.7)					.43
1972	.330 (6.1)		3.25 (38.2)	.85 (8.6)			.67 (5.9)	.59
(2) Health (H)								
1967	.570 (11.0)		1.57 (4.3)	1.73 (19.3)				.52
1972	.690 (11.9)			1.10 (4.75)				.32
County Expenditure for Services Allocated by City and County Government								
(3) Financial Administration ($\$_{co}$)								
1967	.292 (54.1)		1.60 (97.8)	.660 (65.5)			.370 (18.8)	.87
1972	.320 (25.5)		1.44 (34.0)	.710 (27.1)			.480 (13.7)	.74

TABLE V (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
(4) General Control (G_{co})								
1967	.280 (32.0)		1.85 (86.4)	.607 (36.1)			.345 (11.0)	.82
1972	.270 (4.1)		1.63 (8.4)	.87 (7.7)				.40
(5) Police (P_{co})								
1967	.297 (10.7)		1.46 (13.7)	.566 (9.1)			.317 (3.16)	.62
1972			1.93 (13.2)	.81 (8.7)				.25
(6) General Public Buildings (M_{co})								
1967	.639 (22.9)			.788 (5.5)				.40
1972								.00
(7) Highways (Q_{co})								
1967			1.65 (100.3)	.604 (50.3)			.372 (17.2)	.69
1972			1.20 (63.0)	.680 (65.6)			.470 (31.0)	.67
(8) All Expenditures (Z_{co})								
1967	.211 (12.7)		1.46 (35.9)	.566 (20.9)			.506 (15.8)	.67
1972	.230 (12.5)		1.20 (22.0)	.590 (17.3)			.550 (16.6)	.62

TABLE V (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
Natural Resources Allocated by County Government								
(9) Natural Resources (NR)								
1967			3.43 (80.2)	.603 (9.4)			.482 (5.5)	.56
1972			3.50 (63.6)					.46
City Expenditure Allocated Only by the City Governments								
(10) Fire Protection (F)								
1967	.570 (13.6)	2.04 (13.6)	1.67 (5.5)	1.52 (22.3)				.73
1972	.770 (22.2)	1.85 (18.5)	1.34 (3.5)	1.61 (20.8)				.76
(11) Sewerage (S_e)								
1967	.899 (7.6)	3.34 (7.3)						.32
1972	.730 (10.7)	2.03 (8.5)		1.35 (7.8)				.55
(12) Sewerage with no Capital (S_{el})								
1967	.858 (7.5)	2.06 (6.4)						.32
1972	.090 (12.9)	1.97 (10.7)		1.33 (10.3)				.61

TABLE V (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	ln$(\Sigma D_{ji}/n)_1$	ln$(\Sigma D_{ji}/n)_2$	ln$(\Sigma D_{ji}/n)_3$	R^2
(13) Sanitation (S_a)								
1967		3.17	5.48	3.78				.56
		(7.6)	(12.1)	(37.8)				
1972	.860	2.25		.85				.70
	(21.1)	(16.2)		(4.8)				
(14) Library (B)								
1967		2.97	4.13	2.06				.50
		(5.5)	(7.2)	(8.4)				
1972	.680		1.90	1.32				.57
	(17.1)		(7.4)	(11.3)				
(15) Parks and Recreation (PR)								
1967		3.98	4.79	2.78				.64
		(10.8)	(10.8)	(16.5)				
1972	1.01		2.40	1.67				.73
	(28.8)		(9.1)	(16.6)				
City Expenditure for Services Allocated by City and County Government								
(16) Financial Administration ($\$_{ci}$)								
1967	.503	1.35		.657				.57
	(14.3)	(9.9)		(5.7)				
1972	.620	1.86		.930				.73
	(10.3)	(9.7)		(4.9)				
(17) General Control (G_{ci})								
1967	.330	1.60	1.57	1.08				.76
	(10.0)	(17.7)	(11.6)	(25.4)				
1972	.520		.99	.79				.59
	(24.2)		(4.8)	(10.0)				

TABLE V (Continued)

Dep. Var.	ln A	ln U_p	ln Y_m	ln E	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
(18) Police (P_{ci})								
1967	.504 (21.1)	.941 (5.5)	1.70 (12.2)	1.40 (38.2)				.78
1972	.610 (35.7)		1.80 (17.1)	1.00 (17.8)				.72
(19) General Public Buildings (M_{ci})								
1967	.599 (8.5)	.598 (8.46)	1.89 (4.3)	1.15 (6.0)				.41
1972	.800 (17.0)		1.97 (6.0)	1.50 (10.7)				.52
(20) Highways (Q_{ci})								
1967	.500 (28.2)	1.18 (11.8)	1.92 (21.1)	1.15 (35.5)				.83
1972	.440 (24.7)		1.34 (12.8)	1.20 (32.4)				.71
(21) All Expenditures (Z_{ci})								
1967	.380 (28.7)		1.96 (45.1)	.794 (28.6)				.74
1972	.540 (50.7)		1.15 (12.6)	.770 (18.3)				.75

Table V (continued)

where the dependent variables are below:

PW = county government expenditure on public welfare

H = county government expenditure on health

$\$_{co}$ = county government expenditure for financial administration

G_{co} = county government expenditure for general control

P_{co} = county government expenditure for police protection

Q_{co} = county government expenditure on highways

Z_{co} = county government expenditure for total expenditures

NR_{co} = county government expenditure for natural resources

F = city government expenditure for fire protection

S_e = city government expenditure for sewerage

S_{el} = city government expenditure for sewerage with no capital

S_a = city government expenditure on sanitation

B = city government expenditure on libraries

PR = city government expenditure on parks and recreation

$\$_{ci}$ = city government expenditure on financial administration

G_{ci} = city government expenditure on general control

P_{ci} = city government expenditure on police protection

M_{ci} = city government expenditure on general public buildings

Q_{ci} = city government expenditure on highways

Z_{ci} = city government expenditure on total expenditures.

The estimating equations for 1967 reveal several important conclusions. First, the percent urbanization variable is significant only for city expenditure and not at all for county expenditure. What appears to be an obvious relationship requires further explanation. An increase in urbanization could cause an increase in county expenditure. If the urbanized portion of the county population uses many of the county services, then the county government could reflect city spending patterns. This is supported by the fact that elasticities for U_p fall off somewhat for equations 16 through 20 where these city expenditure categories are shared by the county. Also the expenditure categories of sewerage and sanitation, which are exclusively city expenditures, have elasticities of over three.[14]

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[14]The regression model includes ln U_p as an independent variable along with ln A_i because this is consistent with the reasoning developed and will show expenditure relationships in the hierarchy. Recall that a basic premise involved in using linear regression is independence among the independent variables. In the extreme this requires the columns of the X matrix to be pair wise orthogonal so that no multicolinearity exists. Very seldom in economic data does such an ideal occur. Instead the problem is not so much whether collinearity exists but to determine the severity of it. This is because collinearity is detected by consulting the matrix of simple correlations and the sampling variances that are generally a standard part of regression routines. Although other studies on local expenditure have consistently used population by county as an independent variable, it was avoided here because it was feared population by county would correlate highly with urbanization. However when population by county was included as a variable in a matrix of simple correlations it proved to correlate much more highly with ln A than ln U_p. Further when population replaced urbanized area as a variable it proved to be less significant in explaining expenditures than urbanized area. One would have expected instead the U_p and A or U_p and population variables would have presented the more serious multicollinearity problems, but this was not so. Apparently as the coefficient for ln A increased the number of people in the city and town areas is offset by the number of people increasing in the county areas from county to county in some basically random way. For example, if county X has 2,000 people total, 500 of which were urbanized on 15 percent of the county's space but county Y has 8,000 population 400 of which is urbanized on 200 percent of the land, then both the percent of area in cities and the total population increase while the percent of population in cities decreases. Thus as the ln A variable changes there is not a significant systematic change in the U_p variable. This is particularly important for the analysis because it indicates changes in urbanized area are not independent of population but instead are reasonably so for density.

The urbanized area variable was significant for 15 of the equations. Its coefficient was positive, generally inelastic and usually more inelastic for county expenditure than for city expenditure. The fact that the urbanized area variable was significant for city governments was not surprising. City allocation over a greater area is expected to increase outlays particularly for things like sewerage and fire expenditure. The fact that urbanized area was also positively associated with county expenditure was less expected. However, this gives an indication of the spillover for county and city government. Urbanized areas are likely to have a large fringe of non-urbanized population. This fringe of population that is close to but not a part of a city requires the county to increase its allocation of services. The county is an extension of the city. This is also supported by the fact that natural resources, primarily a rural expenditure, show no response to urbanized area. Again the coefficients are modest and the effect is not large but it is highly significant as the large F-values indicate.

The result of the urbanized area variable for the county equations is the opposite with the result obtained from the per capita equations. However, these results are not inconsistent, since the county population surrounding the cities causes the county to spend more money as urbanized area increases, but the fringe population around cities does not represent the total population of the counties. Thus, when the total population of the counties are divided into county expenditures to get the per capita expenditure measure, per capita expenditure has a negative association with urbanized area.

The elasticity of the E variable is greater than one for all but one of the significant city expenditure categories and less than one for all but one of the significant county expenditure categories. F-values are high. This is the opposite sign from the per capita expenditure equations for counties. It is possible elected officials increase expenditures to a small group of constituents. Say, for example, special sanitation or sewerage services were provided for a fringe area around a city. This could increase total expenditures while decreasing expenditures per person for the entire county. In general, the equations give the expected result. Greater numbers of elected officials spend more money because tastes and preferences are more accurately accounted for, administrative costs are higher, or because more elected officials simply like to spend more money.

Of the distance variables, the third, aggregate city distance in county i from cities at least twice as large or 2,500 averaged by the number of cities, was the only one to be significant. Interestingly it is not significant for any of the city expenditures, but it was positive and significant for all but one of the county expenditure categories. Thus, it appears that as the spread of cities is larger in terms of distance the more important becomes the county government. This is true even for financial administration, and general control which undoubtedly results from other expenditure categories requiring additional administrative expenditure. Although the coefficients are not large and in all cases remain inelastic, they are positive. Furthermore their F-values are high and in all but one case show significance at the 99 percent level. Again the institutional setup in Oklahoma is the best explanation for this result. City services like fire, police and sanitation seldom overlap boundaries. Given the arrangement in Oklahoma, this is the best explanation for the distance between cities having no effect on city expenditure.

Expenditure in all categories appears highly dependent on income. Median family income by county is significant for almost all expenditure categories and its coefficient is elastic in all cases. In general, the elasticities are higher for city than county government expenditure categories. This means increased median family income will cause city expenditures to grow relative to county expenditures. Furthermore, the elasticities are higher for a particular class of non-essential expenditures like parks, recreation and libraries. Therefore, there is higher volatility of expenditure to income for these types of services.
Since the range of the data is the same for all the equations, this fact gives a good indication of the divergence of expenditure and expenditure types for areas of different income.

To complete the analysis 1972 data were used in the same regression model. The results were similar but deserve some additional comment. The urbanized area variable for 1967 is positive in 16 cases for both city and county expenditure categories. For 1972, 17 of the urbanized area variables are significant. All are positive for 1972 as they were for 1967 but it appears urbanized area has a stronger effect on city expenditure for 1972 than it does for 1967. All 12 city categories are significant for 1972 but only nine of 12 are significant for 1967. Also the coefficients are slightly higher for 1972 than for 1967. They are however still inelastic. The urbanized area variable reveals that both city and county expenditure increase as urbanized area increases.

The urbanized population variable for 1972 was not as important as it was for 1967. There were no county expenditure categories significant for either 1967 or 1972. However, 12 of 12 of the 1967 equations have positive and significant coefficients for cities, while only five of 12 are significant for 1972. The important city categories of fire, sewerage and sanitation are still significant and elastic but service categories shared between the city and county are not significant for 1972. It is difficult to explain this result. Apparently, urbanized population declined in importance between 1967 and 1972.

Median family income was positive, elastic and significant in 17 of the 21 categories for 1967. For 1972 only ten categories were significant. Although all of them were positive, they were less elastic in 1972 than 1967. This could be due to the increased importance of intergovernmental grants. As well, the coefficients seem to be about the same throughout the city and county categories. This indicates a smaller relative shift to cities in response to increased median family income for 1972 than 1967.

The elected officials variable is stronger for 1972 than for 1967. Nineteen of the 21 expenditure categories are significant for 1972 while 13 of 21 are significant for 1967. The elasticities show no systematic difference between 1972 and 1967. All are positive and all are about the same size. In short, more elected officials increase expenditures either because they raise administrative costs or because they like to spend more money.

The distance variables showed less effect in 1972 than in 1967. The results were very similar however because coefficients were positive, inelastic and significant only for county expenditure categories for both 1967 and 1972. Six distance variables were significant for 1967, only four for 1972. The results support the conclusion that greater distance between cities increases the importance of the county government. In general, the 1972 dollar expenditure equations supported the findings from 1972. The results for 1972 are presented below the results for 1967 in Table V. This provides for easy comparison.

Summary

Using expenditure as the dependent variable provided insight into influences on the hierarchial overlay of governments. Urbanized population as a percent of total county population, shifts expenditures away from the county order to the city order in the hierarchy. Larger incomes increased both city and county order expenditures. Since the elasticities were much higher for city expenditure than for county expenditure, it is concluded higher incomes shift expenditure to the city order relative to the county order. This is also true for the E variable. Both city and county expenditures showed positive elasticities, but the city elasticities were generally higher shifting expenditure toward the city governments. Distance between cities had a positive influence on county expenditure. The coefficients were larger for city categories, shifting expenditure toward city governments. The results show an interdependent but unequal function for local county and city governments. For example, the independent variables show weighted distance between cities affects the county government expenditure while weighted distance of the cities from the county governments does not. The county expenditure sometimes assists cities in the case of spillovers. City expenditure on the other hand is changed by the percent of urbanization and not at all by the distance variables.

Centralization Ratios

Introduction

Another technique for examining expenditure changes in a hierarchy of governments, is the centralization ratio. A centralization ratio is a measure of the share of a central government in the total public sector. The purpose of this section is to develop the centralization ratio for use in examining the overlay of expenditure in Oklahoma. The technique is to substitute the centralization ratio for T_oy from equation nine in Chapter III. The independent variables remain the same. Although the centralization ratio is not nearly as good a proxy for T_oy as the earlier measure using dollar expenditures, it should provide help in examining the overlay of expenditure in Oklahoma. Two previous studies of centralization are reviewed and examined and then a similar procedure is applied to Oklahoma.

Early Studies

This section explores the empirical use of two earlier centralization studies. These studies were selected because they best illustrate the technique to be applied for Oklahoma.

Wallace Oates begins with cross sectional data for 58 countries in an effort to examine to what extent selected variables explain the variation in centralization among countries.[15] He uses four different definitions of the degree of fiscal centralization. The first is the percentage of total public revenues collected by the central government.

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[15] Wallace Oates, Fiscal Federalism, (New York: Harcourt, Brace, Jovanovich, Inc. 1972), pp. 196-219.

The second is the share of the central government in current public expenditures. The third and fourth remove all expenditure but consumption expenditure and non-defense consumption expenditure respectively from the second ratio. Ten independent variables are fit sequentially. The first variable is the percentage of general government current revenue in social security contributions. This was included because the data he used excluded social security programs from the share of central government. This variable (Z) allowed for this discrepancy.

The next class of variables is cost variables: Population (P) and Area (A). He argues, that for larger nations, decentralized jurisdictions are better able to provide a wider range of output.

The final class of variables suggested by Oates deals with demand. Demand is influenced by income and tastes and preferences. Income was entered directly while six dummy variables were entered to account for differences in tastes and preferences. These were defined either as homogeneous or heterogeneous and they included language (L), race (R), religion (T), culture (H), sectionalism (S) and federalism (F).

The first equation and t-values was:

$$(1) \quad C_1 = 108 - \underset{(3.0)}{3.1} \ln P - \underset{(5.2)}{.7}\, Z$$

$$n = 58,\ R^2 = .41$$

where C_1 is the first centralization ratio and P and Z are as indicated. Z is as expected. The log of population (P) was negatively related to centralization.

Area (A) was added to P and Z with the following result:

$$(2) \quad C_1 = \underset{(10.4)}{102} - \underset{(2.0)}{2.2} \ln P - \underset{(1.8)}{.001}\, A - \underset{(5.5)}{.7}\, Z$$

$$n = 58,\ R^2 = .44.$$

Area has a negative sign but is not significant.

Income (Y) is introduced into the third equation after area is removed. It reads:

$$(3)\quad C_1 = \underset{(12.6)}{111} - \underset{(3.2)}{3 \ln P} - \underset{(3.1)}{.006\, Y} - \underset{(4.0)}{.5\, Z}$$

$$n = 58,\ R^2 = .50.$$

Income varies inversely to centralization.

The six dummy variables were added one at a time. This allows an examination of variables intended to serve as proxies for the degree of diversity in demands for public services. Language, race, religion and culture were insignificant. Sectionalism was added to (4). Sectionalism is defined as geographic subareas which identify "self consciously and distinctively" with that area. The equations were:

$$(4)\quad C_1 = 99 - \underset{(1.3)}{1.4 \ln P} - \underset{(3.1)}{.006\, Y} - \underset{(3.4)}{12.5\, S} - \underset{(4.2)}{.6\, Z}$$

$$n = 50,\ R^2 = .58.$$

Although this is a somewhat nebulous definition, the variable proved significant and strongly negative.

Since the sample size for sectionalism (S) was not equal to the sample size run for federalism (F), sectionalism was removed and federalism was put in. Federalism (F) also was strongly negative and significant.

The final equation reads:

$$(5)\quad C_1 = \underset{(12.0)}{96} - \underset{(1.3)}{1.2 \ln P} - \underset{(2.3)}{.004\, Y} - \underset{(4.7)}{15.9\, F} - \underset{(5.5)}{.6\, Z}$$

$$n = 58,\ R^2 = .65.$$

Oates shows a clearer application of theory to empiricism than others. It helps explain what causes expenditure levels and changes in fiscal patterns.

Oates and Litvack

A final review shows an even better application of theory to empiricism.[16] Oates and Litvack treat centralization in state-local finance as the result of both savings per capita from spreading the tax bill among a larger number of consumers and the possibility of associated congestion costs. The model assumes state governments provide a specified set of goods which are close to pure public goods and which are price inelastic. Local governments provide a variety of impure public goods which are subject to congestion costs and which are also price inelastic. With these assumptions then expenditure and price per capita at the state level are expected to decline as the size of the population increases. The size of the population in the more heavily concentrated local governments should have the opposite effect. This occurs for two reasons. There will be congestion costs. More public goods will be provided as population grows at the local level. Therefore, expenditure per capita by state government should vary inversely to the population while a higher concentration of population should increase expenditure per capita by state government at the local level. Fiscal concentration should bear an inverse relationship both to size and the concentration of the population.

Their empirical results are given below:

$$(1)\quad C_1 = 87 - \underset{(-6)}{6\ln P},\ R^2 = .44$$

$$(2)\quad C_1 = 90 - \underset{(-4.4)}{4.3\ln P} - \underset{(-4.0)}{.3U},\ R^2 = .59$$

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[16]W. Oates and J. Litvack, "Group Size and the Output of Public Goods: Theory and an Application to State-Local Finance in the United States," Public Finance, XXV (Spring, 1970), pp. 42-58.

$$(3)\quad C_1 = 91 - \underset{(-5.6)}{5.3 \ln P} - \underset{(-2.5)}{.2U} + \underset{(3.0)}{5.9S}, \quad R^2 = .66$$

$$(4)\quad C_1 = 90 - \underset{(-4.3)}{4.5 \ln P} - \underset{(-3.3)}{.2U} + \underset{(1.6)}{4.2S} + \underset{(1.0)}{2.5L} - \underset{(-1.5)}{3.8C}, \quad R^2 = .70$$

$$(5)\quad C_2 = 346 - \underset{(-8.0)}{28 \ln P}, \quad R^2 = .58$$

$$(6)\quad C_3 = 57 + \underset{(5.6)}{2.2U}, \quad R^2 = .40$$

where,

$\ln P$ = natural log of population

U = percent of population living in metro areas

S = dummy variable for southern region

E = dummy variable for northeast region

C = dummy variable for north central regions

C_1 = state expenditure as a percent of state-local spending

C_2 = state government expenditure per capita

C_3 = local government expenditure per capita.

The explained variation is high and signs are as anticipated with population size and concentration both negative. Equation five shows that expenditure per capita by state governments is inversely related to population size. The last equation shows local spending positively related to urbanization. All six equations confirm the theoretical arguments.

Application to Oklahoma

The purpose in this section is to apply the centralization technique to the state and local government expenditure pattern in Oklahoma. First the equation is presented and explained, then the results are discussed.

$$\text{Let } C_i = \alpha + \beta \ln U_{pi} + \zeta \ln A_i + \pi \ln Y_{mi} + \Theta \ln(1/n\Sigma D_{ji})_1 + \mu \ln(1/n\Sigma D_{ji})_2 + \Omega \ln(1/n\Sigma D_{ji})_3, \; n = 77,$$

where:

C_i = (County Expenditure)$_i$/(County Expenditure + city Expenditure)$_i$,

U_{pi} = percent of population in county i that lives in municipal areas,

A_i = the percent of the total county area for county i that is legally contained in municipal areas

$(1/n\Sigma D_{ji})_1$ = the sum of incorporated city distance for city j from the county seat of county i by county divided by the number of cities, n, in county i, or average distance of cities from the county seat,

$(1/n\Sigma D_{ji})_2$ = the sum of incorporated city distance for city j from the nearest city for each city in county i divided by the number of cities, n, in county i, or average distance between cities,

$(1/n\Sigma D_{ji})_3$ = the sum of incorporated city distance for city j from the nearest city at least twice as large or at least 2,500 population for each town in county i divided by the number of cities, n, in county i, or average distance from a "large" city.

Unfortunately, the expenditure data causes some constraint on the use of the centralization technique. Expenditure data are not separated into each of the county, city and school district governments. Instead expenditure data fall into two groupings: 1) expenditures in all the governments located in each county, and 2) expenditure for the county government only. A third category is derived from the first two. Expenditures for the county government are subtracted from category one; expenditures in all governments in the county. This leaves all of the expenditure for city, school district and special governments by county lumped together. This data can be separated because school district expenditures are under the heading of education and capital expenditure for education. Since the special districts are for development, irrigation, soil, rural water and other specialized needs not categorized, all of this expenditure was included under two headings: natural resources or other and unallocable. With special district and school district expenditure subtracted, the remaining expenditure is for municipalities. Now, all of the expenditure data is separated by government. Since city and county government expenditure data is now separate it is possible to form centralization ratios. However, only six types of expenditure are allocated by both city and county governments. They are financial administration, general control, police, highways, general public buildings and hospitals. This means centralization ratios can be formed only for all of the expenditure data aggregated or for individual expenditure headings. Expenditures allocated exclusively by county government include: public welfare, corrections and health. City or municipality expenditures include: fire, sewerage, sanitation, urban renewal, library and parks and recreation expenditures.

Rationale

The expectation is that all of the coefficients will be negative for the centralization analysis. Increases in urbanized area (A) and urbanized population (U_p), will increase the proportion of city expenditures in total city-county expenditures. This lowers the centralization ratio. An increase in median family income (Y_m) will shift expenditures toward cities relative to counties. Cities are better able to respond to the increased demands for public services by higher incomes. This decreases the centralization ratio. The three distance variables are designed to discover the effects distance between governments has on costs and expenditure. Does distance between points of public service allocation influence expenditure for these governments? The first distance variable takes the sum of the distance of each city in a county from the county seat in that county and adds them. Then this figure is divided by the number of cities to provide an index of the cities distance from its county seat. Suppose a one percent increase in $(\Sigma D_{ji}/n)_1$ causes a percentage decline in the centralization ratio. This means that as this index of city to county distance grows expenditure costs shift to cities. The greater the distance from the county seat, the less the cities can rely on the county for their public service needs. The second and third variables measure spillovers between cities of any population and between cities of greater population. Therefore, if the distance variables are significant, an increase in the distance between government will increase expenditure for the cities. This means the coefficients will be negative.

Results

The first equations are listed as (1) through (6) for 1967 and 1972. The hospital expenditure heading is not included because it was totally insignificant. F-values are in parenthesis. An F-value of 3.98 or larger provides a 95 percent significance level. An F-value of 2.79 or better provides a 90 percent significance level. Results for both 1967 and 1972 are given in Table VI. Although the R-square figures were not large the coefficients were consistent with the earlier expectations. The results give an interesting mixture that varied a great deal depending on the centralization ratio. Equation one shows

TABLE VI

CENTRALIZATION RATIO EQUATIONS

Dep. Var.	ln A	ln U_p	ln Y_m	$\ln(\Sigma D_{ji}/n)_1$	$\ln(\Sigma D_{ji}/n)_2$	$\ln(\Sigma D_{ji}/n)_3$	R^2
Centralization for Financial Administration ($\$\$_c$)							
1967	-.071 (10.77)	-.145 (3.33)					.29
1972	-.080 (6.9)	-.24 (4.8)					.26
Centralization for General Control (GG_c)							
1967	-.065 (94.76)	-.332 (9.25)					.30
1972							.00
Centralization for General Public Buildings (MM_c)							
1967			-3.30 (4.40)				.13
1972							.00
Centralization for Police (PP_c)							
1967	-.401 (38.6)						.34
1972	-.380 (20.5)						.21
Centralization for Highways (QQ_c)							
1967	-.190 (27.2)	-.35 (3.60)					.39
1972	-.14 (103.7)						.61
Centralization Ratio for All Expenditures (ZZ_c)							
1967	-.401 (38.6)				.245 (4.23)		.40
1972	-.320 (68.6)						.48

where: $\$\$_c$ = a centralization ratio for financial administration
GG_c = a centralization ratio for general control
MM_c = a centralization ratio for general public buildings
PP_c = a centralization ratio for police expenditures
QQ_c = a centralization ratio for highway expenditures
ZZ_c = a centralization ratio for all expenditures

the financial administration ratio with a very slight negative coefficient for ln A and a larger though still inelastic relationship to ln U_p. The centralization ratio for general control expenditure in equation two has almost the same coefficients as equation one. The small coefficients for urbanized area indicate that area does not cause a large movement between orders of government for general control or financial administration. The small response to area may be a cost response to increased administrative costs that have resulted from extension of other area wide expenditures. The slightly larger coefficients for ln U_p may be the result of lower individual cost for urban services not feasible in a less urban situation.

In equation three with a ratio of county government expenditure on general public buildings to all government expenditure for general public buildings by county as the centralization ratio, the only significant variable is income. The relative amount of expenditure on public buildings does not show any relation to area, population or relative distance between cities. A one percent increase in median family income by county results in a 3.30 percent decrease in the percent of county government expenditure in total government expenditure in the county. Although income has no significant effect on financial administration or general control, the existence of public buildings seems dependent on high and rising incomes. Financial administration and general control appears to be a necessity not dependent on income, while public building is a luxury that higher income can pay for.

When police and highways make up the centralization ratios, the negative coefficients for ln A are larger indicating that city expansion into larger areas for these types of expenditures means more capital expenditure and larger maintenance costs for further extension of services. Y_m also is significant in explaining the shift to city expenditures for highways.

Equation six has aggregated the expenditure data for local governments. The summed expenditure data picks up the second distance variable. Like the first regressions, the centralization ratio equations failed to select the distance variable except for an equation or two. The institutional setup in Oklahoma prevents much spillover benefit between cities. One city is not able to use many of the services of another city. However equation six does show that as the index of distance between cities increases, more reliance is made of the county government. The effect is only significant when the data are aggregated.

The 1972 equations show only five variables significant while ten are significant for 1967. However, the size and signs of the coefficients are the same for both 1967 and 1972.

While the results for the centralization ratios were not outstanding, they were consistent with the first two sets of equations for the variables significant. The negative coefficients in the centralization ratios indicate a relative shift toward the city level of government. In the per capita expenditure and dollar expenditure equations the elasticity coefficients for A, U_p and Y_m and generally higher for city governments than county governments. This indicates a relative shift toward city government expenditure levels in the same way the centralization coefficients do. The only positive coefficient for the centralization ratio is the third distance variable in Table VI. The shift toward county government is consistent with both the per capita expenditure equations and the dollar expenditure equations.

Summary

The aim in this chapter has been to examine how independent variables affect expenditure levels in a federal hierarchy. A key difference in the equations here is the disaggregation of expenditure categories, the lack of a wide sweeping population variable, and separation of expenditure categories for each order of government. The analysis has allowed more interpretation of differences between local governments. The first section showed what forces affect city and county per capita expenditure. The equation, rationale and results were given. Due to problems with the population data, results were good but modest. The second section showed what forces affect city and county dollar expenditure. The final section applied the centralization technique to city and county centralization ratios in an effort to discover what factors influence the relative shift of expenditures. Again the equation used along with the rationale and results were presented. The results here were consistent with the previous results, but few variables were significant and R-square figures were low.

CHAPTER V

CONCLUSIONS

> A number of political scientists have argued that for a federal system: . . .what activities are expressed and what implied, what activities are protected, and what activities denied only emerge from an elaborate system of political 'horse-trading' in which the variety of interests seeking expression must be compromised.[1]

This dissertation has been an effort to discover existing relationships in a federal system and to refute the notion that expenditure activities in a federal hierarchy are merely a system of political "horse-trading". In practice all of the expenditure tradeoffs in a federal hierarchy cannot be explained by technical variables. However the equations in Chapter IV were designed to show what quantifiable factors affect expenditure movements between two orders of government. The results possess a considerable degree of explanatory power. Furthermore they explore into areas where others have not. First there is the framework of the analysis itself: a Loschian ordering of hierarchial governments. Also efforts were made at breaking apart each order of government instead of lumping them together under the category of local government expenditure. This allowed a more careful examination of relationships existing between local governments themselves instead of assuming they respond to the same things. Several other innovations

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[1]Rufus Davis, "The Federal Principle Reconsidered," American Federalism in Perspective, Ed. Aaron Wildavsky (Boston: Little, Brown & Co., 1967), p. 10.

were useful. The average spatial spread of governments by county and proportion of urbanized area by county proved to be significant variables in the analysis.

The results of the theoretical relationships tested suggest an interdependent but by no means equal function for governments at the local level. Nor do local governments respond equally to the same stimuli. The independent variables in Chapter IV make this stand out. Weighted distance between cities affects the county government expenditure while weighted distance of the cities from the county governments does not. The counties engage in a scattered pattern of expenditure sometimes assisting cities in the case of spillovers and sometimes providing services to cities because they are small and isolated. In the case of natural resources, where most of the expenditure is in special districts, it is possible the slack in rural need is taken over by special districts that transcend county areas. City expenditure on the other hand responds fairly strongly to the percent of urbanization but not at all to the distance variables. The concentration of population increases the demand for services the county cannot easily provide and also for those that it does. Median family income and elected officials both had significant and elastic coefficients for expenditure change.

This study was stimulated by the need to understand the forces changing government expenditure requirements in a public hierarchy of governments. Its objective is policy oriented since good government planning require knowledge of factors causing growth or decline of government expenditures. For example, if planners know that increased incomes shift expenditure away from county governments toward city governments, they may be able to plan more effectively. The value of the approach taken in this study is that it provides a sense of scale and content for formulation of government expenditures. If it is recognized that local governments possessing certain characteristics are more susceptible to growth or decline than others, then planning of the space economy should be greatly aided.

In concluding this study it is stressed that the empirical results are intended to show a way in which changes occur in a theoretical hierarchy of federated governments. Although more goes into predicting degrees of variation than appears here it is believed that the relationships posited are of importance and the empirical findings are presented in support of this contention.

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