THE ECONOMICS OF PUBLIC LIBRARIES

by

KATHLEEN FOLEY FELDSTEIN

A.B., Radcliffe College

(1962)

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE

DEGREE OF DOCTOR OF

PHILOSOPHY

at the

MASSACHUSETTS INSTITUTE OF

TECHNOLOGY

October 1976

(i.e. February 1977)

Signature of Author. . . . . Signature redacted
Department of Economics

Certified by. . . . . Signature redacted
Thesis Supervisor

Accepted by. . . . . Signature redacted
Chairman, Departmental Committee on Graduate Students

Archives

FEB 9 1977

LIBRARIES

THE ECONOMICS OF PUBLIC LIBRARIES

by

KATHLEEN FOLEY FELDSTEIN

Submitted to the Department of Economics

in October 1976 in partial fulfillment of the requirements

for the Degree of Doctor of Philosophy

ABSTRACT

The thesis presents a model of the economics of public libraries using a national sample of public libraries for the year 1968. The first part of the model is the collective demand for library service as reflected in locally financed expenditure on public libraries. Individual demand for the use of library services, as distinct from collective demand for library provision, is considered in the second part of the model. A parallel issue considered in the thesis is the estimation of cost functions for public libraries.

Chapter Two analyzes the community's demand for the provision of library services. The model assumes that decision-makers maximize some weighted function of individual preferences. The weights reflect the local pressure groups which exercise an influence over the level of the service. When individual demands for library provision are aggregated, expenditure on libraries depends on five types of variables: price variables including the influence of intergovernmental aid, income variables, tax structure, taste variable, and expenditure on other public goods and services. In the estimation, linear equations are used for the sample as a whole and for three community size subgroups. Both ordinary least squares (OLS) and instrumental variables (IV) estimation methods are used.

The results suggest that unconditional state aid leads to substitution of intergovernmental grants for own expenditure, particularly in small communities. The pressure group hypothesis is compared with a simple median preference voter model. Using either model, income is the important socio-economic determinant of expenditure on libraries. Education and age groups generally do not have significant influences.

In Chapter Three there is a discussion of the nature of library costs, followed by a section which analyzes

library variable cost functions. The existence of economies of scale and the implications for public policy are examined in detail. The main conclusion is that library systems exhibit slightly decreasing returns to scale while individual library branches have increasing returns to scale. The implication is that having fewer large branches is probably preferable to having more small branches. The cost functions suggest that the current zero price policy of public libraries should be reconsidered.

Individual demand for the public library is analyzed in Chapter Four. The theory of consumer search behavior is applied to the market for books. An aggregate demand function for library services is estimated, using a constant elasticity demand function and using both OLS and IV estimators. The estimation shows that the most important quality determinant of library circulation is the relative number of staff members and that the influence of additions to stock is much greater than that of the size of stock. The most significant socio-economic determinant of library circulation is education while there is no direct relationship between income and library use. These results are in striking contrast to those of Chapter Two explaining library expenditure. The estimation also suggests that there is "crowding" in the consumption of public library services.

Throughout the thesis attention is drawn to the implications of results for public policy. Different methods of introducing prices are considered. The direction for future research on public libraries depends on the collection of better data, suggestions for which are made.

Franklin M. Fisher
Professor of Economics, Thesis Supervisor

ACKNOWLEDGEMENTS

Particular thanks are due to Martin Feldstein and to my principal thesis supervisor, Professor Franklin Fisher. They have both encouraged me from my earliest interest in economics. This encouragement has extended to prodding at times on both their parts, but I am, now at least, grateful for this too. The second member of my thesis committe, Professor Cary Brown, offered very valuable comments and saved me from more than one serious error.

Dan Frisch and Amy Taylor were very helpful when computing problems arose. Jeanne Taylor Hapgood and Maureen Kay managed to fit the typing of the thesis into already busy schedules.

Helen Austin, Mary Casey and Barbara Carroll have provided babysitting services, the proverbial sine qua non of the thesis.

To Margaret, Janet, and Marty, thanks for being patient.

TABLE OF CONTENTS

		Page
Chapter 1.	Introduction	1
	I. Background	1
	II. The Public Library Model	10
	Appendix 1-A: The Data	17
	Appendix 1-B: Libraries and Copyright	27
Chapter 2.	Local Library Expenditures	31
	I. Models of Political Choice	34
	II. The Library Budget Model	37
	III. The Results	55
	IV. Conclusion	71
Chapter 3.	Public Library Costs	73
	I. The Nature of Library Costs	74
	II. Cost Functions	77
Chapter 4.	Individual Demand for Public Library Services	90
	I. Consumer Search	91
	II. The Demand Function	103
	III. The Results	114
Chapter 5.	Conclusion	133
References		140

LIST OF TABLES

		Page
A-1.	Variable Definitions--Library Data	20
2.1.	Definitions of Variables Used in Expenditure Equations	52
2.2.	Locally Financed Expenditure on Library Services: All Libraries	56
2.3.	Locally Financed Expenditure on Library Services: A Comparison of Ordinary Least Squares and Instrumental Variables Estimates	57
2.4.	Locally Financed Expenditure on Library Services: Libraries Serving Communities with Population less than 50,000	58
2.5.	Locally Financed Expenditures on Library Services: Libraries Serving Communities with Population Between 50,000 and 100,000	60
2.6.	Locally Financed Expenditure on Library Services: Libraries Serving Communities with Population Between 100,000 and 500,000	62
2.7.	Locally Financed Expenditure on Library Services: Instrumental Variables Estimates	64
2.8.	Locally Financed Expenditure on Public Libraries: Effects of Related Expenditures	69
3.1.	Cost Functions with Scale Measured by Circulation	80
3.2.	Average Cost Functions with Scale Measured by Size of Stock	84
3.3.	Average Cost as a Function of Stock Size	85
4.1.	Definitions of Variables Used in Demand Equations	111
4.2.	Determinants of Public Library Circulation: All Libraries	117
4.3.	Determinants of Public Library Circulation: Libraries Serving Communities with Population less than 50,000	119
4.4.	Determinants of Public Library Circulation: Libraries Serving Communities with Population between 50,000 and 100,000	121

LIST OF TABLES (contd.)

		Page
4.5.	Determinants of Public Library Circulation: Libraries Serving Communities with Population greater than 100,000	123
4.6.	Determinants of Public Library Circulation: All Libraries	131

Chapter 1.

INTRODUCTION

I. Background

Like the little red schoolhouse, the public library is part of the romantic landscape of America. It is an institution which is difficult to challenge even though the conditions which gave rise to the public library have largely ceased to exist. This thesis will undertake a reexamination of the grounds for public library provision and will develop a model of the public library system as it exists today.

The public library as a free, publicly supported, circulating service available to all citizens began around the middle of the nineteenth century when the Boston Public Library was founded.[1] Before then, private subscription libraries were fairly common in large towns and throughout the Northeast. Mercantile libraries, often aided by business interests, existed in many communities as educational centers for workers. These may have been the origin of the librarians' article of faith that libraries are important vehicles for self-education of the uneducated lower classes and of immigrants. Purely commercial rental libraries were sometimes available.

---

[1] A good history of public libraries in the United States is contained in Elmer Johnson (1965).

There were a few instances of true public libraries, but it was not until about 1850 that state legislatures began to allow local governments to levy taxes for public libraries. These laws and the example of the financially solid establishment of the Boston Public Library were the stimuli to a rapid growth in public libraries.

The history of the public library movement is one of steady growth with a few noticeable spurts. The first of these is associated with Andrew Carnegie,who,at the turn of the century,offered funds for the construction of libraries provided that the communities agreed to support their continuation. He aided the construction of about 2,500 libraries in North America and Great Britain. Carnegie was of course a great believer in the self-education function of public libraries.

The federal government became involved in public libraries after 1933. The Works Progress Administration was the source of both workers and new buildings, and through the WPA library services were greatly expanded and extended to cover a much wider proportion of the population. Nevertheless, it was felt that rural areas were inadequately provided with public library services and in 1956 the Library Services Act was passed. This act provided federal aid for the development and expansion of public library services in rural areas.

The act was amended in 1964 to become the Library Services and Construction Act, and in this format aid was available to urban and rural libraries. In addition it has become national policy to support the development of regional library systems, through which access to all levels of library services,including specialized reference material, can be made available to all citizens.

Public libraries have constituted a very small but steady proportion of local public expenditures. In 1960 public libraries received slightly more than one percent of local expenditures. Pfister and Milliman (1970) suggest it is the very smallness of the amount allocated to libraries that has allowed them to retain a "halo" effect without any reexamination of the grounds for public provision of libraries.

In addition to the steady expenditure on public libraries by local communities, it has been national policy for the last twenty years to expand public library provision. Throughout that period policy has been characterized by a "needs" approach, partly fostered by the strong lobbying activities of the American Library Association. For example, librarians have urged fixed minimum standards for book volumes per capita without regard to local characteristics.[2]

---

[2]See Pfister and Milliman, 1970, for a discussion of this.

In the major research analysis undertaken by the National Advisory Commission on Libraries (Knight and Nourse, 1969), there seems to be no critical evaluation of the rationale for having public libraries.

Federal aid has been maintained in the last few years despite efforts of the administration to reduce aid. Public libraries continue to be a national policy interest, as evidenced by the recent announcement of a forthcoming Presidential Conference on Libraries. Thus it would seem that this is a good time to undertake at last a critical study of public library provision.

Furthermore, the nature of library production processes may create continuing cost pressures, as suggested by Baumol and Associates (1969) in their study for the National Advisory Commission. Before rushing to the conclusion that more governmental aid is required to ensure the survival of public libraries, it is worth investigating the feasibility of and justification for user fees to support library services.

Public provision or subsidy is usually considered appropriate when the marginal cost of production is less than the average cost, or when there are significant externalities of production or consumption. Public support may be desirable in order to modify individual consumption. When this is the case, the good is considered a merit good. Recently a slightly different class of public good has been discussed in the literature, namely that for which an option

demand can be said to exist. This is a good whose purchase is infrequent and uncertain, and for which there are substantial discontinuities in production. It has been argued that in these cases public subsidy may be required to maintain production, even if in most respects the good can be considered private.[3]

The marginal cost criterion for public subsidy of library services will be discussed in Chapter Three, Public Library Costs. There it will be argued that marginal costs are not very different from average costs for the major library service, circulation. Reference services should be analyzed separately because of their different nature. Unfortunately, no statistics are available for this purpose.

Among librarians and other social scientists concerned with libraries, the most common arguments for public provision are the merit good nature of the library (i.e., the desirability of substituting social preferences for private tastes) and to a lesser extent, the externalities argument. The merit aspects of the library seem to have been very important to the founders of the early American public libraries.

Throughout the history of public libraries in America it is a recurrent theme that public libraries are a part of

---

[3]This idea was developed by Weisbrod (1964) who gives as examples national parks, hospital beds, and firefighters.

the public education system. However as public school systems have developed and as school libraries have been improved, this function of public libraries has steadily eroded in practice if not in the views of policy makers and of librarians. School libraries have been greatly improved under the Elementary and Secondary Education Act; libraries in institutions of higher education have received assistance through the Higher Education Act.

The ideas of the library as a home university and as an adjunct to the public education system for the acculturization of immigrants were relevant throughout the nineteenth century and into the twentieth but are no longer significant today (Molz, 1972, Banfield, 1972). This type of justification is still used in advocating an effort to change the nature of the public library service in order to attract non-user groups in the population, especially ghetto residents of central cities. However, as critics like Banfield are quick to point out, it is unclear that the public library is the correct medium for this function; in addition there has been little if any evidence of success in this type of effort.

Externalities in consumption are often claimed for the public library. It is a common argument that an educated man confers benefits to the entire community. To the extent that the public library serves as a source of self education,

the library provides educational benefits to the community at large. The use of the education analogy can lead to arguing that library services ought to be equally available and of equal quality to all.

The public library is a good example of an option demand good. The library can serve an archival function for all members of the community, with a small likelihood of excess demand developing at any time for a particular book. The reference resources which are always available particularly satisfy this function; circulating services do to a lesser degree. In addition, the library can be seen as an example of a cooperative in which the members can take advantage of possible economies of scale in the use of staff, for example. Surveys often show that non-users support the public provision of library service (Mendelsohn, 1969; Pfister and Milliman, 1970). This can be taken as support for both the externalities argument and for the option demand nature of libraries.

Economic studies of libraries were nonexistent until the late 1960's. At that time several cost studies and some attempts at demand studies were made. These include the study by Baumol (1969) in which a cost analysis similar to his earlier study of the performing arts (Baumol and Bowen, 1966) was outlined. Unfortunately, the data were extremely

inadequate and the results are inconclusive.[4] This analysis also seems to assume that the rationale for public libraries need not seriously be questioned.

Others have examined the grounds for public provision and found them wanting.[5] Pfister and Milliman (1970) took this position in their exploratory cost-benefit study of public libraries. Their study has good summaries of previous surveys on library users, and a good discussion of the library profession's position on library provision. Their data are limited to Indiana libraries and their analysis is essentially descriptive.

Haynes Goddard (1973) has made a cost-benefit analysis of the same Indiana libraries. He concludes, as do Pfister and Milliman, that there are economies of scale in the production of library circulation. This conclusion applies to Indiana libraries, most of which are very small (only eight percent serve populations of 50,000 or more). These studies will be considered again in Chapter Three.

Finally, Newhouse and Alexander (1972) developed a book-selection model in their analysis of the Beverly Hills, California public library. They too consider the rationale for public libraries, but maintain a neutral stance.

---

[4] See Appendix A of this chapter in which Baumol's data are discussed.

[5] Herbert (1962) is a strong opponent of free public libraries in the United Kingdom.

The present study used a national sample of public libraries supplemented by socio-demographic data on local communities (See Appendix A for a description of the data) and considers both demand and supply sides of the library system.

II. The Public Library Model

This section presents a simplifed exposition of the model of public libraries developed in the thesis. The object of this presentation is to show the causal structure of the model and the relationships among the parts of the model.

The model consists of a local government expenditure function, an individual demand function, a quality production function, and input equations. The unit of observation for the model is the local community. There are five endogenous variables:

y_1 = local expenditure on public libraries, per capita (pc)

y_2 = circulation pc

y_3 = "quality" of library

y_4 = additions pc

y_5 = staff pc

The "quality" of a public library is an unobservable variable. However, it is a function of other variables which can be measured. When quality appears as an explanatory variable in the simplified model below and in the actual estimation, the observable variables upon which quality depends will be substituted for it.

The exogenous or predetermined variables are:

x_1 = average family income

x_2 = median education level

x_3 = federal government aid for public libraries pc

x_4 = state government aid for public libraries pc

x_5 = wage rate for library staff

x_6 = stock of books pc.

There are other exogenous variables used in the actual estimated equations, but no additional endogenous variables. An equation explaining stock could be included in the model. The analysis which follows could be expanded to include more variables without changing any of the conclusions.

The structural equations of the model are:

Local Government Expenditure Function:

(1) $y_1 + \beta_{12}\chi_1 + \beta_{13}\chi_2 + \beta_{14}\chi_3 + \beta_{15}\chi_4 = U_1$

Individual Demand Function:

(2) $y_2 + \beta_{22}\chi_1 + \beta_{23}\chi_2 + \beta_{24}y_3 = U_2$

Quality Production Function:

(3) $y_3 + \beta_{31}y_4 + \beta_{32}y_5 + \beta_{33}\chi_6 = U_3$

Input Demand Functions:

(4) $y_4 + \beta_{41}\chi_5 + \beta_{42}y_1 = U_4$

(5) $y_5 + \beta_{51}\chi_5 + \beta_{52}y_1 = U_5$

Equation (1) shows that local per capita expenditure for public libraries (y_1) depends on individual characteristics such as income (x_1) and education (x_2) and external factors such as government aid (x_3 and x_4). The particular specification of the relationship depends on the voting model chosen. In Chapter Two alternative models are discussed. Empirical analysis using equations similar to (1) above allows testing

the median preference model against a more general pressure group hypothesis (See Chapter Two for an explanation of these models.)

Individual use of the library can be analyzed using per capita circulation. This individual demand is to be distinguished from voter demand for provision of library services (equation (1)). As equation (2) shows, such individual demand for public library services depends on characteristics of the individual and on the local level of library quality (y_3). This sensitivity to quality is a characteristic of any good for which there are differences in quality. For all such goods, and at any price, individual demand would vary depending on that quality. It is not possible to measure library quality ((y_3) in the model) directly. However, equation (3) shows that library quality is a function of measurable inputs. Substituting equation (3) for y_3 in equation (2), an estimable demand function is derived which uses input measures as a method for measuring quality:

$$(2') \quad y_2 + \beta_{22}x_1 + \beta_{23}x_2 + \beta_{24}(-\beta_{31}y_4 - \beta_{32}y_5 - \beta_{33}x_6) = U_2 - \beta_{24}U_3.$$

These input measures are not to be thought of as "producing circulation." They are rather a method of measuring sensitivity of circulation to quality. Their coefficients in equation (2') are composites of the effect of quality on

demand (β_{24}) and of the contributions of the inputs to quality (β_{31} and β_{32}). The coefficients of the other explanatory variables in the final equation (2') can be estimated directly. Their coefficients are pure demand effects and not composites.

Staff and new book inputs are endogenous variables. Equations (4) and (5) show that input demands depend on the library budget (y_1) and on the wage rate (x_5). The existing stock of books could be included as well. The price of books does not vary because the book market is a national one. Although equations (4) and (5) have not been estimated, this does not affect the estimation of equations (1) and (2') which are the interesting parts of the model.

There are four equations in the final model: (1), (2'), (4) and (5). The discussion above has shown why production variables can enter the demand equation. Both equations (1) and (2') can be estimated and correspond to the actual equations estimated in Chapters 2 and 4 of the thesis.[6]

Chapter 2 analyzes the local government expenditure function represented in this simplified model by equation (1).

---

[6]Equations (1) and (2') satisfy the necessary and sufficient rank condition for identifiability. Although x_5 was not actually used in the estimation, in equation (1) and in the actual estimation there are other exogenous variables (such as x_3 and x_4) which act as instruments for the endogenous variables. Estimation with instrumental variables using such instruments will be consistent although not as efficient as TSLS which would use all the excluded exogenous variables including x_5.

This equation represents a simplified attempt to model a community's decision to provide for a public library service. This can be interpreted as the voters' demand for provision of a library service. In Chapter Two, which elaborates the theory of equation (1), different models are considered. The simplest model for explaining voter support of a public library service is the median preference model and the simplest expression of that model is to use the median income voter. The median voter model works best when the local budget allocation is viewed as a single decision. For a particular service and for a small service, like libraries, used by a minority of the population, it seems desirable to go beyond the simple model and to include other socio-economic variables that a priori should be important.

Chapter Two also looks particularly at the influence of intergovernmental aid on locally financed expenditure. While state and federal aid is a small part of the library budget (less than 10 percent), it is an important potential policy variable. It is important to know how sensitive local communities are to such incentives.

Chapter Three digresses from the analysis of public library demand. This chapter is concerned with library costs. Cost functions using both circulation and size of stock as scale measures are estimated. An important question with policy implications, the existence of economies of scale, is examined in detail.

The model returns to individual demand for public library services in Chapter Four. The theory of this chapter is based on equation (2') of the simplified model.

Equation (2') is concerned with demand for use of the public library service as distinct from provision. While there are a priori reasons to expect the two relationships to have similarities, there is no reason to expect them to be the same. The ability to analyze these two aspects of demand for libraries is a significant improvement over most studies of public services which are limited to the first analysis, expenditure on that service, and on production processes.

In this chapter particular interest is focused on the socio-economic profile of users and a comparison of socio-economic characteristics which are important in expenditure for services with those which are important for use of services. This chapter also includes a discussion of consumer search behavior as it applies to public libraries.

In addition to the estimation of empirical functions, the thesis considers several questions of policy interest. The most important of these is the examination of the principle of free access to public library services. The possibility of user charges is suggested, and different methods of imposing charges are considered. The influence of intergovernmental aid on the level of expenditure is examined. Other potentially important developments are the introduction

of technical improvements in library technology and the move toward more centralization with the development of regional library systems. Whenever results bear on these questions, the implications are sketched out.

Appendix 1-A

THE DATA

The data on libraries that are used in this study are based on a survey conducted by the United States Office of Education of public libraries serving areas with at least 25,000 inhabitants for the year 1968.[7] Ninety-three percent, or 1057 libraries responded to the questionnaire. These libraries include both local, i.e., community, and county libraries. Although in some respects, such as internal resource allocation, the two types of library might behave in a similar manner, in other respects, such as library budget determination, their economic models should differ. Therefore it is important to study them separately. The analysis in this thesis is directed only to the local public libraries.

From the total of 1057 reporting libraries, those libraries serving individual communities were identified. Since the library survey did not include any data on the communities served by the libraries, socio-economic information on the localities, as well as revenue and expenditure data, were drawn from the 1967 County and City Data Book.[8] It was possible to collate the public library data and the community

---

[7] A summary of this survey is contained in Office of Education (1970). I am grateful to the Office of Education for making available a computer tape of the data.

[8] I am grateful to the Harvard Institute of Economic Research for making this data tape available.

data in 371 cases, which comprise the final sample used throughout the thesis. This was done by verifying that the public library data and the city data referred to the same population. The reporting libraries had been asked to use the 1960 Census of Population figure in reporting the population served. Since this is the same figure used in the 1967 County and City Data book, there was little ambiguity in determining the sample.

The sample which resulted from this procedure includes 36 states. Georgia did not respond to the original sample; other states are missing from the final sample because the libraries all seemed to be county libraries. Finally some states are not included because libraries in those states apparently serve more than one community.[9] There was a tendency for omitted states to be from the South. However the final sample does include 6 Southern states.

Very large metropolitan libraries are underrepresented in the final sample, probably because they continued to report their data according to library systems. For the United States as a whole 285 or 25 percent of the libraries served communities with population between 25,000 and 34,999;

---

[9] Previous Office of Education surveys had used library systems rather than the independent, locally autonomous library as the reporting unit. The survey report noted that some data continued to be reported for library systems.

271 or 24 percent served populations between 35,000 and 49,999; 335 or 30 percent served populations between 50,000 and 99,999; 206 or 18 percent served populations between 100,000 and 499,999; and 38 served populations of 500,000 or more. The corresponding proportions for the sample used in the thesis are: 98 or 26 percent (25,000-34,999); 95 or 25 percent (35,000-49,999); 103 or 28 percent (50,000-99,999); 58 or 16 percent (100,000-499,999); and 13 or 4 percent (500,000 or more). Frequently separate regressions were estimated for population subgroups.

Table A-1 defines the variables used in the model and gives the sample means, variances, maximum values and minimum values. When a variable definition is followed by NR, this means that not all libraries provided this information. This does not mean that the variables were not included in the statistical analysis but that when such variables were used the sample had to be limited to those libraries which did respond.

The variable for the number of branches is known to contain errors. This occurred because the survey questionnaire did not distinguish between main library and branch libraries. The count for "Central Library and Branches" was made by adding one to the number of branches reported. This was the procedure used by the Office of Education and was

Table A-1

Variable Definitions

Library Data

Variable Name	Definition	Sample Mean	Standard Deviation	Minimum	Maximum
Population	Population of area served, based on 1960 census.	124070	322830	25000	3550400
Branches*	Central library and branch libraries.	4.39	7.86	1.0	63.0
Additions	Number of volumes added during fiscal year, 1968.	17939	41286	1143	393210
Stock	Total number of volumes held at end of fiscal year.	222190	460000	16079	3949600
Circulation	Total number of loan transactions of all printed and audio-visual materials during year.	588540	1037200	34634	9708800
Staff	Total library staff, in full-time equivalents.	6.16	14.44	.40	133.40
Budget	Operating receipts during the fiscal year.	454300	992240	24350	9746600

Table A-1 continued

Variable Name	Definition	Sample Mean	Standard Deviation	Minimum	Maximum
Local	Operating receipts from the local government.	459400	1080800	15000	8762400
State*	Operating receipts from the state government.	34439	158650	0	1605100
LSCA*	Operating receipts from federal government, under Library Services and Construction Act.	15982	46318	0	366600
Total Expenditure	Operating expenditure during the fiscal year.	464100	1060800	23355	9736300
Book Expenditure	Expenditure on books during fiscal year.	70530	173420	1460	1700500
	Data on Local Community**				
Area	Land area, square miles, 1960.	24.493	44.46	1	455
Increase*	Percentage population increase 1950-1960	89.60	646.70	-33.3	12176
Nonwhite*	Percentage nonwhite 1960.	7.44	9.99	.1	57.5

Table A-1 continued

Variable Name	Definition	Sample Mean	Standard Deviation	Minimum	Maximum
Median Age	Median age of population.	30.98	4.63	20.1	54
Youth	Percentage of population under 18 years.	34.00	4.91	13.4	48.4
Old	Percentage of population 65 years and over.	9.68	3.57	2.0	28.2
Median Education	Median years of education completed for persons 25 years and over.	11.18	1.18	8.4	15.8
Low Education	Percentage of adults with less than 5 years of education.	6.08	4.08	.3	30.0
High Education	Percentage of adults with 12 or more years or education	46.57	11.8	19.4	89.0
School	Persons 5 to 35 years old enrolled in school.	28261	69722	5539	754650
Median Income	Median family income in 1959.	6471.2	1351.6	3755	13933
Low Income	Percentage of families with income under $3,000.	14.40	6.65	3.30	40.50

Table A-1 continued

Variable Name	Definition	Sample Mean	Standard Deviation	Minimum	Maximum
High Income	Percentage of families with income $10,000 and over.	18.92	10.00	4.8	68.4
Revenue*	Total city government revenue, in thousands.	16709	43664	788	415220
Tax*	Total tax revenue, in thousands.	10194	27322	218	298190
Property Tax*	Property tax revenue, in thousands.	7786	18970	96	189370
Total Expenditure	Total city government expenditure, in thousands.	16741	41697	774	401030
Educational Expenditure*	Local expenditure on education, in thousands.	2434	6726	0	84921
Public Welfare Expenditure*	Local expenditure on public welfare, in thousands.	1061	5044	0	56630
Parks Expenditure*	Local expenditure on parks and recreation, in thousands.	935	2540	0	26026

* Data for variables marked with an asterisk have some missing observations. The mean and other sample characteristics for each such variable refer to the full sample of respondents for that variable.

followed in this analysis. To the extent that the libraries had already counted the main library among their branches, the number of library outlets is overstated. The data do not include any information on the number of hours during which the library is open, and thus equal weight is given to all branches, although branches frequently have limited hours of service.[10]

The variable which is used for library circulation is very broad and includes all printed and audiovisual materials. The photo-charging systems used by many libraries do not allow fine distinctions between different types of material circulated. This is a serious gap in the data, but it is not clear how libraries can be motivated to introduce a method of making such distinctions. Photo-charging systems also make it very difficult to record the frequency of circulation of individual books.

The other variables seem to be free of serious errors or inadequacies. Some libraries did not adequately break down their expenditure data. Thus it was not possible to study factor costs in great detail, although in principle the survey collected detailed wage and material costs. Some variables have a large number of missing observations. This did not

---

[10] Southern library systems were segregated until the middle of the twentieth century. Location patterns inherited from this period may have effects on current use patterns.

pose any problems except that the number of degrees of freedom was sometimes considerably reduced in going from one specification of an equation to another.

There is a separate question of the data one would wish to have for a study of this sort. The most obvious deficiency in the data which are being collected now is that distinctions are not made between different library services. No separate data are being collected for adult and juvenile services, although it is possible for modern photocharging systems to be coded for such obvious distinctions. Previous Office of Education surveys did separate adult and juvenile circulation. The data would be improved greatly by a return to that classification system. Similarly no distinctions are made among books, magazines, records and other audiovisual materials. There is no national data collection on reference services, either in the provision or use of these services. There is no information on the organizational structure of libraries, such as number of division heads or budget allocation among divisions.

Despite such omissions in the Office of Education Survey, it does seem to provide the best available data on public libraries. Previous surveys were made by the Office of Education but the reporting units and information collected did not appear to be sufficiently comparable to warrant using these surveys.

Other studies have used state data and data on individual libraries. The only previous use of the Office of Education Survey material was used in a study by Mathematica for the National Advisory Commission on Libraries (Baumol et al., 1969). It used aggregate national data from the annual reports of public library statistics by the Office of Education (along with other data sources for other types of library), but the authors note: "Many of our time series were completely discredited when we were informed ..... that the statistics were averages in which any cost figures that had not been reported were taken to be zero!" (Baumol et al., 1969, p.169).

It was hoped that the demand statistics could be supplemented by the data from a national poll conducted by the Gallup organization for the National Advisory Commission on Libraries. However, the data had been destroyed after a few years and were unavailable at the time of this analysis.

Appendix 1-B

LIBRARIES AND COPYRIGHT

An important welfare consideration is the relation between public libraries and copyright provisions. There are two separate questions. First, should copyright protection extend to the public library's lending service? Second, how will technological changes in library storage and retrieval systems be consistent with copyright protection?

The grounds for having a copyright system are analogous to those for a patent system, although since copyrighted works are not a productive resource so much as a final output, certain arguments are weakened and others are inapplicable.[11]

The argument is basically that without copyright legislation there will be underinvestment in creative production. With appropriate copyright protection, the supply of creative effort will increase. In the context of patents Arrow (1962) has argued that underproduction continues to be a problem even with legal protection of property rights because of the inherent risk in invention, the imperfect

---

[11] There is a large economic literature on patents. See especially Arrow (1962), Hirshleifer (1973), and Machlup (1958).

appropriability of the patent system, and the inability of royalty schemes to capture all the benefits. These arguments all apply with equal strength to copyrights. Indeed the actual copyright protection is less strong than patent protection, so the degree of underproduction may be greater.

The conclusion to be drawn from these arguments is that in order to stimulate creative effort, some kind of a monopoly rent structure must be devised. However such copyright systems lead to inefficiency in the use of the resulting product. By its very nature, information, once produced, has zero marginal cost. Optimum utilization of information requires zero charge.

Another problem inherent in the copyright system is that of determining the supply of creative effort under any particular scheme. This is important for setting both the degree of protection and the length of life of the copyright. Some of the resulting supply would have been produced without the protection, the remainder would not have been. The inefficiency resulting from the copyright protection in the use of the first type of supply must be balanced against the gain from the production of the second type of supply.

Libraries affect this basic copyright issue in three ways. The existence of lending libraries makes the

appropriability of the benefits from the books even less perfect because of multiple lending. Thus they contribute toward underproduction. Secondly, they cause redistribution toward borrowers from buyers. The existing copyright protection does provide some remuneration to authors and thus does stimulate some of the existing production. This cost is borne almost wholly by book purchasers. The cost of books could be lower if authors' royalties were borne by all readers. Libraries can also stimulate production; without library sales many books would not be profitable to produce. This is especially true for scientific books.

The system might be changed in various ways. Direct fees for particular books could be collected and contributed toward a national royalty pool, which itself could have various methods of distributing royalties to individual authors.[12] Alternatively, a charge could be made for being a registered borrower. This would be simpler administratively but would introduce distortions. New borrowers, uncertain of their potential gains from the use of the library, might be discouraged from joining. The method chosen would depend on whether the library had user fees in general.

Automatic storage and retrieval systems and electronic reproduction raise further copyright problems. The

---

[12] This is the system used in Sweden and advocated by Herbert (1962).

existence of such systems would allow libraries to consolidate their holdings, particularly of books which circulate infrequently, and thus to improve library efficiency. However, when copies are made there is a clear possibility of copyright infringement. It is difficult to establish when copying falls under "fair use" provisions which have applied to occasional copying in the past and when it is a violation. Until now the courts have ruled in favor of libraries but the potential magnitude of the problem is only beginning to be apparent. Journals particularly are arguing for the necessity of protection against reproduction in order to ensure their own survival. Specific regulations need to be developed so that determination of infringements need not be arbitrary.

Chapter 2.

LOCAL LIBRARY EXPENDITURES

There are two aspects of the demand for local public services: the demand for the provision of services and the demand for the use of services. In general, public expenditure studies have examined only the first of these aspects. The model of public libraries developed in this thesis includes both types of demand. The demand for provision of public library services is analyzed in this chapter. More specifically, this chapter estimates the determination of library budgets. The use of public library services will be studied in Chapter 4, "The Demand for Public Library Services."

The determination of the library budget is one part of a general local budget allocation process.[1] Although the approach here will be to view library budgets as a collective community decision, the model will be related to recent studies which evaluate local expenditures

---

[1]The public library is generally supported by the local community, although library districts and intercommunity libraries are not uncommon. County libraries, which should follow a different budgetary pattern, are excluded from the sample.

in the theoretical framework of individual demand. Section I describes alternative models of local political choice and discusses previous local expenditure studies, with emphasis on recent studies of "shared goods." Section II develops the model used in this chapter. A major objective in local expenditure studies has been the estimation of the influence of intergovernmental aid. Public libraries receive aid from both state and federal levels. The estimation will include an examination of the influence of this aid. Section III presents the results of estimating the demand for provision of public libraries.

Average per capita expenditure on the public libraries in this study in 1968 was about $4.30, 90 percent of which is locally financed. This represents only about 1 percent of the local budget. Although public libraries serving populations of 25,000 or more constitute a small proportion of all libraries in the United States,[2] they receive the bulk of the expenditure on libraries and serve the great majority of the population. Total public library income in 1968 was $698 million (Ennis, 1972). Total

---

[2] In 1960 there were 8,190 public libraries, more than half of which served populations less than 5,000, and only three percent of which served populations greater than 100,000 (Winger, 1963).

operating income for public libraries serving populations of 25,000 or more was $432 million. Capital income for these libraries was $66.8 million. Furthermore the clear direction of public policy is toward developing systems which will serve larger populations. The influence of intergovernmental aid may be of particular interest as higher government levels encourage local communities to combine into systems.

I. Models of Political Choice

The theoretical literature on public goods is well known. The central concept in the demand for public goods is the problem of revealing individual preferences in the context of voting for public provision of goods and services. Perhaps because of the difficulty of resolving this problem, the empirical literature on local expenditures until recently did not attempt to incorporate individual demand theory explicitly. Instead, the emphasis has been on determining the influence of intergovernmental aid on local expenditures. However, individual demand theory has implicitly determined the choice of explanatory variables. Income variables have always been included, as well as measures of the influence of intergovernmental aid.[3]

Recent studies, particularly those of Bergstrom and Goodman, (1973) and Borcherding and Deacon, (1972) have tried to be more explicit in their use of individual demand theory and have drawn on the median preference model developed by Bowen (1943) and associated with later works by Downs (1957) and others. This model shows that under majority rule the quantity of public services supplied

---

[3]These studies are critically summarized in Inman (1974) and Oates (1972).

will be equal to the median of the quantities demanded. Bergstrom, Goodman, Borcherding and Deacon also assume that median voter preferences can be approximated by the preferences of the citizen with median income.

Using this approximation, they attempt to estimate the demand function for this median income individual. Both studies use a measure of tax share as a price proxy and both omit any measure of the price influence of intergovernmental aid. Although both studies criticize the ad hoc nature of the choice of variables in previous expenditure studies, both find it useful to include in the estimation variables which are not properly part of an individual demand function. Borcherding and Deacon acknowledge that their price variable is probably not a good approximation because of the omission of intergovernmental aid.

An alternative to the median preference model concentrates on the preferences of local decision-makers. Inman (1974) calls his version of this the entrepreneurial model and assumes that budgets are determined by the interaction of political leaders' preferences and bureaucrats' preferences. Inman also emphasizes the importance of estimating the relation between expenditure and use of public services.

A final model is the incremental budget model used by Davis, Dempster and Wildavsky (1966). In a study of federal budgets, they found that each year's budget (B_t) is determined mainly by a linear function of the budget of the previous year (B_{t-1}). The function is of the form: $B_t = 1 + c\ B_{t-1}$, where c is a bureau-specific mark-up.

Pressure groups have been studied in the normative theory of public choice (Steiner, 1974) but empirical models have not used this approach. The hypothesis that local decision-makers respond to varying pressures from different groups and that these pressures vary with the public service under consideration is appealing because it combines the median voter and the entrepreneurial models without the restrictions of the median income hypothesis. The analysis in this thesis will compare the median voter model and a combination of the pressure group concept and the incremental budget model.

II. The Library Budget Model

The median preference model applies best when determination of the local budget level is viewed as a single decision. When the budget is divided into several subcategories, the possibility of coalitions among groups of interested voters weakens the applicability of the median preference hypothesis. Even if decision-makers do respond to median preferences, the identification of median preferences with median income is unlikely to be correct for any given public service, and particularly for a service like libraries, which are used by a minority of the population.

The model to be developed here assumes merely that decision-makers maximize some weighted function of individual preferences. The weights on individuals or groups of individuals reflect the influential pressure groups in the community. The actual estimates which are derived later in the chapter can be used to develop a pattern of the pressure groups to which the decision-makers respond and to compare the pressure group hypothesis with the median voter model. The model also incorporates the incremental budget assumption. The model can be referred to as the pressure-group-incremental-budget model.

The decision-makers wish to maximize

$$W = W(u_i, \ldots, u_n) \qquad (2.1)$$

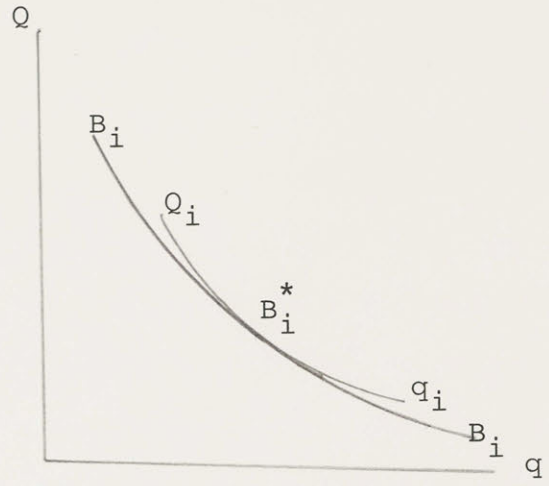


Figure 1a

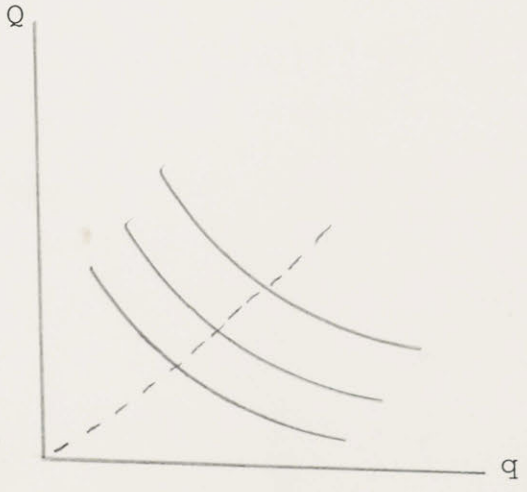


Figure 1b

where W is the social welfare and the u_i refer to the individual utility functions. The individual's desired level of library expenditure depends on his expected use of the library, as well as on the usual price, income, and taste variables. Unlike some public services such as sanitation and like others such as police protection, there may be considerable variation in individual use of the library service. Expected use is not simply a matter of tastes but depends on the production process. Greater expenditure does not necessarily imply greater potential use but rather use depends on how the expenditure is translated into services.[4]

In the production of the service there is a trade-off between quantity and quality. Figure 1 shows a simplification of this trade-off by assuming that there is a single dimension for both quantity (Q) and quality (q). For any budget level, B_i, the library will choose a particular quantity/quality package. An expansion curve can be derived showing the relationship between the library budget and the service package. Figure 1a shows an indifference curve between quality and quantity (Qq) and a production possibility curve (B_iB_i). The point of tangency between the two curves B_i^* is one point on the expansion curve relating the library's budget to quantity and quality.

---

[4]Individual use will be related to library inputs directly in Chapter 4.

Figure 1b shows a set of consumer indifference curves between quantity and quality. The expansion curve implied in figure 1a could be superimposed on these indifference curves to show the relation for the individual between the library budget and the quantity and quality of library service.

Although the individual voter does not know this expansion curve precisely, he does have an expectation, based on past library performance, of how the service package combination will depend upon the budget in the relevant range. He therefore chooses a desired expenditure level on the basis of these expectations as well as of his income, the price to him (i.e., his share of the tax burden), and other variables.[5]

Individual utility can be expressed as

$$u_i = u\ (Q(B),\ q(B),\ y_i - s_i B_k,\ r_i), \qquad (2.2)$$

where Q, quantity, is a function of B, the library budget; q, quality, is a function of B; s_i is price or tax share, y_i is income, and r_i refers to all other influences such as tastes, education level, etc.

In principle the individual can maximize his utility with respect to B, the library budget, and can thus

---

[5] Representing the consumer's preferences in this way implies that the underlying utility functions are separable between library services and all other consumption.

choose a unique level of expenditure for which to vote or exert his influence.

When individual demands are aggregated, the pressure-group-incremental-budget model would represent local own expenditure per capita as a function of price variables, income variables, tastes, and related expenditures:

$$L = L\ (p,\ G_0,\ t,\ y,\ Ed,\ Exp), \qquad (2.3)$$

where p is the price implied by matching aid, G_0 is per capita exogenous aid, t is some measure of the tax structure, y may be median family income or proportions in various income groups, Ed may be median education or proportions in different education groups, and Exp refers to related expenditures (which are endogenous themselves).

One further point about the local population should be noted. The model employed here assumes that only large budget items, such as schools, influence the individual decision process for choosing a local community. Since the population is not mobile with respect to minor expenditures, the determination of the library budget will not involve simultaneity with the determination of the relevant local population. Thus the Tiebout hypothesis that the local population is itself endogenous is not relevant (Tiebout, 1956). Library expenditures and other expenditures,

however, will be interdependent. Indeed, in principle the amount of the local budget allocated to the public library depends on the prices of all other community expenditure items, as well as on the price of library service, community income and community tastes.

Before describing the actual estimation of the equation, the nature and measurement of specific variables will be discussed.

The cost to the local community of any public service is influenced by intergovernmental aid.[6] A careful specification of this influence is important for analyzing how state and local governments can affect library service. Intergovernmental payments for libraries to governments may be block grants or matching grants. Block grants are usually based on population or per capita income. They are exogenous to the individual community and thus may have an income effect on local spending but no price effect. With matching grants the higher government level pays a certain share of each dollar of expenditure, usually beyond some

---

[6] Resource prices are assumed to be constant across libraries. The market for books is clearly national. Professional librarians are probably mobile; if nonprofessional labor is also mobile, then it will be true that labor and capital costs are approximately constant. The estimation assumes that labor is sufficiently mobile to justify ignoring inter-community differences in factor prices.

minimum level. If there is a maximum amount to the grant, it is called a closed-end matching grant; otherwise it is open-end. Open-end matching grants always reduce the net purchase price (to 1-m where m is the matching rate) and thus there is always a price effect. Closed-end matching may or may not have a price effect. If the local community expenditure exceeds the maximum of the grant, it is clear that the price effect is not operational at the margin. If the community spends less than the maximum there is a net reduction in the price of additional units of the service.

Libraries receive aid from both state and federal levels. Although many states have matching arrangements, examination of the actual data strongly suggests that the grants are closed-end and that most libraries are receiving the maximum amount of aid.[7] Because of the small number of observations for which a price variable seems important, all state aid was assumed to be unconditional for the estimation.[8]

---

[7] This conclusion is based on the information contained in State Payments to Local Government, 1967, Census of Governments (U.S. Bureau of the Census, 1968) and in the basic library data.

[8] If there is some element of matching, the state aid coefficient is biased as a measure of the importance of nonmatched funds but does allow some interpretation of the possible price effects. To see how the coefficient can be interpreted if there are some state matching grants, assume that all intergovernmental aid is from the state government to local governments. Then total local expenditure (E) is equal to the sum of local own expenditure (L), and state aid ($S = S_0 + m_S E$):

(a) $E_i = L_i + S_i$, for community i.

To know the true influence of state aid both block (S_0) and matching (changes in the value of m_S), the relation which should be estimated is:

8 (continued)

(b) $L_i = a_0 + a_1 S_{0i} + a_2 (1-m_S)_i + \sum_{j=B}^{n} a_{ij} X_{ij} + e,$

where the X's refer to other variables. Instead, because it is impossible to derive the net price of state aid, the estimated equation is:

(c) $L_i = B_0 + B_1 S_i + \sum_{2}^{n} B_{ij} X_{ij}$.

If state aid for libraries is all in the form of block grants, the two equations are equivalent. If aid is purely on a matching basis and the estimated effect of total aid on local own expenditure (L) is negative (as will be shown to be the case in the next section) then the price elasticity must be less than one.

This can be shown most easily for the case where expenditure depends only on price and not on any X's as in Equation b. The price of library services to the community implied by the matching rate is the ratio of local expenditure of own funds (L) to the total amount of library expenditure (E = L + S): p = L/E. With a constant price elasticity demand funtion,

(d) $E = k\, p^{-a}$, where $a > 0$.

This implies that

(e) $pE = k\, p^{1-a}$

or, since p = L/E that

(f) $L = k\, p^{1-a}$.

It is clear from this equation that if p and L vary in the same direction, a must be less than one. Thus, if a higher matching rate (that is, a lower price) implies less local own expenditure, the price elasticity must be less than one. If the estimated equation is misspecified and uses S instead of m_S as an explanatory variable, the sign of the true coefficient depends on the regression of the omitted variable on the included variables. Since $S = \left(\frac{m_S}{1-m_S}\right) L$, a higher value of S must imply either a higher L or a higher m_S or both. A higher value of S due to a higher L must imply a

In 1968 federal funds (F) based on the Library Services and Construction Act (LSCA) were determined according to a formula based on state population and income, and with certain minimum expenditure requirements. Federal funds for those states which qualified varied between a 33 percent minimum matching rate and a maximum of 66 percent. Without detailed information on state formulas and pass-through arrangements to the local communities, it is impossible to derive a price variable for federal payments. Although these funds may be endogenous to the states, it is likely that they are considered exogenous by individual communities. Thus the dollar amount of federal funds is used in the budget equation.[9]

---

8 (continued)
positive coefficient on S in the regression of L on S. Thus a negative coefficient on S must be due to an inverse relation between m_S and L. A negative coefficient of S therefore implies that a higher value of m_S is associated with a lower value of L, or equivalently, that a lower price is associated with less local expenditure and thus an absolute price elasticity less than one. In this example expenditure was assumed to depend only on prices and all aid was assumed to be conditional. In fact aid is often mixed and other variables do enter.

[9]The estimates in the next section show a positive effect of federal aid on local expenditure. It is therefore not possible to establish a bound on the magnitude of the price elasticity as it was for the state aid.

The share of the property tax in total community tax revenue is an aspect of the price variable to the individual voter.[10] The higher is the share of the property tax, the more the individual residents feel they are paying for the service. The lower is that share, the higher is the sales and income tax components, and the more is payment for the service being exported. For a pressure group model such a tax-price variable may be more appropriate than the usual tax variable which is more concerned with the distribution of the tax burden over citizens in the community, and in particular, the share borne by the median voter.

In principle the prices of other public sector goods and services should be included with possible price influences on library appropriations. Certain public expenditures, such as education and recreational facilities, may be related to libraries. Here again the net price, after federal and state aid is accounted for, is the relevant measure. In fact the prices of other services will have to be omitted from the estimation for practical reasons. Instead the total expenditure on related services will be included among explanatory variables.[11] Because library expenditures are such a small part of the overall local

---

[10] It would be preferable to know the residential property tax share in total tax receipts, but this information was not available.

[11] These related expenditures will be discussed more fully as taste variables.

budget, it is reasonable to assume that increasing appropriations to the library will not significantly affect amounts available for other public services. An instrumental variable estimating procedure will be used to allow for endogeneity of related expenditures.

Median family income and proportions at the extremes of the income distribution are used as income measures. The influence of median income as a proxy for the median preferences of the community has already been discussed. Both low and high income groups may exert positive influences in determining library expenditure. Low income groups are often said to support public expenditures in general because they do not perceive themselves as paying for the services. For a local expenditure like libraries where the property tax is such an important revenue source, this argument may be particularly strong because low income groups are more likely to rent. These groups may not perceive themselves to be bearing a large burden of that tax relative to their expected use of local public services.

High income groups may also support library expenditures because of a high expected benefit cost ratio, in their case because they are likely to be frequent library users. Library expenditures may be income elastic if the public library is considered a form of community wealth, as an archive.

Socio-demographic measures are useful for repre-

senting local tastes and expected library use. Most library surveys show strong positive correlation between library use and education, and a negative relationship with age, although old people are regarded by librarians as among the best potential users. School children are usually cited as the most frequent library users (e.g., Berelson, 1949). It should be interesting to evaluate the importance of these individual demand characteristics, which will be analyzed with the current data in the demand chapter, in determining library budgets.

In the estimation three areas of local public expenditure have been included as likely to be related to public library expenditure. A priori public expenditure on education is most closely related both because of the historical association of libraries with the education system and because communities which value education highly may also value highly books and therefore libraries. In so far as libraries can be considered a recreational resource of the community, library expenditure may be related to recreational expenditure. However, arguments can be made to support either direction for the relation. If a community values recreational facilities highly, they may value each separate facility in a similar relation. However libraries and other recreational facilities might be considered to be competing for funds, and therefore a com-

munity which supports one facility well may not support the other well.

Finally communities which bear a heavy public welfare burden may be less likely to give strong support to public libraries. It is commonly argued that as public welfare loads increase, funds are withdrawn from other services. However, expenditure on welfare, as on any other public expenditure, may indicate a community's willingness to tax itself for collective services. Thus public welfare expenditure and public library expenditure may be positively related.

No community will determine any budget as if starting de novo. Instead it will evaluate the quality of the existing services and will then decide at which level to maintain them. Indeed the incremental budget model maintains that each year's budget is determined mainly by the budget of the previous year. Past performance measures are needed to represent quality. The size of the library stock may be a useful indicator of past investment and of past performance, as well as a measure of library size. The community has a resource which they wish to maintain. The more past investment, the more reason to maintain this resource. The size of stock may also represent the potential importance of the library as a pressure group itself.

The use of a stock variable introduces possible

bias in the estimation. Communities which have a large book stock may generally also be communities which have a strong taste for libraries. Since taste is very imperfectly measured by socio-demographic variables, the residual will contain much of the taste effect. By the usual omitted variable or specification error analysis, it is clear that all coefficients will be biased and are in some degree a reflection of tastes. Over time the taste effect will wear off but current tastes are clearly reflected in current acquisitions and therefore in recent stock.

It is possible to eliminate some of the influence of small stock differences due to taste differences by categorizing libraries into size groups and using the resulting dummy variables as an instrument for stock. To the extent that this method is successful, the estimates will be consistent. This will be discussed below.

To summarize, the equation to be estimated uses per capita locally financed expenditure on libraries (L) as the dependent variable. Given the amounts of federal aid and the state aid, the decision about the total library budget is behaviorally equivalent to the decision about locally financed expenditure on libraries.

Expenditure on libraries depends on five types of variables: (1) price variables; (2) income variables; (3) tax structure; (4) taste variables; and (5) expenditure

on other public goods and services. Table 2.1 shows the specific variables used in the estimation.

Linear equations were estimated for the sample as a whole and for three population subgroups: population served by the library between 25,000 and 50,000; population served between 50,000 and 100,000; and population served between 100,000 and 500,000. Very large metropolitan libraries with large reference services may have very different processes of budget appropriation from both small and medium sized community libraries. Therefore libraries serving cities with more than 500,000 inhabitants were omitted from the subgroups, although they are included in the overall estimation.

Both ordinary least squares (OLS) and instrumental variables (IV), to correct for the relation between stock and tastes and between related expenditures and tastes, have been estimated. In general the consistent IV estimator (described in Section III) caused very minor changes in the coefficients. Therefore the equations have not always been estimated by IV, and some OLS results are presented.

Because of the nonresponse for certain variables, the sample size differs depending on the specification of the equation. There are always more than 90 degrees of freedom (DF) except for some equations for the population

Table 2.1

Definitions of Variables Used in Expenditure Equations*

Variable Type	Symbol	Definition
Dependent Variable	Local	Locally financed expenditure on libraries, per capita.
Intergovernmental Aid	State Block Grants per Capita	Dollar amount of state aid for public libraries.
	LSCA: Federal Grants per capita	Federal grants per capita, under Library Services and Construction Act.
Price Variable	Protax	Property tax revenue as a proportion of total local tax revenue.
Related Public Expenditures	Education Expenditure	Local expenditure on education.
	Park Expenditure	Local expenditure on parks and recreation.
	Public Welfare Expenditure	Local expenditure on public welfare.
Socio-demographic Variables	Med Inc	Median family income.
	Loinc	Proportion of families with income less than $3,000.

Table 2.1 continued

Variable Type	Symbol	Definition
Socio-demographic Variables (cont.)	Hiinc	Proportion of families with income greater than $10,000.
	Med Ed	Median Years of school completed among adults.
	Loed	Proportion of adults who have completed less than 5 years of education.
	Hied	Proportion of adults who have completed 12 or more years of education.
	Percent Nonwhite	Proportion of population who are nonwhite.
	Pop Incr	Percentage change in population 1950-1960.
	Med Age	Median age of population.
Other	Stock per capita	Number of volumes held at end of year, per capita.

* Table A-1 of Chapter I gives complete definitions of the variables, with sample means, standard deviations, maxima and minima.

groups. Even with these samples there are always at least 30 degrees of freedom.

III. The Results

The following analysis of the estimation considers three separate issues. First is the effect of intergovernmental aid on local expenditures. Second, the income and taste distribution of local communities is considered. Here the median voter model of local expenditure can be compared with a pressure group model and the incremental budget model. Finally the relation between library budgets and other local expenditures is considered.

The basic equation estimated is:

$$L = a_1 S + a_2 F + a_3 \text{ Protax} + a_4 \text{ Medsch} + a_5 \text{ Inc} + a_6 \text{ Stock} + u.$$

The equations estimated in Tables 2.2 through 2.7 are all variants of this equation. Tables 2.2 and 2.3 suggest that local communities substantially substitute state library aid for previous local own expenditure. For libraries as a whole, a one-dollar increase in state aid leads to a decline of about 80 cents in local own expenditures on libraries. Where equations are estimated separately for communities of different size (see Tables 2.4 through 2.7), it appears that this substitution occurs mainly in communities with population less than 50,000. In these small communities the coefficient of state aid implies that there is complete substitution. For medium-sized and large communities the effect of state aid is uncertain. The point estimates suggest that there is partial substitution, but the standard errors are large

Table 2.2

Locally Financed Expenditure on Library Services: All Libraries*

	(1)	(2)	(3)
State Block Grants per capita	-.820	-.666	-.832
	(.343)	(.341)	(.328)
LSCA: Federal Grants per capita	.658	.614	.453
	(.481)	(.478)	(.463)
Protax	-1.796	-1.523	-1.359
	(.465)	(.429)	(.469)
Loed	.037		.035
	(.036)		(.035)
Hied	.009		.016
	(.013)		(.014)
Med Ed		.095	
		(.090)	
Loinc	-.065		-.080
	(.024)		(.026)
Hiinc	.036		.032
	(.016)		(.017)
Med Inc		.00046	
		(.00008)	
Stock per capita	1.492	1.486	1.578
	(.104)	(.103)	(.106)
Percent Nonwhite			.032
			(.010)
Pop Incr			.0005
			(.0005)
Constant	1.833	-2.020	1.019
	(.730)	(.904)	(.732)
$\bar{R}^2$	.62	.62	.66
D.F.	207	209	199

* The equations were estimated by ordinary least squares. Standard errors are shown in parentheses. The dependent variable in both equations is Local. All variables are defined in Table 2.1.

Table 2.3

Locally Financed Expenditure on Library Services: A Comparison of Ordinary Least Squares and Instrumental Variables Estimates*

	(1)	(2)
State Block Grants per capita	-.820 (.343)	-.712 (.359)
LSCA: Federal Grants per capita	.658 (.481)	.712 (.486)
Protax	-1.796 (.465)	-1.692 (.478)
Loed	.037 (.036)	.030 (.037)
Hied	.009 (.013)	.008 (.013)
Loinc	-.065 (.024)	-.064 (.024)
Hiinc	.036 (.016)	.039 (.016)
Stock per capita	1.492 (.104)	1.327 (.188)
Constant	1.833 (.730)	2.063 (.765)
$\bar{R}^2$	.62	
D.F.	207	207

* Equation 2 was estimated by instrumental variables with stock endogenous. Four dummy variables were created corresponding to stock size groups: Sta = Stock per capita less than 1.1279; Stb = Stock per capita between 1.1279 and 2.0872; Stc = Stock per capita between 2.0872 and 3.0465; Std = Stock per capita greater than 3.0465. These dummy variables were used as instruments for stock. Standard errors are shown in parentheses. The dependent variable in both equations is Local. All variables are defined in Table 2.1.

Table 2.4

Locally Financed Expenditure on Library Services: Libraries Serving Communities with Population less than 50,000*

	(1)	(2)	(3)
State Block Grants per capita	-1.301	-1.196	-1.323
	(.450)	(.442)	(.426)
LSCA: Federal Grants per capita	.893	.883	.990
	(.619)	(.602)	(.582)
Protax	-1.264	-1.226	-.923
	(.699)	(.634)	(.672)
Loed	-.016		
	(.050)		
Hied	-.008		
	(.017)		
Med Ed		.042	.078
		(.125)	(.141)
Loinc	-.038		
	(.035)		
Hiinc	.054		
	(.020)		
Med Inc		.0005	.0004
		(.0001)	(.0001)
Stock per capita	1.463	1.466	1.533
	(.146)	(.140)	(.156)
Percent Nonwhite			.007
			(.014)
Med Age			.034
			(.039)

Table 2.4 continued

	(1)	(2)	(3)
Pop Incr			.0008 (.0007)
Constant	1.682 (.984)	-2.093 (1.24)	-3.667 (2.09)
$\bar{R}^2$	.65	.66	.70
D.F.	97	99	91

* The equations were estimated by ordinary least squares. Standard errors are shown in parentheses. The dependent variable in all equations is Local. All variables are defined in Table 2.1.

Table 2.5

Locally Financed Expenditure on Library Services: Libraries Serving Communities with Population between 50,000 and 100,000*

	(1)	(2)	(3)
State Block Grants per capita	-.602	-.611	-.086
	(.758)	(.828)	(.876)
LSCA: Federal Grants per capita	2.800	2.453	1.109
	(1.513)	(1.688)	(1.936)
Protax	-2.103	-1.445	-1.951
	(.826)	(.873)	(.990)
Loed	.249		
	(.076)		
Hied	.089		
	(.030)		
Med Ed		.232	.176
		(.199)	(.214)
Loinc	-.119		
	(.042)		
Hiinc	-.027		
	(.033)		
Med Inc		.0003	.0005
		(.0002)	(.0002)
Stock per capita	1.594	1.670	1.736
	(.198)	(.215)	(.237)
Percent Nonwhite			.026
			(.024)
Med Age			-.055
			(.052)

Table 2.5 continued

	(1)	(2)	(3)
Pop Incr			.0002 (.001)
Constant	-1.292 (1.52)	-3.632 (1.89)	-2.188 (2.99)
$\bar{R}^2$	.68	.61	.61
D.F.	49	51	47

* The equations were estimated by ordinary least squares. Standard errors are shown in parentheses. The dependent variable in all equations is Local. All variables are defined in Table 2.1.

Table 2.6

Locally Financed Expenditure on Library Services: Libraries Serving Communities with Population between 100,000 and 500,000*

	(1)	(2)	(3)
State Block Grants per capita	-.425	-.133	.063
	(.716)	(.656)	(.571)
LSCA: Federal Grants per capita	-.561	-.473	-.295
	(.907)	(.827)	(.712)
Protax	-2.044	-1.896	-1.152
	(.922)	(.746)	(.743)
Loed	-.003		
	(.081)		
Hied	-.024		
	(.035)		
Med Ed		-.140	-.142
		(.180)	(.167)
Loinc	-.087		
	(.053)		
Hiinc	.150		
	(.070)		
Med Inc		.0015	.002
		(.0003)	(.0003)
Stock per capita	1.152	1.212	1.412
	(.218)	(.199)	(.186)
Percent Nonwhite			.037
			(.013)
Med Age			-.087
			(.045)

Table 2.6 continued

	(1)	(2)	(3)
Pop Incr			-.0003 (.0017)
Constant	3.505 (2.05)	-4.315 (2.03)	-6.122 (2.69)
$\bar{R}^2$	.72	.75	.81
D.F.	33	35	32

Table 2.7

Locally Financed Expenditure on Library Services: Instrumental Variables Estimates*

	(1)	(2)	(3)
State Block Grants per capita	-1.247 (.452)	-.538 (.763)	-.434 (.717)
LSCA: Federal Grants per capita	.943 (.621)	2.804 (1.515)	-.584 (.908)
Protax	-1.209 (.701)	-2.053 (.830)	-2.077 (.923)
Loed	-.024 (.050)	.251 (.076)	.0005 (.081)
Hied	-.009 (.017)	.090 (.030)	-.022 (.035)
Loinc	-.035 (.035)	-.120 (.042)	-.088 (.053)
Hiinc	.056 (.020)	-.027 (.033)	.144 (.070)
Stock per capita	1.370 (.158)	1.521 (.217)	1.219 (.217)
Constant	1.830 (.990)	-1.235 (1.52)	3.406 (2.05)
D.F.	97	49	33

* Equation (1) is for communities with population less than 50,000; equation (2) refers to communities with population between 50,000 and 100,000; equation (3) refers to communities with population between 100,000 and 500,000. The equations were estimated by instrumental variables with stock endogenous. See footnote to Table 2.3 for a description of the instruments. Standard errors are shown in parentheses. The dependent variable in all equations is Local. All variables are defined in Table 2.1.

relative to the coefficients. Although these coefficients for the influence of state aid may be biased if there are state matching plans, the effect of the bias would be an underestimate of the negative influence of unconditional aid.

The coefficient on federal LSCA aid suggests that there has been an error in the classification. Since block aid has only an income effect, the coefficient should be negative or close to zero. In fact, the coefficient is positive, although it is generally not significant. This probably results from a combination of matching provisions, which were not known for this study, and aid for special projects which would be associated with increases in local own expenditure.

The ratio of property tax receipts to all tax receipts, called Protax in the regressions, was used as a price variable. It consistently has a significant negative influence on library expenditures. The variable measures the importance of the property tax in the community's revenue sources. The more reliant the community is on the property tax the fewer dollars it allocates to public libraries. This must be related to the voters' perception of the burden of this tax. The larger is the proportion of tax revenue from non-property sources, the more likely is the burden to be exported.

The estimation shows that family income level is a major determinant of local library expenditure. Two income measures were used, median income and proportions at the extremes of the income distribution. Median income has often been used as a proxy for the median voter. The median voter's preferences for additional consumption are a positive function of his income, among other things. Therefore higher median income should mean higher expenditure. The evidence is that the level of median income is indeed related to library expenditure in every size community. Proportions at either end of the income distribution indicate the possible importance of pressure groups. In general, the existence of more families at the lower end of the income distribution implies a significant negative influence on library expenditure, while the presence of more higher income families is associated with more library expenditure. The exceptions to this strong general pattern are that in small communities the negative influence of low income loses significance and that in medium-sized communities the influence of high income is not different from zero.

Education groups were included also as indicators of potential pressure groups. The estimates suggest strongly that education level is an important determinant of library expenditure in medium-sized communities and that it is insignificant in small and large communities. Other socio-

demographic variables were in general insignificant. However, in large communities a higher percent nonwhite implies significantly more expenditure on public libraries, while median age exerts a significantly negative influence (see Table 2.6).

To summarize, the most important population characteristic for explaining library expenditures is the level of family income. While median income level is a good indicator of this influence, the estimation shows that proportions at income extremes are also important measures of potential pressure groups. The evidence shows that the two models do about equally well at explaining the level of local expenditure. Using Theil's criterion for choosing between 2 specifications (Theil, p.214), the model with the higher corrected multiple correlation coefficient ($\bar{R}^2$) should be preferred. In fact, the models have equal $\bar{R}^2$ for the overall sample. By this criterion the pressure group model is preferable only for communities with population between 50,000 and 100,000. For larger communities the median income hypothesis is preferable. For small communities the $\bar{R}^2$ for the median voter model is higher than that for the pressure group model but by only .01.

The influence of education level seems to be important only in medium-sized communities. These results, which are concerned with the demand for provision of library services,

will be contrasted with the influence of population characteristics on the demand for library use in Chapter 4.

As expected, stock has a significantly positive effect, suggesting that there is a desire to maintain a given resource. A consistent estimator, based on the Wald method (1940), was used in addition to OLS. Four dummy variables were created, corresponding to "stock per capita (pc) less than the mean stock per capita minus one standard deviation (s.d.)," "stock pc between the mean minus one s.d. and the mean stock pc," "mean stock pc plus one s.d.," and "stock pc greater than the mean plus one s.d." These dummy variables were used as instruments for stock, in the hope that some of the small differences in stock due to tastes would be eliminated. The consistent estimators generally differ from the OLS estimates by less than 10 percent. This suggests that the bias may be small in relation to the true impact of past investment. The results are tabulated in Tables 2.3 and 2.7.

It proved difficult to take account of the possible endogeneity of related local expenditures. A large proportion of the sample did not report education expenditures, perhaps because of non-overlapping library and school districts. Therefore in most equations related expenditures were omitted. Table 2.8 shows the results of applying a consistent instrumental variables estimator to a sample of 121 libraries. In

Table 2.8

Locally Financed Expenditure on Public Libraries:
Effects of Related Expenditures*

Equation	Education Expenditure	Park Expend.	Public Welfare Expend.	Protax	Income	Median Educ.	Stock	Constant	DF
1	-2.061			-1.511	.0009	.044	.585	-2.248	115
	(4.149)			(.995)	(.0002)	(.115)	(.115)	(1.37)	
2	5.093	132.55		-.458	.0010	-.096	.509	-3.593	114
	(4.957)	(45.53)		(1.094)	(.0002)	(.129)	(.122)	(1.49)	
3	1.605	93.457	11.946	-1.110	.0011	-.062	.501	-3.494	113
	(5.680)	(55.36)	(9.876)	(1.207)	(.0002)	(.130)	(.121)	(1.48)	

* The equations were estimated by instrumental variables; the three related expenditures are excluded from the instrument list. Standard errors are shown in parentheses. The dependent variable in all equations is Local. All variables are defined in Table 2.1. The following instruments were used: population, number of branches, population increase, median age, school enrollment, all expenditures excluding capital expenditures.

these equations related expenditures were included as explanatory variables, and the following instruments were used: population, number of branches, population increase, school enrollment, all expenditures excluding capital expenditures.

The surprising result that there is no significant relation between school and public library expenditures might be explained by looking at school library funds. It may be that communities which spend heavily on education also provide good school libraries and that school children then use these rather than the public library. The significantly positive relation between library expenditure and recreational expenditure is also surprising. Towns which have high parks and recreation expenditures may also have a high property tax dependence, given the other variables in the equation. This may explain why the property tax variable is insignificant for the equation. Finally it appears that library expenditure is not in competition with public welfare expenditure; the coefficient is positive but has a large standard error.

IV. Conclusion

This chapter has investigated one aspect of the demand for public libraries: the provision of local funds for public libraries. The model is based on elements of individual demand theory. Individual preferences are aggregated into pressure group influences on local decision-makers. This pressure group hypothesis is combined with an incremental budget model, which uses stock as a proxy for the previous year's budget. Stock also represents a resource endowment for the community. The estimation also emphasized the influence of intergovernmental aid on local preferences.

The results suggest that unconditional state aid does lead to substitution of intergovernmental grants for own expenditure, particularly in small communities. The possible bias from the omission of price information implies that the true substitution effect may be even greater than these estimates.

The significant coefficient of median income in the present series of regressions appears to support the hypothesis that the median quantity of public library services demanded by the community's voters can be approximated by using the preferences of the median income voter (as suggested by Bergstrom and Goodman, 1973, and Borcherding and Deacon, 1972). However, it is clear that other income

groups also have significant effects on library expenditure. A higher proportion of low income voters has a significantly negative influence on medium-sized communities and the proportion of high income families is significant and positive in small and large communities. Thus the ability to explain a significant proportion of variation in expenditure by the level of median income cannot justify using the median income approximation without testing the influences of other income groups. In addition, tests should be made for other potential pressure groups, especially those which are expected to use the service. For public libraries, education and age groups would be potential influence groups. The estimates suggest that education is generally insignificant except in medium-sized communities where both the proportion with low education and the proportion with high education exert positive influences on the level of spending. Nor does the median age of the community seem to matter in general, although it does have a significantly negative impact in large communities.

Chapter 3.

PUBLIC LIBRARY COSTS

In Section One of this chapter there will be a general discussion of the nature of library costs. Section two will analyze library cost functions. Before discussing the nature of library costs and their relationship with size, it is worth considering what policy implications might be drawn from a study of library costs. National library policy for the last several years has emphasized the development of library systems or regional networks. The purpose has been to bring public library service within easy approach of all and to provide access through links with higher levels of the system to all types of library service. To prepare such a national library network adequately, a knowledge of scale effects and of optimal location of libraries would be desirable. This chapter should provide some information for this purpose.

In addition, the estimation of library cost functions will give information about the desirability of public subsidies. As discussed in the first chapter, one of the main arguments for public support of libraries is that the marginal cost of providing the service is close to zero or at least less than average cost. It is important that some test of this argument be made.

I. The Nature of Library Costs

In 1968 for all public libraries serving areas with at least 25,000 inhabitants, 64.3 percent of operating expenditures were for wages and salaries and 18.2 percent were for library materials, including books and audio-visual items, and binding. The remaining 17.5 percent is reported only as services from other libraries and all other operating expenditures. The state averages of wages and salaries expenditures ranged from a low of 54.4 percent in North Dakota to a high of 74.3 percent in the District of Columbia. The low state share for books and binding was in Michigan with 13.8 percent and the high was in Hawaii with 29.5 percent. The mean wage share for the libraries used in the sample is approximately 65 percent and the mean book share is approximately 15 percent. There is a considerable range, however, going from 19 percent to 80 percent for wages and salaries and from 5 percent to 42 percent for materials.

In one of the few studies of library costs, Baumol (1969) emphasizes the importance of library staff in the production of library services and argues that the possibilities for improved labor productivity are extremely limited. He compares libraries to colleges in this respect and argues that library costs will inexorably rise relative to average cost increases in the economy.

The large variation in the share of expenditures allocated to staff in the current sample suggests that there may be more variation in labor productivity than the national and state averages would imply. In fact output per staff does vary, from a low of 2,800 volumes circulated per staff member to a high of 35,270 with a mean of 12,740. The coefficient of variation is 39 percent. The possibilities for improved labor productivity depend critically on the possibility of introducing labor-saving innovations in library technology. It is clear that there are automatic techniques which are applicable to certain facets of library operation, in particular cataloging and check-out procedures. Other parts of library service, for example reference, depend more on personal service by librarians and are therefore more difficult to automate. Since reference services are more important in large libraries, there should be a tendency for labor productivity to fall as libraries increase in size. However, it is not economic to introduce automatic equipment for very small libraries. This factor should tend to raise output per staff as library size increases. It is difficult to separate these two influences with the kind of data that is currently available.

The trend toward systems may lead to some changes in future characteristics of library costs. Book purchases

may be reduced because interlibrary loan programs may eliminate the need for certain specialized books throughout the system. Interlibrary cooperation may allow automated cataloging and processing procedures to become economic and may lead to improved labor productivity.

Baumol does not investigate the influence of branches on library costs. In an unpublished study of costs in British public libraries, Jacob Moreh (1970) found that expenditures and labor requirements increase more than proportionally with branches.

II. Cost Functions

Economies of scale can be studied from cost functions or from the production function. The production function provides additional information about the relative productivity of different factors of production. However, certain conditions must be met in order to estimate a production function. In particular, it must be assumed that production is operating along the production possibility frontier for efficiency. In the case of the public library, this assumption is unlikely to hold. Because of their very nature there is likely to be excess capacity in libraries, except for certain types of book at certain times. The option demand characteristic of libraries, which was discussed in Chapter One, is one reason for this. The public library serves as a community archive which at some uncertain time may be demanded. At any given time, a small fraction of the library's books are in demand.[1]

---

[1] Although a production function for the public library is likely to be a misspecification, regressions were estimated using circulation as the dependent variable and factor inputs as explanatory variables. Both Cobb-Douglas and Constant Elasticity of Substitution functions were estimated. The results obtained were consistent with the cost functions estimated in this chapter and with the production function estimates of Goddard who studied small Indiana public libraries (Goddard, 1973). The regressions implied that returns to scale in library circulation decline from approximately constant returns in communities with less than 35,000 inhabitants to significantly decreasing returns to scale in communities with populations between 100,000 and 500,000 inhabitants. A production function for libraries was estimated with time series data by Black (1969). Unfortunately the sample was not comparable from year to year. The author used dummy variables to attempt to adjust for the growth of the sample. An additional problem was high correlation between bookstock and labor inputs (0.99), which made the standard errors very large and both coefficients insignificant.

The existence of excess capacity does not affect the usefulness of estimating cost functions, which will be presented in this section. The cost functions suggest that marginal operating costs are substantially greater than zero for the circulation function of the library. The data used in this study do not include information on capital depreciation and imputed interest payments. Therefore total operating expenditures are not equivalent to total cost. The cost functions estimated in this chapter therefore refer only to operating costs.

Cost functions represent measures of production costs as functions of scale measures. The dependent variable may be total or average cost, and marginal cost estimates can be derived from the total cost functions. Two possible measures of scale for the cost function are output and fixed capital stock, in this case volumes of books held. Since stock is used for non-circulation services, it is more inclusive of library costs than the available output measure, circulation, but for estimating marginal cost, output is a better measure of scale.

An additional aspect of library size that should have an influence on costs is the number of branches. There are two ways of including this influence: by entering the number of branches as a separate variable in the cost functions, or by estimating costs per branch. The difficulty is

that the variable is not standardized, e.g., there is wide variation in the size of branches and in the number of hours of operation. Again both approaches are taken. If a consistent pattern emerges, more confidence can be placed in individual estimates.

Finally, a measure of intensity of capital utilization can be constructed for libraries, and included in the cost functions. This will serve as an indicator of short-run cost variations, although cross-section cost functions usually refer to the long-run.

Thus the cost measures of interest are: total operating cost (TOC), average operating cost (AOC), and marginal operating cost (MOC). The functions to be estimated are:

$$TOC = f(C,B),$$

$$AOC = f(S,I,B),$$

$$TOC/B = f(C/B),$$

where

TOC = total operating expenditures,

C = circulation,

AOC = TOC/C

B = number of branches

S = number of volumes held,

I = C/S.

Table 3.1 shows total cost estimates for all

Table 3.1

Cost Functions with Scale Measured by Circulation*

Equation	Dependent Variable	C	C^2	B	C/B	$(C/B)^2$	Constant	$\bar{R}^2$	DF
1	TC	.733 (.018)					$-.134 \cdot 10^5$ $(.106 \cdot 10^5)$	.827	354
2	TC	.730 (.042)	$.134 \cdot 10^{-8}$ $(.159 \cdot 10^{-7})$				$-.125 \cdot 10^5$ $(.147 \cdot 10^5)$	.826	353
3	TC	.527 (.025)		43256 (3880)			$-.500 \cdot 10^5$ $(.106 \cdot 10^5)$	.876	312
4	TC	.496 (.044)	$.122 \cdot 10^{-7}$ $(.145 \cdot 10^{-7})$	43549 (3897)			$-.420 \cdot 10^5$ $(.143 \cdot 10^5)$	.875	311
5	TC	.505 (.025)		37426 (3798)				NA	313
6	TC	.413 (.035)	$.407 \cdot 10^{-7}$ $(.110 \cdot 10^{-7})$	41505 (3881)				NA	312
7	TC/B				.464 (.020)		$.303 \cdot 10^5$ $(.439 \cdot 10^4)$	.626	313
8	TC/B				.443 (.055)	$.373 \cdot 10^{-7}$ $(.906 \cdot 10^{-7})$	$.323 \cdot 10^5$ $(.658 \cdot 10^4)$	.625	312

* The equations were estimated by ordinary least squares. Standard errors are in parentheses. $\bar{R}^2$ is not reported for equations 5 and 6 because they were constrained to have no intercept.

libraries with less than one million volumes. The few libraries with more than one million volumes were arbitrarily excluded as being more likely to be reference libraries and to have a different circulation and cost pattern. All equations were estimated by ordinary least squares. Before discussing the implications of the estimates, some average figures should be mentioned. The mean expenditure for all these libraries in 1968 was $292,420 and the mean circulation was 417,160. The mean average cost per circulation was about $.705. The average stock size was 140,830 and the mean average cost per volume was $2.01. The average intensity of utilization was 3.2 with a range from .520 to 9.09.

With these figures in mind, the estimates in Table 3.1 are easier to interpret. The linear total cost function in equation 1, with scale measured by output, implies a constant marginal cost of $0.73, which is slightly greater than the observed average cost for the sample. The quadratic function, equation 2 in Table 3.1, yields a marginal cost, estimated at the mean, of $0.73. The quadratic term is not significant.

The number of branches is a significant and positive variable as can be seen in equations 3 and 4. The marginal cost of circulation estimates, when the number of branches is held constant, drop to $0.53 and $0.51, less

than average cost. Since the number of branches acts something like a constant term, these equations were re-estimated without an intercept. The results, shown in equations 5 and 6, are similar, with even lower marginal cost estimates ($0.51 and $0.44). The implication of these results is that operating diseconomies for the system as a whole coexist with potential economies at the branch level. This is further supported by equations 7 and 8 which are estimates of per branch cost functions. The estimates of the marginal cost of additional circulation per branch are $0.46 and $0.45 respectively. The quadratic terms are uniformly insignificant.

These estimates are based on variable costs only. If capital costs are not a function of output, the marginal cost estimate would not be affected by the inclusion of fixed costs. Average cost would, however, be higher. Marginal cost may therefore be less than true average cost. The implication is that marginal cost pricing, while still the optimal policy, would not fully cover costs. Public subsidy would be necessary, at least for library construction. If capital costs are a function of circulation, marginal costs as well as average costs will be higher but average cost may still be greater than marginal. The optimum pricing policy will still be to charge marginal operating cost.

The influence of stock size on library costs can

be interpreted more easily in average cost functions, where costs are adjusted for output differences, than in total cost functions. Table 3.2 shows average variable cost functions for all libraries with stock less than one million volumes. Equation 1 implies that unit costs rise with stock size to a maximum near 668,000 volumes, after which average variable cost declines. Table 3.3 shows the average variable cost at various stock sizes. Equations 2 and 3 in Table 3.2 show that changes in capacity utilization are by far the most significant factor in explaining average variable cost. This suggests the importance of estimating a circulation function, which will be examined in the next chapter on library demand.

If the size of the stock is 150,000 volumes (slightly greater than average stock size for the sample), equation 2 implies that average variable cost is about $(1.11 - .1(C/S)). At average intensity of utilization (3.2), the average variable cost is greater than observed average variable cost for the sample. For average variable cost at this size to be equal to observed average variable cost for the whole sample, intensity of utilization must be about 4.

Another way to interpret equation 2 is to examine the relation between unit costs and stock size, holding intensity of utilization constant. The relation is similar to that in equation 1. Average variable cost rises with

Table 3.2

Average Cost Functions with Scale Measured by Size of Stock*

Equation	Dependent Variable	S	S^2	C/S=I	B	Constant	$\bar{R}^2$	DF
1	AC	$.124 \cdot 10^{-5}$	$-.928 \cdot 10^{-12}$			.567	.072	353
		$(.304 \cdot 10^{-6})$	$(.389 \cdot 10^{-12})$			(.034)		
2	AC	$.581 \cdot 10^{-6}$	$-.308 \cdot 10^{-12}$	-.122		1.028	.331	352
		$(.264 \cdot 10^{-6})$	$(.334 \cdot 10^{-12})$	(.010)		(.048)		
3	AC	$-.208 \cdot 10^{-7}$	$-.933 \cdot 10^{-13}$	-.125	.026	1.040	.335	310
		$(.342 \cdot 10^{-6})$	$(.353 \cdot 10^{-12})$	(.011)	(.010)	(.053)		

* The equations were estimated by ordinary least squares. All variables are measured in logs. The dependent variable, average cost, is AC = TC/C. The explanatory variables are: S = size of stock per capita, S^2, and C/S. The last variable measures intensity of capacity utilization and is sometimes referred to as I. The standard errors are in parentheses.

Table 3.3

Average Cost as a Function of Stock Size

I. Costs based on Equation 1, Table 3.2

Stock Size	Average Cost
50,000	.627
100,000	.682
150,000	.732
500,000	.955
1,000,000	.879

II. Costs based on Equation 2, Table 3.2, holding C/S constant at its average value (3.2).

50,000	.670
100,000	.697
150,000	.722
500,000	.856
1,000,000	.915

III. Costs based on Equation 3, Table 3.2, holding C/S constant at 3.2 and B constant at its average value (4.4).

50,000	.758
100,000	.756
150,000	.754
500,000	.726
1,000,000	.649

stock size but now reaches a maximum at a higher level of volumes, about 943,000. Again Table 3.3 shows average variable cost at various sizes when capacity utilization is held constant. Finally, equation 3 shows that where both branches and intensity of utilization are held constant, there is no significant relation between stock size and average cost.

The meaning of these results is that average variable cost rises with size of stock (as implied in equation 1) as a result of two factors. Average intensity of utilization falls as stock size increases while the number of branches increases.[2] Equations 2 and 3 show that the influence of each of these factors is to raise average variable cost. The partial effect of stock increases is itself an insignificant factor.

---

[2]The relationship between intensity of utilization and stock size can be seen by looking at the partial effects of changes in stock and in intensity of utilization on average cost. If stock is held constant at, say, 150,000, which is slightly greater than the sample average, equation 1 shows that $\frac{dAC}{dS}$ is approximately .96 (10^{-6}). Similarly, still holding stock constant at 150,000 and now also holding intensity of utilization constant, equation 2 shows that $\partial AC/\partial S$ is .49 (10^{-6}). Since $\frac{dAC}{dS} = \frac{\partial AC}{\partial S} + \frac{\partial AC}{\partial I}\frac{dI}{dS}$, the second term on the right-hand side must be positive. From equation 2 it is clear that $\frac{\partial AC}{\partial I}$ is negative. Therefore dI/dS must also be negative.

The main conclusion to be drawn from the cost functions is that library systems exhibit slightly decreasing returns to scale while individual library branches have increasing returns to scale. From a pure efficiency viewpoint there are economies to be gained from reducing the number of branches in a library system. However, there are distributional reasons for establishing library branches. These may be more important than the cost reductions that might be possible from expanding individual plants.

Since the existence of economies of scale is such an important policy question, the results of the estimation suggest that more data about branch size and factors influencing capacity utilization should be gathered. Individual communities which face expansion decisions and regions which are considering the establishment of regional library systems could benefit from such information. Initial inefficiencies from increasing branches may have to be weighed against the distributional advantages of additional branches.

The implication of these results for library planning is that having fewer large branches is probably preferable to having more small branches. This may seem to contradict the policy implications of previous studies which show that library use falls off quickly with distance from the nearest

branch (Ennis, 1972). However it may be that use falls off so quickly that whenever individuals have to travel more than a few blocks, they will choose the best available library rather than the nearest. Whenever the individual travels by car this would seem the likely decision rule. The demand results of Chapter 4 will show in fact that negative influences, such as poorer quality of stock, associated with additional branches apparently prevail and that the total effect on circulation of additional branches is insignificant or negative. Therefore both cost and use factors suggest that planners should prefer expansion through existing branches rather than through new branches. Of course, distributional advantage of additional branches may override efficiency considerations.

The cost functions estimated in this Chapter suggest that the current zero price policy of public libraries should be reconsidered. It is clear that marginal operating cost is substantially greater than zero and closer to average operating cost than to zero. Charging borrowers system marginal operating cost would approximately cover total operating cost. If price were equal to branch level marginal operating cost, revenue would not fully cover total operating cost. Neither pricing method would cover capital and interest costs, for which public support would still be required, as a minimum.

If prices are to be introduced into public libraries, there are two general approaches. One is to institute a charge for a library card; the other is to charge separately for individual services. The second approach would allow efficient marginal cost pricing for each service but it would be difficult to monitor the exemptions from charges which might be desired on distributional grounds. It would also require that marginal cost estimates be made for reference services, in-library use, and so on. The marginal cost figures estimated here attribute the costs of all services to circulation. It would be impractical and unfair to charge borrowers for non-circulation costs. The fee for book circulation would have to be considerably less than the figure estimated here. Some analysis of the price elasticity of demand would be required as well. Perhaps the most practical method would be a general borrower's file with several possible charges, combined with some rental arrangement for current best-sellers.

Chapter 4.

INDIVIDUAL DEMAND FOR PUBLIC LIBRARY SERVICES

This chapter will investigate the determinants of individual demand for the public library and the possible implications for library policy. Section I applies the theory of consumer search behavior to the market for books. This market is an example of a market with an equilibrium dispersion of prices. Product differentiation, consumer ignorance, search costs, differing valuations of ownership benefits and of book durability all contribute to the coexistence of many versions of a particular book. In addition to hardback and paperback editions, the public library, the rental library and the bookclub are separate sources for the same book. In this section the interdependence of library demand and market demand for books in general will be analyzed. The influence of consumer search behavior on library and bookstore inventory policy will be considered.

In section II an aggregate demand equation based on the elements of individual choice behavior is developed. Finally section III describes the estimation of such an aggregate demand equation.

I. Consumer Search

The library attracts two types of readers: those who are interested in a particular book or books, and those who are primarily interested in browsing, possibly followed by choosing particular books. For each type of reader there are two choices. The first is the decision to buy or to borrow; the second is the choice of a final consumption bundle. Involved in these choices are elements peculiar to the nature of the market, as well as elements common to all consumer goods. Any good which may be rented or purchased can be analyzed similarly.

In choosing between buying and borrowing a particular book the consumer must evaluate the relative cost at the library over the bookstore and the benefits of ownership. The cost at the bookstore includes price, the probability that the book is not stocked, the search time, and the travel time. At the library, the cost includes again the probability that the book is not in stock or is out on loan, the search time, the travel time, and,in addition,the limited loan period and the cost of return trips.

The relative benefits of ownership depend on the type of book and its durability. For a best seller the ownership benefits are high at first, but drop very low once the book has been read, or the paperback edition is available, or the library queue has disappeared. For a reference book the ownership

benefits are probably steady but may never be as high as for the best seller. The market for used books suggests an index for relative ownership benefits and the rapid rate of decline of these benefits.[1]

If the consumer is interested solely in a particular book, he can reduce the cost of the book at both sources by a telephone inquiry. If he does not call in advance, it can be assumed that there is some extra utility from making the trip. If the individual does make advance telephone calls and then chooses to borrow rather than buy, it can be assumed that

$$V(B) - P_L - W_L > V(B) + V(0) - P_B - W_B \,, \qquad 4.1$$

where V(B) is the value in dollars of reading the book, V(0) is the value of owning the book, P are the prices at each source, and W are the waiting costs at each source.

Library and bookstore browsers, as well as readers who seek a specific book but are induced to make further use of library or bookstore services, will follow a search process.[2] A major distinction between book search (for simplicity, "book" search will be used to refer to search in

---

[1] Newhouse and Alexander (1972) suggest using rental library charges. However many more books are available in the used book market than in the rental market.

[2] The extensive economic literature on search behavior began with Stigler (1961). For a good summary of this literature through 1972 see Hirshleifer (1973).

either the library or the bookstore) and the process usually considered in consumer search models is that in the present case the search does not always enter the individual utility function with a negative sign. Search is a form of consumption with positive utility attached to it. This feature is not unique to the market for books. Other examples are art and music, and to a lesser extent, restaurants and individual foods. The latter differ slightly in that the potential positive gain from further search must be balanced against the potential loss from foregoing the most highly valued previous sample. For books and the arts the very novelty of further sampling is a positive gain. Search can thus sometimes be considered a leisure good or form of recreation with price equal to the time lost. Even comparison shopping for a lower price engaged in by consumers who have a relatively low opportunity cost of time is to some extent a leisure good. Search as fun, in the form of browsing, is distinct from search for a particular book where search does have the usual negative value.

At some point the negative utility value of lost time must equal or outweigh the gains from search, the gains including both the value of the information and of the consumption. There is a trade-off between the time cost of search and the information-consumption benefits for both present and future periods. The usual rule for optimality

holds: search should be continued until the expected marginal benefit from further search equals the expected marginal cost.

It should be noted that library search is a search for quality and not for price. Within the library most elements of the relative library price, which were outlined earlier, do not vary. The search for quality is exactly analogous to the search for the lowest price. The only difficulty is for the consumer to establish mentally a reservation quality which is used to determine the optimal sampling strategy.

Optimal sampling strategy for the browser involves choosing a method of scanning the bookshelves. Morse (1970) has suggested that optimal browsing strategy is similar to the process of optimal radar search for submarines. The individual must evaluate the "interest potential", defined as the ratio of the expected number of books of interest to the total number of books, of each library section. If this is equal over sections, the optimal strategy is to allocate a fixed amount of time equally over all sections. If the interest potential is unequal, the individual must concentrate his search accordingly. Section III will relate this search factor to the empirical estimates of demand.

A variation of Morse's model and the usual search model can be used for the individual to choose between the library and the bookstore. Instead of a fixed amount of time,

the individual has a reservation time. While he enjoys the browsing or search process, he knows that after some point diminishing returns set in and the opportunity cost of time rises. In addition, it is assumed that the individual can establish a reservation quality, or minimum satisfaction level.

Consider the optimal amount of search time for the individual. If this can be determined for the library and for the bookstore, it can be used to evaluate the expected gain from using the library and that from using the bookstore. The individual can be expected to choose the source with the greater expected gain.

The expected gain from finding a book at the library, conditional on the optimal time limit T, can be written as:

$$E(G) = P(F) \cdot U(F) - C(B) \cdot P(F) - C(S) \quad , \qquad 4.2$$

where E(G) is the expected gain from finding a book at the library with time limit T, P(F) is the probability of finding a book at the library with time limit T, U(F) is the utility from finding a book, C(B) is the utility cost of the book at the library, excluding search costs, and C(S) is the cost of search. An analogous expression holds for the bookstore.

Assume that the individual can scan r books per minute, and that the probability that a given book is of interest and is recognized to be such is s_l and s_b for the library and bookstore respectively. Then,

$$P(F) = 1 - (1-s_1)^{rT} \quad , \qquad 4.3$$

where T refers to minutes of time. Also

$$E(G) = (1 - (1-s_1)^{rT})\ (U(F) - C(B)) - C(S) \qquad 4.4$$

$$= (1 - (1-s_1)^{rT})\ A - pT \ , \text{ where A is} \qquad 4.5$$

the constant term (U(F) - C(B)),and where p is the individual's opportunity cost per minute of search. If the individual knows s_1 and r from past experience, he can determine the optimal maximum amount of time T* to allocate to the library. To determine this, consider first the possibility that the individual may search for the full time T* and not find any satisfactory books. In this case the gain is (-pT*), and the probability of this happening is $(1-s_1)^{rT*}$. The other possibility is that the individual does find a book at $t \leq T*$, in which case the gain is (A - pt). Here the probability depends on each t or on each R, where R = rt is the number of trials. The probability of success on the Rth trial is the probability of failure for the first (R-1) trials, followed by success on the Rth:

$$P(R) = (1-s_1)^{R-1}s_1 \quad . \qquad 4.6$$

To evaluate the expected gain at the library, it is necessary to sum from R=1 to R=R*=rT* the expected gain

from each number of trials:

$$E(G/R^*) = \sum_{R=1}^{R^*} (A - (p/r)R)\ ((1-s_1)^{R-1}\ s_1) - (1-s_1)^{R^*}\ (p/r)R^* \quad . \qquad 4.7$$

This equation can be maximized with respect to R* by taking the derivative with respect to R* and using the first order conditions to obtain the best R*.

This procedure can be followed for both the library and the bookstore. If the value of time, the value of having the book, the scanning rate and the probability of satisfactory books being in stock are known, then a numerical expression for the expected gain can be derived for each source and the individual will choose the source with the greater expected gain.

While no individual will follow such an artificial procedure in choosing between the library and bookstore, there must be implicit calculations about the value of time on a given occasion, the likelihood of a particular type of book being available, and the relative ownership benefits of such a book type which lead a consumer to choose one book source or the other on a given occasion.

Sampling strategy also involves a decision between sampling at home or in the library. The reader can take out on loan more books than he expects to read and can sample

more thoroughly and leisurely at home than he could in the library. Sampling at home involves a lower opportunity cost of time but also entails more effort. The decision must depend partly on the loan period, on fines, and on travel time. This option is not available at the bookstore, or at least could not be used habitually.

A distinction has been made in the consumer search literature between inspection and experience goods (Nelson, 1970). Books would be an inspection good if a final consumption choice could be made by scanning the shelves alone. This would be true if the individual were looking for any book by a particular author, for example. If the choice could not be made without some reading of the book jackets or the books themselves, then books would be an experience good. The distinction is of interest generally because there is an implication that larger samples will be made for inspection goods, with resulting differences in market structure. The only relevance of the distinction to libraries, however, is that there might be a different inventory policy. If most readers will choose their books by inspection alone, the library may keep a larger number of titles on the shelves; if, however, readers like to study the books before choosing, diminishing returns to search may set in earlier, and thus the library should be more selective about the number of books on the shelves.

Browsing habits of library users have implications for the introduction of electronic scanning devices. Electronic methods are most useful when books are an inspection good or the individual can describe his desired consumption bundle fairly precisely. The more random is the consumer's method of sampling and the more he wants to experience the good before making a final decision, the more difficult it should be to introduce satisfactorily automatic retrieval devices.

Certain inferences about library and bookstore acquisition and discard policies can be made from the preceding discussion about search behavior. The demand for best-sellers should probably be considered separately from that for other books. In this case the consumer is more likely to be seeking a particular book and there is a premium on early acquisition. In addition the initial advantages of ownership and the probable shorter waiting time favor purchase of best-sellers. Against these considerations must be balanced the nondurability of ownership benefits for best-sellers and the relatively high bookstore price.

The probable effects of these characteristics of best-sellers on bookstore inventory policy are clear. Bookstores should be motivated to have a large supply (relative to the public library) of the most current best-sellers in hardback, and to decrease this inventory sharply as

paperback editions appear and as library queues fall. In fact, library waiting lists could be utilized as an indicator for the rate of change of bookstore demand. That bookstores can and do simultaneously sell hard and paperback versions of the same book reflects both consumer ignorance and consumer preferences for durability and possibly for luxury qualities.

Public library behavior with respect to best-sellers is less clear. Best-sellers are probably leading candidates for user charges as a way of allocating the scarce supplies but librarians may wish to avoid charges and to use best-sellers as a type of loss leader. They may also feel that a zero price policy acts to improve the income distribution effects of the public library. It would be possible to collect data on the income distribution of library users in general compared with borrowers of best-sellers. User surveys could be conducted to test whether users who are seeking a particular best-seller are motivated to make use of other library services or to withdraw other books.[3]

Whatever pricing policy the library chooses, it is faced with the difficult task of determining an inventory

---

[3]Some public libraries do have service charges or rental fees for best-sellers. The current method of data collection does not identify these libraries.

policy. Without profit maximization and with the additional problem of storage, since inventory rotates rather than being depleted, the optimal strategy is unclear. The library must decide when to purchase an additional copy of a popular book. This will depend on the length of the waiting list, the average loan period and the expected attrition rate of the waiting list. The waiting time will raise the cost of the book at the library relative to the bookstore, so that there will always be some people who will choose to buy rather than wait any longer, or who will decide not to read the book at all. They will not remove themselves from the list typically, so that the library will have to work out the expected drop-out rate.

For books in general, there must be a distribution policy over types of books in the collection, if search is to be both pleasant and fruitful.[4] Within any given category there is probably a minimum useful size and a possible maximum size beyond which diseconomies in search enter. Libraries will obviously be biased toward an older stock and bookstores will be relatively stronger in current collections and in collections for which ownership benefits

---

[4]Newhouse and Alexander (1972) develop a book selection decision rule for the library. They conclude that libraries should buy books that are expensive and circulate frequently.

are high. These would tend to be certain reference books and books in high, inelastic short-run demand.

Discard policy involves the relationship between frequency of circulation and frequency of in-library use. That is, some books may not circulate frequently but may serve a useful purpose as inspection goods. They may actually increase the consumer value of books which do circulate. It would not be difficult for libraries to establish a test for such in-library use. The library may also feel a responsibility to screen periodically for books which are out of date.

Another inventory decision which becomes relevant as the number of volumes in the library becomes very large is that of withdrawing some books from open shelves. The open shelves are intended for the casual browser, while those in storage become available only to the specialized user or the user who is interested in particular titles stored there.

All of these inventory issues are more properly part of the supply side of the library model, but are considered here because of their relation to consumer search behavior.

The next section of this chapter will be concerned with aggregate demand.

II. The Demand Function

To see how the consumer's search behavior is related to the aggregate demand for library services, consider first the individual demand function. For any individual, the demand function can be thought of as a probability function:

$$P(i) = f(\text{prices, income, tastes, city size}), \qquad 4.8$$

where P(i) is the probability that the individual will make a trip to the library. Once in the library, the individual will choose to take books home, or make use of other library services depending on his search characteristics, tastes, and library quality characteristics. Aggregate demand reflects the outcome of the above probability function when aggregated over the community and over the number of trips taken by each individual.

While it is not possible to estimate directly the demand for books at the bookstore, certain inferences can be made from the estimation of the library demand function. For a given variable, its effect on relative price at the library can be used to infer the influence of that variable on bookstore demand.

The results of search behavior can similarly be analyzed by asking what search theory would imply about

the coefficients of the demand function, or conversely what the demand coefficients suggest about the sign of the net costs of search. These implications will be reconsidered after the descriptions of the determinants of the demand function and of the actual estimating procedure.

Several demand functions should be estimated, corresponding to the various library outputs. However, the data currently collected permit only the estimation of the demand for the library's circulating service, as approximated by aggregate circulation in each library system.[5] This is the library service which is best characterized by the search discussion of the previous section and which has a close market substitute. The following discussion refers mainly to book circulation, although much of it is applicable to other library services.[6]

The various components of the price at the library are largely implicit and have to be represented by proxies. The time cost of travel to and from the library, both

---

[5] The existence of option demand should lead to excess capacity in the provision of books. Therefore it is reasonable to assume that the library is not producing at capacity, that there is not a queue for the use of the library, and that it is possible to estimate a demand function using actual circulation statistics.

[6] In an unpublished paper, Young (1970) presented a statistical study of library circulation in England and Wales. He found library book expenditure, the number of branches per square mile, and education level to be consistently significant in explaining demand.

initially and for returning books, and the time cost of search within the library are the main elements of the implicit price of borrowing. It has been shown that library use is a declining function of distance traveled (Ennis, 1972). Travel costs are reduced as the number of branches and related outlets (bookmobiles, for example) increases, although the quality of the library's selection may also be reduced. The size of the area served per branch is a possible approximation to traveling distance.

Time costs in general should decline also as the number of hours during which the library is open rises; the more the library is open the greater is the possibility for the consumer to use the library when his own opportunity cost of time is low. Unfortunately, the data do not include the number of hours during which the library is open. While this should not vary much over libraries for the main library, it may vary considerably for branches. This omitted variable will bias all coefficients, and particularly the coefficient of the number of branches, which variable probably has a nonlinear relation with hours open. As communities just perceive the need for branches, they are likely to open small outlets which are open only during high demand hours. As branches increase some of them are likely to become full-time operations. For very large communities,

small or mobile outlets may become important again.

The costs of search in the library may be represented by library quality proxies. The obvious choices are measures of the size of the stock and of recent acquisitions, the size of staff, both professional and nonprofessional, the number of branches, and expenditures on various items.

After price, the usual determinants of demand are income and taste, represented by socio-demographic variables. There is a conventional view that the public library is a middle-class institution serving the middle class for their recreational needs (Ennis, 1972, Leigh, 1950). Low-income, lower-class groups once may have used the library as a people's university, or as a means of cultural assimilation. However true this may have been in the past, the public library does not currently attract these groups. Still according to this view, upper-income groups also use the library less than middle-income groups, because they are more likely to build their own personal library. To evaluate the current data according to this conventional wisdom, it will be useful to look at the proportions of the population at the income extremes, as well as at average income measures. Since the budget model looked more at pressure groups than at the median income voter for understanding library budgets, it is consistent to do the same in this study of library use.

There is general agreement likewise about the importance of educational background for library usage, (Berelson, 1949; Mendelsohn, 1969). In the classic study of library users, Berelson found in 1949 that the greatest number of library users (absolutely as well as proportionally) were high-school graduates, and that highly educated people were greatly overrepresented among users, while adults with a grade-school education only were greatly underrepresented. In a 1967 national survey Mendelsohn confirmed this relationship of use with education. More than 50% of college-educated adults surveyed made some use of public libraries, 23% were moderate users and 17% were heavy users (where heavy user was defined to be nine or more trips to the public library within a three-month period, and moderate use to be three to eight trips). In contrast, 69% of the high-school educated were non-users, and 90% of the grade-school educated were non-users.

Library usage appears also to be strongly related to age. The Berelson study showed that children and school-enrolled young adults were by far the greatest users of public libraries. Juveniles made up about twice as large a proportion of library registration as they did of the population. Recent surveys which show juveniles to be between 50% and 70% of library users support this finding, (Mendelsohn, 1969; Newhouse and Alexander, 1972).

Old people, in contrast, are known to be infrequent users, despite their greater leisure time for reading and their low opportunity cost of time spent in using the library. This may be explained by difficulties in travel arrangements.

Because Mendelsohn surveyed adults only, his study provides no evidence on school children. However, he finds the same age profile of users among adults: 40 percent of those aged 21-34 used the library regularly, 36 percent of those 35-49, while only 21 percent of those over 50 make regular use.

Mendelsohn reports on other user characteristics, including sex, marital status, and race. An interesting result of the survey is that 60 percent of the non-users replied that there is nothing public libraries might do to induce these people to use the library. Forty percent of non-users report themselves to read books very little and to prefer magazines, newspapers and television. Twenty percent report that they are book readers but acquire their books from other sources.

A final determinant of demand is quality of service. Individuals will build a level of expectation about library service which will affect their comparison of the library with the bookstore or other sources of information and/or entertainment. Quality cannot be measured directly, but as the simple model of Chapter One showed, library quality is

itself a function of measurable inputs, size of stock, additions and staff, which can be substituted for quality in the estimated equation. These measures unfortunately introduce endogeneity into the right-hand side of the equation, since communities with high taste for libraries or with demand pressure will increase their services. This problem requires that a two-stage estimating procedure be used.

Crowding is a measure of the degree to which a public service approaches the case of a pure public good, in which consumption of the good by one individual does not reduce the amount available to any other individual. If the good is a pure public good, per capita consumption depends only on total inputs and taste factors, but not on population size. In the equation:

$$\frac{C}{N} = A^{\beta_1} B^{\beta_2} L^{\beta_3} N^{\alpha} \qquad (4.9)$$

where C is total consumption, N is population size, A, B and L are inputs, the parameter α measures the degree of crowding, or the degree to which the good is public. If $\alpha = 0$, per capita consumption does not depend on population size and the good is a pure public one. If the correct specification is:

$$\frac{C}{N} = \left(\frac{A}{N}\right)^{\beta_1} \left(\frac{B}{N}\right)^{\beta_2} \left(\frac{L}{N}\right)^{\beta_3} \qquad (4.10)$$

which is equivalent to

$$\frac{C}{N} = A^{\beta_1} B^{\beta_2} L^{\beta_3} N^{-(\beta_1 + \beta_2 + \beta_3)} \qquad (4.11)$$

the good is a private good because per capita consumption depends on per capita inputs. In this case, the parameter α in equation (4.9) is equal to the negative of the sum of the input parameters or $-\Sigma\beta_i$. If there are constant returns to scale, α is equal to -1. This is the case considered by Bergstrom and Goodman (1973) and Borcherding and Deacon (1972).

The estimation will include population size explicitly as an explanatory variable in order to estimate directly the degree of crowding in public library circulation. Previous estimates of crowding have been indirect, as implied by local expenditure functions.

Finally, the prices of competing goods and services should also be included as explanatory variables. Although this information is not available, it does not seem unreasonable to assume that the price of the library relative to these alternatives does not vary much over a cross-section.

For the estimation a constant elasticity demand function is assumed. Table 4.1 defines the variables used in the alternative specifications discussed below. Because of the probable endogeneity of the quality variables, instrumental variables (IV) estimates were made in addition

Table 4.1

Definitions of Variables Used in Demand Equations*

Variable Type	Symbol	Definition
Dependent Variable	Circ	Total loan transactions of all printed and audiovisual materials, per capita.
Variables used for price, search cost, and quality	Add	Book acquisitions, per capita.
	Sto	Number of volumes held at end of year, per capita.
	Sta	Total staff, including professional and and maintenance, per capita.
	Bra	Central library and branch libraries, per capita.
	Dist	Area served per branch.
	Qual	Expenditure per addition
Socio-demographic variables	Med Inc	Median family income.
	Lo Inc	Proportion of families with income less than $3,000.
	Hi Inc	Proportion of families with income greater than $10,000.
	Med Ed	Median years of school completed among adults.
	Lo Ed	Proportion of adults with less than 5 years of school completed.

Table 4.1 continued

Variable Type	Symbol	Definition
Socio-demographic variables (cont'd)	Hi Ed	Proportion of adults who have completed 12 or more years of school.
	Med Age	Median age of population.
	Yth	Proportion less than 18 years of age.
	Old	Proportion 65 years of age or older.
	Sch	Persons 5 to 35 enrolled in school, divided by population.
	Nonw	Proportion of population who are nonwhite.
	Pop	Population served.

* Table A-1 of Chapter I gives complete definitions of the variables, along with sample means, standard deviations, maxima, and minima.

to OLS. Because libraries were more likely not to respond to questions about certain variables which were used as instruments, the IV estimates had to be based on a smaller sample. The similarity in the results obtained by the two methods is, therefore, reassuring. For population subgroups, only OLS estimates are reported. Although the IV procedure improves the consistency of the coefficient estimates, the reduction in the degrees of freedom reduces efficiency. If the data were subdivided by city size, the degrees of freedom would probably be so small as to offset the improvement in estimation method.

III. The Results

The estimation provides information about the importance of library quality variables, the socio-economic profile of the public library user, the influence of search behavior on public library demand, and the existence of "crowding" in public library circulation. The results have policy implications both for internal library management and for community and national library policy.

Library quality is represented by acquisitions, number of staff, stock of books, and number of branches. The evidence shows that the most important quality determinant of library circulation is the relative number of staff members. Additions and stock size have coefficients which are similar in magnitude but since the ratio of stock to additions is more than ten, the absolute influence of additions is much greater than that of size of stock. For libraries in communities with more than 100,000 inhabitants, relative size of stock is not significantly different from zero.

The relative unimportance of bookstock size in library circulation is surprising. One possible explanation is that the circulation of older books must require greater amounts of staff time, both for processing and because of the greater likelihood of bibliographic request. The theory

of search behavior discussed in section I of the current chapter also helps to explain the coefficients. Since new acquisitions are often shelved separately, the search and reshelving time for new books is probably much less than for older books. Search theory predicts that rewards from search should initially increase with size of stock, but eventually larger stock increases the time cost of search by more than the expected benefit. This is consistent with the rise and the decline in the coefficient for stock size.

Search theory also explains the relatively greater importance of additions at every size. As discussed above, when different sections of the library have different interest potentials, the library user optimizes by concentrating first on the section with greatest interest potential. Since new acquisitions are more likely to contain books of interest, the consumer will generally begin his search in the collection of recent books. Only after he has searched this area will he turn to other sections, where the expected proportion of books of interest may be lower although the absolute number may be higher. In small and medium libraries the search time may be sufficiently small for new books that the consumer can effectively search stock as well as additions. Finally, in large libraries reference services are likely to become more important, and the proportion of

the stock that circulates or that is on open shelves is likely to decline.

In order to understand better the relation between stock size and circulation, it would be desirable to know more about the age composition of the stock. The data are not currently available, but this is an important question for future research. The estimates here suggest that the most important measure of library stock would be the age distribution of that stock. A knowledge of the relationship between circulation and age of stock would be very helpful for librarians in making decisions to retire books from easy access or to eliminate them from stock altogether.

The number of branches has two countervailing effects, one associated with travel time, the other with search. Since additional branches may reduce average travel time, the number of branches might be expected to be positively related to library usage. The actual negative or insignificant results, as shown in Tables 4.2 through 4.5, are consistent with search behavior. As the number of branches increases, the quality and size of stock at each branch are likely to be reduced. Duplication both in stock and in new acquisitions becomes more likely as the number of branches rises. Thus, as an indicator of quality, the number of branches would be

Table 4.2

Determinants of Public Library Circulation: All Libraries[1]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Med Inc	-.102	-.029					-.114	-.068
	(.120)	(.120)					(.123)	(.122)
Hi Inc			.018	.020	-.113	-.100		
			(.085)	(.084)	(.094)	(.092)		
Lo Inc			.067	.030	-.008	-.034		
			(.073)	(.073)	(.080)	(.078)		
Med Ed	1.505	1.386	1.471	1.359			1.386	1.635
	(.194)	(.194)	(.225)	(.223)			(.202)	(.185)
Hi Ed					.750	.683		
					(.136)	(.135)		
Lo Ed					-.017	-.023		
					(.045)	(.044)		
Med Age	-.203	-.151	-.237	-.172	-.149	-.094		
	(.130)	(.128)	(.143)	(.141)	(.143)	(.142)		
Yth*								.023
								(.006)
Old*							.006	.021
							(.006)	(.008)
Nonw	-.029	-.027	-.034	-.029	-.022	-.017	-.026	-.019
	(.012)	(.012)	(.014)	(.014)	(.014)	(.014)	(.012)	(.012)
Sch							.393	
							(.149)	

Table 4.2 continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dist		.076		.075		.069		
		(.021)		(.022)		(.021)		
Bra	-.036		-.032		-.024		-.036	-.029
	(.036)		(.036)		(.036)		(.036)	(.035)
Add	.192	.172	.176	.160	.166	.153	.182	.172
	(.049)	(.048)	(.044)	(.043)	(.043)	(.043)	(.043)	(.043)
Sto	.241	.257	.240	.259	.229	.249	.208	.237
	(.062)	(.061)	(.063)	(.062)	(.062)	(.061)	(.064)	(.063)
Sta	.460	.492	.474	.501	.474	.499	.470	.468
	(.066)	(.065)	(.065)	(.064)	(.064)	(.063)	(.064)	(.063)
Qual	.037	.025						
	(.047)	(.043)						
Pop	-.095	-.084	-.096	-.085	-.086	-.078	-.094	-.086
	(.021)	(.020)	(.021)	(.020)	(.021)	(.020)	(.021)	(.021)
Const	3.012	2.719	2.256	2.551	3.173	3.392	3.304	.743
	(1.23)	(1.18)	(.893)	(.844)	(.860)	(.799)	(1.24)	(1.26)
$\bar{R}^2$	.726	.736	.726	.736	.736	.744	.730	.738
DF	318	318	318	318	317	317	318	318

[1]The equations were estimated by ordinary least squares. The variables are defined in Table 4.1; all variables except those marked by an asterisk are measured in logs. The dependent variable in every equation is the log of circulation per capita. Standard errors are in parentheses.

Table 4.3

Determinants of Public Library Circulation:
Libraries Serving Communities with Population less than 50,000[1]

	(1)	(2)	(3)	(4)
Med Inc	-.190	-.138		
	(.162)	(.165)		
Hi Inc			-.011	-.143
			(.117)	(.132)
Lo Inc			.095	.029
			(.095)	(.105)
Med Ed	1.265	1.250	1.248	
	(.311)	(.308)	(.336)	
Hi Ed				.649
				(.228)
Lo Ed				-.038
				(.063)
Med Age	-.129	-.122	-.159	-.048
	(.204)	(.201)	(.213)	(.219)
Nonw	-.037	-.032	-.044	-.027
	(.017)	(.017)	(.019)	(.020)
Dist		.050		
		(.035)		
Bra	-.007		.002	.013
	(.059)		(.059)	(.058)
Add	.203	.180	.210	.197
	(.079)	(.080)	(.071)	(.069)
Sto	.257	.260	.248	.239
	(.087)	(.086)	(.087)	(.086)
Sta	.456	.485	.455	.449
	(.101)	(.102)	(.094)	(.093)

Table 4.3 continued

	(1)	(2)	(3)	(4)
Qual	-.009	-.032		
	(.092)	(.093)		
Pop	-.301	-.303	-.289	-.313
	(.141)	(.135)	(.141)	(.141)
Const.	6.625	6.311	4.877	5.908
	(2.13)	(2.12)	(1.97)	(2.02)
$\bar{R}^2$	.695	.70	.70	.71
DF	147	147	147	146

[1] The equations were estimated by ordinary least squares. The variables are defined in Table 4.1; all variables are measured in logs. The dependent variable in every equation is the log of circulation per capita. Standard errors are in parentheses.

Table 4.4

Determinants of Public Library Circulation:
Libraries Serving Communities with Population between 50,000 and 100,000*

	(1)	(2)	(3)	(4)	(5)	(6)
Med Inc	.141	.298			-.045	.242
	(.253)	(.243)			(.280)	(.270)
Hi Inc			.133	.023		
			(.168)	(.178)		
Lo Inc			.065	-.0005		
			(.168)	(.173)		
Med Ed	1.756	1.519	1.582		1.662	1.667
	(.361)	(.348)	(.419)		(.371)	(.355)
Hi Ed				.828		
				(.250)		
Lo Ed				.032		
				(.101)		
Med Age	-.049	-.206	-.603	-.583		
	(.230)	(.231)	(.299)	(.296)		
Yth*						.031
						(.010)
Old*					.004	.024
					(.012)	(.014)
Nonw	-.002	-.010	-.010	-.006	-.00008	.010
	(.020)	(.019)	(.027)	(.028)	(.020)	(.020)
Sch					.691	
					(.335)	

Table 4.4 continued

	(1)	(2)	(3)	(4)	(5)	(6)
Dist		.133 (.037)				
Bra	-.098 (.059)		-.087 (.059)	-.086 (.059)	-.095 (.059)	-.086 (.057)
Add	.160 (.075)	.125 (.071)	.109 (.066)	.108 (.066)	.120 (.066)	.111 (.064)
Sto	.394 (.117)	.451 (.111)	.401 (.118)	.400 (.119)	.336 (.121)	.378 (.115)
Sta	.376 (.121)	.401 (.115)	.420 (.118)	.404 (.119)	.458 (.120)	.430 (.113)
Qual	.082 (.063)	.059 (.059)				
Pop	.032 (.150)	-.024 (.142)	.025 (.151)	.018 (.150)	.051 (.151)	.047 (.146)
Const	-1.478 (3.14)	-1.804 (2.96)	.462 (2.26)	1.476 (2.21)	-.021 (3.21)	-4.886 (3.05)
$\bar{R}^2$	.74	.76	.73	.74	.74	.75
DF	85	85	85	84	85	85

* The equations were estimated by ordinary least squares. The variables are defined in Table 4.1; all variables except those marked by an asterisk are measured in logs. The dependent variable in every equation is the log of circulation per capita. Standard errors are in parentheses.

Table 4.5

Determinants of Public Library Circulation: Libraries Serving Communities with Population greater than 100,000[1]

	(1)	(2)	(3)	(4)
Med Inc	-.151	-.155		
	(.448)	(.457)		
Hi Inc			-.227	-.267
			(.265)	(.299)
Lo Inc			-.153	-.111
			(.242)	(.274)
Med Ed	1.566	1.519	1.876	
	(.412)	(.458)	(.565)	
Hi Ed				.709
				(.366)
Lo Ed				-.102
				(.140)
Med Age	-.011	.006	.049	-.016
	(.324)	(.332)	(.336)	(.349)
Nonw	-.056	-.057	-.039	-.036
	(.038)	(.039)	(.044)	(.043)
Dist		.023		
		(.056)		
Bra	-.049		-.054	-.032
	(.090)		(.090)	(.091)
Add	.224	.229	.159	.164
	(.119)	(.119)	(.114)	(.117)
Sto	-.025	-.025	-.039	-.039
	(.182)	(.184)	(.185)	(.184)
Sta	.618	.608	.654	.638
	(.167)	(.166)	(.172)	(.180)

Table 4.5 continued

	(1)	(2)	(3)	(4)
Qual	.133	.140		
	(.143)	(.144)		
Pop	-.079	-.069	-.074	-.061
	(.050)	(.046)	(.050)	(.049)
Const	3.292	3.661	2.177	4.383
	(4.37)	(4.24)	(1.99)	(2.02)
$\bar{R}^2$	.70	.70	.70	.71
DF	64	64	64	63

[1] The equations were estimated by ordinary least squares. The variables are defined in Table 4.1; all variables are measured in logs. The dependent variable in every equation is the log of circulation per capita. Standard errors are in parentheses.

predicted to have a negative influence on circulation. The results suggest that this influence of the number of branches weighs stronger than the reduced travel time with extra branches.

The area served per branch is another way of representing the reduction in travel time with additional branches. This variable, called Distance in the regressions, was used an an alternative to the number of branches. If travel time is an important determinant of library use, there should be an inverse relation between distance and circulation. In fact, the area per branch is significantly positive. This perverse result suggests that the variable may represent some other factor which is related to city size. Search theory offers an alternative explanation of the coefficient. When travel costs are high borrowers may be tempted to check out many more books than they actually read. Area served per branch may also reflect the quality of the collection. A larger area served may mean a better collection and thus higher circulation. It is most likely that this variable represents a taste for libraries, especially since the availability of library substitutes is probably inversely related to this variable. A final quality variable, expenditure per book acquired, or Quality in the regressions, was insignificant.

The most significant socio-economic determinant of library circulation is education. The positive influence of rising educational level on library demand is striking and consistent over population size groups. This can be seen in Tables 4.2 through 4.5. Where education extremes were used as the relevant measure, the proportion of the population with 12 or more years of school was always significantly positive and the proportion with less than 5 years of school was insignificant as a determinant of library usage.

The evidence suggests that there is no direct relationship between income and library use. Neither median income nor proportions at income extremes are significant variables. Past studies have suggested a strong association between middle income and library use. The results presented here cannot directly support or contradict that view since the level of median income is not equivalent to the proportion of the population in some middle range. However it is counterintuitive since for non-inferior goods, consumption is usually expected to rise with income. The insignificance of rising median income or of more high income families for explaining library use may be the result of two factors. The price of using the library as well as the price of reading is

mainly the cost of time lost. Since the opportunity cost of time rises with income, there may be a tendency toward an absolute decline in reading. This is probably a small factor and may well be offset by the ability to buy more leisure time activities, such as reading, as income rises.

The other tendency is a possible shift toward book purchase as income rises. Some support for this hypothesis comes from the consumer expenditure survey for 1960-61. (Bureau of Labor Statistics, 1966). This survey shows average family expenditures on books (excluding school and technical) by income class. The average arc elasticity of demand for middle income families is about 1.5. Thus the income elasticity of demand for books in general seems to be quite high.

Another surprising aspect of the influences of income and education on library use is the contrast with their influences on library expenditure. The analysis of Chapter 2 showed that expenditure was strongly related to income level and that the influence of different education categories was important only in medium-sized communities. The explanation for this contrast lies in the fact that intensity of preferences can be expressed through use, but not through voting behavior. High income individuals may show willingness to spend more for the provision of library services as a whole without having as intense preferences for circulating books as do individuals with high education levels. In his voting behavior, each individual

can affect the library budget but can vote only once. The outcome of the voting process reflects either the median voter or the dominant coalition, depending on the correct voting model. Circulation of books, in contrast, depends on everybody who uses the library. The characteristics of those who use the library most will be best at explaining use but not necessarily at explaining expenditure on libraries. Possible implications of this contrast will be examined in the concluding chapter.

The final socio-demographic factor analyzed is the proportion of the population that is non-white. This coefficient is significantly negative for the sample as a whole, but when population subgroups are examined this coefficient is significant only for small communities. This suggests that the variable may be related to regional factors, since northern nonwhites are concentrated in large cities, while this is not the case in the South. It is well known that nonwhites are non-users of public libraries, but the evidence here implies that, at least for communities with more than 50,000 inhabitants, this association is due to other influences such as income and education rather than to race.

Population size was included as a direct measure of the possibility of crowding in the consumption of the public library service. In the estimation per capita circulation was regressed on per capita input variables, population size,

and other variables which are independent of population size, such as education and income. Thus the relevant equation can be simplified to:

$$\frac{Circ}{Pop} = \left(\frac{Sto}{Pop}\right)^{B_1} \left(\frac{Add}{Pop}\right)^{B_2} \left(\frac{Sta}{Pop}\right)^{B_3} Pop^{a} \qquad (4.12)$$

where variables are as defined in table 4.1. If this equation is compared to the earlier equation 4.9:

$$\frac{C}{N} = A^{\beta_1} B^{\beta_2} L^{\beta_3} N^{\alpha} \qquad (4.9)$$

it can be seen that if $\alpha = 0$, i.e., the good is public, the estimate of a should be equal to the sum of the input parameters or $\sum_{i=1}^{3} B_i$. If, however, the good is private, i.e., $\alpha = -\Sigma \beta_i$, the estimate of a should be zero.

In fact, for the sample as a whole, the coefficient on population was actually negative and significant. Thus it appears that there is crowding in the consumption of public library services. When the sample is divided into population groups, the coefficient is negative but generally insignificant for large communities. Again the evidence is that the public library service acts like a private good. In medium size communities the coefficient is insignificant. This coefficient, too, suggests that there is some degree of crowding, since the coefficient cannot be distinguished from the pure private case (a = 0).

These results are consistent with the indirect estimates of Borcherding and Deacon (1972) and Bergstrom and Goodman (1973). Both of these studies concluded that

there is crowding in local public services.

Table 4.6 shows a demand equation using an instrumental variable (IV) estimating procedure. The results are similar to those already reported. An important difference is that the relative proportion of the population who are nonwhite becomes an insignificant variable. The coefficients of the quality variables do not change much in size but have larger standard errors where adjustment is made for their endogeneity. Median education is still significantly positive, while relative median income continues to have a negative influence. Again population size has a significantly negative coefficient. The similarity in results obtained by the simple and two-stage estimating methods is encouraging, particularly in view of the considerably reduced sample size for the IV results.

Table 4.6

Determinants of Public Library Circulation:
All Libraries:

	(1)	(2)
Med Inc	-.022 (.264)	
Low Inc		-.074 (.146)
Hi Inc		-.216 (.146)
Med Ed	1.220 (.301)	
Low Ed		-.014 (.094)
High Ed		.799 (.330)
Age	-.260 (.255)	-.139 (.284)
Nonw	-.007 (.003)	-.005 (.003)
Dist	.102 (.030)	
Add	.059 (.283)	.170 (.459)
Sto	.188 (.250)	.174 (.299)
Sta	.720 (.298)	.544 (.338)

Table 4.6 continued

	(1)	(2)
Pop	-.118	-.104
	(.032)	(.034)
Const	4.881	4.282
	(3.46)	(2.02)
D.F.	198	197

* The equations were estimated by two-stage least squares. The dependent variable in each equation is the log of circulation per capita. All variables are defined in Table 4.1 and all are measured in logs. Standard errors are in parentheses.

Chapter 5.

CONCLUSION

The broad purpose of the analysis in the preceding three chapters has been to present a library model which deals with both aspects of the demand for public services. As has been emphasized in earlier chapters, community demand for the provision of a public service such as public libraries is only one facet of the community's demand. Individual use of the service constitutes the other aspect of demand.

Chapter Two analyzed the provision of local funds for public libraries. The analysis combined a pressure group model with the incremental budget hypothesis and compared this model with the median voter model. The estimation emphasized the influence of intergovernmental aid on local preferences.

The results showed that unconditional state aid does lead local communities to reduce own expenditure. The estimation also showed that the influential pressure groups in determining public library expenditure are income groups, with the level of median income the most significant. Education groups in general do not have a separate important effect on expenditure.

The cost of library services was studied in Chapter Three. The evidence of the cost functions estimated there suggests that marginal costs are greater than average operating costs for the system as a whole. At the same time there are potential economies of scale at the branch level. Even at the branch level, marginal operating cost is much greater than zero. This analysis implies that the current level of public subsidy of public library services cannot be justified on marginal cost grounds. Public expenditures are probably required for establishing libraries, for certain library services, and for distributional reasons.

The analysis returned to demand in Chapter Four, which was concerned with individual use of public library services. The first part of the chapter developed library demand as an example of search behavior. In the second part of the chapter a demand function was estimated. Here the important results were that library quality, as represented by input levels, and level of education are the major determinants of public library use.

The evidence presented in this study suggests that free provision of public library circulating services cannot be justified on marginal cost grounds. There are three implications from this conclusion. First, libraries should consider the institution of user charges and should

study the relative merits of different charge systems. Second, other library functions, in particular the reference service, should be studied to determine contribution to marginal cost. Finally, other grounds for public subsidies of libraries such as income distribution should be investigated.

For all of these analyses it is necessary to collect more and better data. Better data on branch size and the number of hours during which the library is open would not be difficult to obtain. Because of modern photocharging systems, distinctions among types of book circulated would require more time and effort but would still not be difficult if a coding system is established.

Information about existing use of fees and about noncirculating library services should be gathered on a national basis, after some preliminary data gathering to test survey questions. All of this recommended additional data should be collected with a view toward the possibility of doing time series studies. Past library surveys through the Office of Education have not been sufficiently comparable to justify time series analysis.

The distributional impact of public libraries is a potential justification for having free use of library services even when marginal cost is greater than zero.

Without knowing the incidence of local property taxes and of intergovernmental transfers, it is only possible to speculate on distributional tendencies. The evidence of the library expenditure model is that higher median income leads to more expenditure on libraries, while the demand analysis suggests that the partial effect of higher median income is not significantly different from zero. These two tendencies could be interpreted to mean that higher income residents support subsidizing library users although this is a redistribution away from themselves. The expenditure results further imply that the higher the proportion of families with income over $10,000, the higher the expenditure on libraries. In contrast, the proportion of families with income less than $3,000 is often a significantly negative variable.

The demand analysis suggests that the beneficiaries of public library subsidies are not necessarily those who support library provision. There is a strong positive association between income level and library expenditure and between level of education and library use, while there is generally no significant relation between education and expenditure level or between income level and use. To know the true extent of the redistribution it would be necessary to know the distribution of the tax burden. In addition, library supporters may

gain benefits from having a public library which are not reflected in library circulation.

If charges are to be introduced into the public library, there are several approaches. The possibilities can be grouped into those which charge for particular services and those which require a single charge for having access to the services. Fines for overdue books, which are already generally used, are an example of the first, as are fees for requesting a book. Another example would be to put the circulation of best-sellers on a rental basis. Here it should be possible to use the economic rule for optimality and set price equal to marginal cost, although a rule would have to be established for the size of the book inventory.

To recommend pricing systems for library services, it is again necessary to collect more data. For this purpose national data are desirable but not required. Detailed cost studies for representative libraries would allow a central policy board such as the American Library Association to establish guidelines.

The second charging system is to have a set fee for a library card. This is much simpler to administer but less justified on economic grounds. It could be considered a price of admission or access to the library and used in conjunction with a marginal pricing system for

particular services.

Any pricing method can be adjusted to allow for distributional considerations. In particular, charges could be waived for school children and for the elderly. Also the setting of prices could easily be combined with royalty collections.

The direction for future research on the economic aspects of public libraries depends very much on the collection of additional data. A time series study of the data analyzed here would allow for less tentative conclusions about the effects of income and education which have been speculated upon here. In addition, the effect of age of stock upon circulation could be estimated. This would have important policy implications.

This study did not deal with the reference function of libraries. This would be a useful area for future research, especially for university libraries, on which some data are already collected. The impact of technological changes on library provision and use is perhaps the most significant policy consideration for the future of public libraries. Economic analysis can be used to study technological innovations as they are introduced and to recommend among alternative proposals.

When the technical analysis is completed there

will always be judgments about the importance of non-economic arguments in the provision of public services. The contribution of the economic analysis is to specify where such judgments are consciously or inadvertently being made and to present the range of possible alternatives. The analysis of public library provision presented in this thesis may be useful for developing a more rational basis for choice.

REFERENCES

Arrow, Kenneth J., "Economic Welfare and the Allocation of Resources for Invention," in The Rate and Direction of Incentive Activity Economic and Social Factors. Conference #13 of Universities--National Bureau Committee for Economic Research, etc. Princeton University Press, Princeton, 1962. pp.609-25.

Banfield, Edward C., "Needed: A Public Purpose," in Conant, Ralph W. (ed.), The Public Library and the City. MIT Press, Cambridge, Massachusetts, 1966.

Baumol, William J. and William G. Bowen, Performing Arts--The Economic Dilemma. MIT Press, Cambridge, Massachusetts, 1966.

Baumol, William J., "The Costs of Library and Informational Services," in Knight, Douglas M. and Nourse, E. Shipley (eds.), Libraries at Large. Bowker Company, New York, 1969.

Berelson, Bernard, The Library's Public. Columbia University Press, New York, 1949.

Black, Stanley W., "Library Economics," in Knight, Douglas M. and Nourse, E. Shipley (eds.), Libraries at Large. Bowker Company, New York, 1969.

Bergstrom, T. C. and Goodman, N.P., "Private Demand for Public Goods," American Economic Review, June 1973, Vol. 63, No. 3, pp.280-296.

Borcherding, T. and Deacon R., "The Demand for the Services of Non-Federal Governments," American Economic Review, December 1972, No. 62, pp.891-901.

Bowen, H., "The Interpretation of Voting in the Allocation of Economic Resources," Quarterly Journal of Economics, November 1943, No. 58, pp.27-48, reprinted in Arrow, K. and Scitovsky, T. (eds.), Readings in Welfare Economics, Homewood, New Jersey, 1969.

Bureau of Labor Statistics, U.S. Department of Labor, Consumer Expenditures and Income. 1960-61, Washington, D.C., 1966.

Conant, Ralph W. (ed.), The Public Library and the City, MIT Press, Cambridge, Massachusetts, 1965.

Conant, Ralph W. and Molz, Kathleen (eds.), The Metropolitan Library. MIT Press, Cambridge, Massachusetts, 1972.

Davis, O., Dempster, M.A.H., and Wildavsky, A., "A Theory of the Budgetary Process," American Political Science Review, September 1966.

Downs, Anthony, An Economic Theory of Democracy. Harper and Row, New York, 1957.

Ennis, Philip H., "The Library Consumer," in Conant, Ralph W. and Molz, Kathleen (eds.), The Metropolitan Library. MIT Press, Cambridge, Massachusetts, 1972.

Goddard, Haynes C., "Analysis of Social Production Functions: The Public Library," Public Finance Quarterly, Vol. 1, No. 2, April 1973, pp. 191-204.

Herbert, A. P., "Libraries: Free-for-All?" Hobart Paper 19, Institute of Economic Affairs, London, 1962.

Hirschleifer, J., "Where Are We in the Theory of Information?" American Economic Review, Papers and Proceedings, Vol.63, No. 2, May 1973, pp.31-39.

Inman, Robert P., "The Political Economy of Local Fiscal Behavior: An Interpretative Review," Fels Discussion Paper #49, Fels Center of Government, University of Pennsylvania, February 1974.

Johnson, Elmer, A History of Libraries in the Western World. Scarecrow Press, Metuchen, New Jersey, 1965.

Knight, Douglas M. and Nourse, E. Shipley (eds.), Libraries at Large. Bowker Company, New York, 1969.

Leigh, Robert D., The Public Library in the United States. Columbia University Press, New York, 1950.

Machlup, Fritz, An Economic Review of the Patent System, Study No. 15 of the Subcommittee on Patents, Trademarks, and Copyrights of the Committee on the Judiciary, U.S. Senate, 85th Congress, 2nd Session, Washington, 1958.

Morek, Jacob, "The Operating Expenses and Labour Productivity in Public Libraries, 1958/59 and 1965/66," unpublished paper, c. 1970.

Morse, Philip, "Search Theory and Browsing," The Library Quarterly, Vol. 40, No. 4, October 1970, pp.391-408.

Nelson, Phillip, "Information and Consumer Behavior," Journal of Political Economy, Vol. 78, No. 2, March-April 1970, pp.311-329.

Newhouse, Joseph P. and Alexander, Arthur J., An Economic Analysis of Public Library Services, Lexington Books, Lexington, Massachusetts, 1972.

Oates, Wallace, Fiscal Federalism, New York, 1972.

Office of Education, U.S. Department of Health, Education, and Welfare, Statistics of Public Libraries Serving Areas With at Least 25,000 Inhabitants, 1968, U.S. Government Printing Office, Washington, D.C., May 1970.

Pfister, Richard L., and Milliman, Jerome W., "Economic Aspects of Library Service in Indiana," Report #7, Indiana Library Studies, Bloomington, Indiana, 1970.

Steiner, Peter O., in Blinder, Solow, Break, Steiner and Netzer, The Economics of Public Finance, The Brookings Institution, Washington, D.C., 1974.

Stigler, George, "Information in the Labor Market," Journal of Political Economy, Vol. 70, Supplement, No. 5, Part 2, October 1962, pp.94-105.

Theil, H., Economic Forecasts and Policy, North-Holland Publishing Company, Amsterdam, 1961.

Tiebout, Charles M., "A Pure Theory of Local Expenditures," Journal of Political Economy, October 1956.

Tiebout, Charles M., and Willis, Robert J., "The Public Nature of Libraries," in Conant, Ralph W. (ed.), The Public Library and the City. MIT Press, Cambridge, Massachusetts, 1965.

U.S. Bureau of the Census, Census of Governments, 1967, Vol. 6, No. 4, State Payments to Local Governments, U.S. Government Printing Office, Washington, D.C., 1968.

U.S. Bureau of the Census, County and City Data Book, 1967, U.S. Government Printing Office, Washington, D.C., 1967.

Wald, A., "The Fitting of Straight Lines if Both Variables Are Subject to Error," Annals of Mathematical Statistics, 11, pp.284-300, 1940.

Weisbrod, Burton A., "Collective-Consumption Services of Individual-Consumption Goods," Quarterly Journal of Economics, Vol. 78, No. 3, August 1964, pp.471-77.

Winger, H. W., "Characteristics of the Medium Size Public Library," The Medium Size Public Library: Its Status and Future, Leon Carnovsky and Howard Winger (eds.). University of Chicago Press, Chicago, 1963.

Young, Ralph, "Determinants of Demand for the Public Library Lending Service," unpublished paper, c. 1970.