



The impact of population growth on the welfare of a community
by Thomas Vincent OKeefe

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE
in Applied Economics
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Abstract:

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A major reason for these results was that population growth changed the age distribution in the Bozeman area.

In Chapter 4, conclusions are reached on the problems of inferring the impact of population growth on the welfare of a community from a cost-revenue analysis. The major problems involve the failure of the political process to reveal the pure community demand curve for public goods, the inability to assign monetary values to externalities, and the lack of direct pricing in the public sector.

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THE IMPACT OF POPULATION GROWTH ON

THE WELFARE OF A COMMUNITY

by

THOMAS VINCENT O'KEEFE, JUNIOR

A thesis submitted in partial fulfillment
of the requirements for the degree

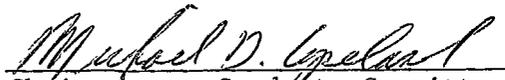
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Abstract

This research addresses the problems of measuring the impact of population growth on the welfare of a community. The purpose of this research is to address the problems of accurately measuring the impact of population growth on the welfare of a community with the intent to assist local government officials in formulating decisions related to population growth.

Chapter 1 is a detailed statement of the problem as well as a literature review of population growth studies. The literature review results in the selection of a cost-revenue analysis as the analytical method most commonly used to measure the impact of population growth on the welfare of a community.

A theoretical analysis of the impact of population growth on the welfare of a community is developed in Chapter 2, emphasizing how a community maximizes its welfare and the possible effects of population growth on the point of welfare maximization. The theoretical approach to measuring welfare changes due to population growth is compared to cost-revenue analysis to determine the problems of measuring the impact of population growth on the welfare of a community. The analysis is limited to the public sector.

Bozeman, Montana was selected for the empirical cost-revenue analysis because it has been experiencing rapid population growth since 1960 and because there is currently debate about the impact of uncontrolled growth in the Bozeman area.

The results of the cost-revenue analysis, calculated in Chapter 3, indicate that population growth generated more revenue than costs. A major reason for these results was that population growth changed the age distribution in the Bozeman area.

In Chapter 4, conclusions are reached on the problems of inferring the impact of population growth on the welfare of a community from a cost-revenue analysis. The major problems involve the failure of the political process to reveal the pure community demand curve for public goods, the inability to assign monetary values to externalities, and the lack of direct pricing in the public sector.

Chapter 1

STATEMENT OF THE PROBLEM AND LITERATURE REVIEW

Statement of the Problem

Local governing bodies are faced with increasingly difficult decisions regarding population growth. Local government officials have difficulty assessing the total impact of population growth on the welfare of the entire community. Many of these difficulties occur because what may be a benefit or loss to one part of the community may not necessarily be a benefit or loss for the entire community. The purpose of this research is to address the problems of accurately measuring the impact of population growth on the welfare of a community with the intent to assist local government officials in formulating decisions related to population growth.

The remainder of Chapter 1 consists of a literature review of population growth studies. The literature review will lead to the selection of an analytical method commonly employed in population studies to measure the impact of population growth on the welfare of a community. The selection of an analytical method will be based on the amount of information each alternative method provides, the practical applications of each method, and the frequency

with which each method is used by local governments.

Chapter 2 consists of a theoretical analysis of the impact of population growth on the welfare of a community. Emphasis is on how a community maximizes welfare and how population growth affects the community's point of welfare maximization. This analysis requires discussions pertaining to the concept of "welfare," the distinction between private and public goods, and the conditions necessary for welfare maximization.

Empirical data from the Bozeman area will be analyzed within the framework of the analytical method in Chapter 3. The analysis of population growth in the Bozeman area will be divided into two sections because the operations of the Bozeman city government and school district are completely independent of one another.

Conclusions will be reached in Chapter 4 concerning the problems of measuring the impact of population growth on the welfare of a community. These problems can be pinpointed by examining how adequately the empirical example reflects changes in welfare due to population growth. These evaluations of the accuracy of the empirical analysis in reflecting welfare changes due to population growth will be based on the theoretical analysis of welfare maximization in Chapter 2. After discovering particular problem areas, recommendations will be made on ways to help alleviate the problems.

Bozeman, Montana has been selected as a case study because it has been the scene of rapid population growth in the recent past. Between 1970 and 1975 this city has grown from 18,600 to 21,700, a rate of more than double the national average. Estimates have been made that Bozeman will continue to grow at a rapid pace through 1990, reaching a total population level estimated at between 29,558 and 42,379.¹ These statistics have generated debate over the impact of uncontrolled growth in the Bozeman area. By using Bozeman as a case study for this research, it is possible to provide direct assistance to local governing officials while simultaneously addressing the problems of measuring the impact of population growth on the welfare of a community.

Literature Review

Researchers have long been concerned with measuring the impact of population growth on the revenues and expenditures of municipal governments.² Using several basic approaches developed

¹Paul Bolton and others, Bozeman Area Growth Study (Bozeman: Bozeman City-County Planning Board, 1975), p. 6.

²Included in these early studies are: Municipal Costs and Revenues Resulting from Community Growth by Isard and Coughlin; City Expenditures in the U.S. by Brazer; Urban Growth and Municipal Services: Uses and Methods of Cost-Revenue Analysis by Esser; Measuring Factors Affecting Expenditure Levels for Local Government Services by Hirsch; Municipal Cost-Revenue Research in the United States by Mace; Factors Associated with Variations in Municipal Expenditure Levels by

in the 1950s and 1960s, their studies have compared public costs with public revenues as affected by population growth. For example, some studies used regression analysis to test the correlation between population growth and related variables. These focused on four primary areas:

1. Possible economies of scale in the provision of public services;
2. Fiscal effects of political fragmentation;
3. Relationship between local expenditures and state and federal aid; and,
4. Expenditure responses to changes in fiscal capacity.³

Examples of the emphasis of these early population growth studies in these areas are the works of Brazer, and Scott and Fender in which most of the variables analyzed were directly related to one of these four areas.⁴

²Scott and Fender; and, The Costs of Municipal Services in Residential Areas by Wheaton and Schlussheim.

³John Weicher, "Determinants of Central City Expenditures: Some Overlooked Factors and Problems." National Tax Journal, XXIII, No. 4 (December, 1970), p. 379.

⁴Harvey Brazer, City Expenditures in the United States (New York: National Bureau of Economic Research, Inc., 1959), and Stanley Scott and Edward Fender, Factors Associated with Variations in Municipal Expenditure Levels (Berkeley: University of California, 1957), cited by John Weicher, "Determinants of Central City Expenditures: Some Overlooked Factors and Problems," National Tax Journal, XXIII, No. 4 (December, 1970), p. 380.

By the early 1970s, economists such as John Weicher began to point out the disadvantages of limiting the scope of regression analyses to these commonly used variables. Weicher discussed the importance of taste and socio-economic service condition variables as they related to population growth.⁵ Taste variables, as defined by Weicher, include racial and ethnic compositions of a city, adult education levels, and age distribution. Socio-economic service condition variables include population density, average size of retail stores and manufacturers, average number of people per unit, and mean January temperature. Each of these variables partly determines the costs associated with population growth. For example, fewer crimes are committed in colder areas and areas with a high proportion of educated adults. Also, many larger stores and manufacturers provide their own security guards and sprinkler systems. These factors tend to diminish the cost of police and fire protection.⁶

A second type of population growth study common in the 1950s and 1960s focused on the effects of population growth on the expenditures of local governments. These expenditure analyses included the previously cited works of Hirsch, Wheaton, and Schlussheim.

⁵Weicher, *op. cit.*, pp. 380-383.

⁶*Ibid.*

"With the exceptions of Wheat and Schlusshiem in The Costs of Municipal Services in Residential Areas, most of the literature involves some measures of average costs as opposed to marginal costs."⁷

Recent studies, such as The Costs of Sprawl and The Bozeman Area Growth Study, have continued to rely on average cost estimates for measuring monetary changes due to population growth.

Most recently expenditure analysis has been combined with revenue estimates to form cost-revenue analysis. "A cost-revenue analysis has become a powerful tool for answering some of the questions asked in relation to population growth."⁸ Given that the goal of a population growth study is to measure the monetary changes due to population growth, there is not a more commonly used analytical tool.

Recent cost-revenue studies have eliminated some of the weaknesses common in early cost-revenue analyses. For example, the work of Paula Martin and the Connecticut Development Corporation entitled Cost-Revenue Impact Analysis for Residential Developments, documented the importance of using marginal cost estimates as opposed to average cost estimates. They point out that

⁷Paula Martin and others, Cost-Revenue Impact Analysis for Residential Developments (Washington: National Technical Information Service, 1974), p. 231.

⁸Ibid., p. 3.

"it would be quick and easy, but also very inaccurate, to divide the present budget of a given department by the community population to obtain an average cost figure and then to multiply the number by the number of new residents to determine their costs on the community. An average cost figure assumes that the costs of activities will increase in direct proportion to population - an unsatisfactory proposition."⁹

In this sense, cost-revenue analysis has developed to where it can be understood as an attempt to measure the net monetary loss or gain to a community from population growth.

The net annual impact of population growth on the community may be quite different on a per capita basis as compared to an incremental basis.

"These differences generally reflect significant differences between per capita and incremental costs. Whereas incremental costs may be low in communities where unused facilities are available for an increased population, it may be expected that the new residents would assume their proportionate part of the costs associated with these existing unused facilities."¹⁰

For example, the marginal cost of an additional resident to a community may only result in increased costs of \$100 as compared to a pre-existing average per capita cost of \$200. If the new resident generates a proportionate share of revenues, the community has a net gain in revenues.

⁹Ibid., p. 4.

¹⁰Ibid., p. 224.

While cost-revenue analysis has evolved from average cost estimates to marginal cost estimates, this does not mean to imply that it can precisely measure all of the costs related to population growth. As Paula Martin and the Connecticut Development Corporation also pointed out:

"Cost-revenue impact analysis deals only with dollar costs and revenues, the analysis does not identify or measure any of the non-monetary effects of development. It does not involve judgments as to whether the citizens want their community to grow or not. On these and other issues dealing with matters which¹¹ are essentially intangible, the analysis is silent.

Because external effects surround the population growth of any community, a cost-revenue analysis cannot measure the total impact of population growth.

The problems surrounding the non-monetary external effects were commented on by Professors Layton Thompson and Dana Myrick of Montana State University in their study of the economic development of Big Sky, Montana. They pointed out that

"...a net increase in tax revenue over cost of services would presumably be pleasing to most tax payers, but some might well approve a net increase in costs of public services over tax revenues if substantial other kinds of benefits resulted, such as better markets for their

¹¹Ibid., p. 3.

products or wares, more jobs, or access to recreation areas."¹²

However, it should also be suggested that even a large net increase in revenues over costs may not be desirable to most tax payers if substantial other kinds of costs result, such as pollution, noise, crime, privacy loss, and damage to wildlife. Therefore, even if a cost-revenue analysis is a perfect reflection of changes in costs and revenues, it cannot measure all of the changes due to population growth.

Selection of an Analytical Model

The decision criterion for selecting an analytical method includes the amount of information each method provides, its practical applications, and the frequency with which each method is used by local governments. Based on these factors, a cost-revenue analysis is preferred to either a regression or expenditure analysis. For example, a cost-revenue analysis is preferred to an expenditure analysis because it can potentially measure all of the monetary changes due to population growth. Also, local government officials have tended to rely on cost-revenue analysis rather than regression

¹²Layton Thompson and Dana Myrick, "Increased Tax Base and Increased Costs of Public Services Resulting from Economic Development: A Case Study Involving Big Sky, Montana, Inc." (Staff Paper, Montana State University, 1975), p. 1.

analysis because it requires less knowledge of statistical methods. The advantages of a cost-revenue analysis probably explain why the most recent growth studies in the Bozeman area, such as the "Northeast Annexation" and the Bozeman Area Growth Study, have used cost-revenue analysis rather than expenditure or regression analyses.

Chapter 2

THEORETICAL ANALYSIS OF THE IMPACT OF POPULATION GROWTH ON THE WELFARE OF A COMMUNITY

In Chapter 1, it was stated that the purpose of this research was to examine the problems of measuring the impact of population growth on the welfare of a community. However, welfare was not defined or discussed except to imply that welfare depends upon more than pecuniary income. In this chapter, a definition of welfare will be developed including a discussion of the conditions necessary for welfare maximization. After describing how a community's welfare is maximized, the impact of population growth on the point of welfare maximization will be discussed. In Chapter 4, the theoretical conclusions regarding the proper measurement of community welfare changes due to population growth will be compared with the results of the cost-revenue analysis to determine the problems of using this analytical technique to estimate the impact of population growth on community welfare.

"The objective of welfare economics is the evaluation of the social desirability of alternative economic states. An economic state is a particular arrangement of economic activities and the resources of the economy."¹³

¹³J.M. Henderson and R.E. Quant, Microeconomic Theory (2d. ed.; New York: McGraw-Hill Book Company, 1971), p. 254.

Each particular arrangement results in a certain combination of goods and services that can be divided into two classes; private and public.

Private and Public Goods

Private goods and services are divisible, implying that the consumption of a private good by one individual has no direct effects on the preference functions of other individuals for that good.¹⁴ Conversely, a pure public good such as national defense, is indivisible.

"A public good is one with the property of involving a 'consumption externality'¹⁵ in the sense of entering

¹⁴Paul Samuelson, "Pure Theory of Public Expenditure and Taxation," Public Economics, eds. J. Margolis and H. Grulton (Great Britain: International Economic Association, 1969), p. 102. Preference functions indicate the ranking of alternative bundles of private and public goods and services. Preference functions only show a preference of one bundle of private and public goods and services over another bundle. The level of satisfaction, or utility, from any one bundle cannot be compared with the level of satisfaction from another except to say one bundle results in more satisfaction than another.

¹⁵Ibid., p. 110. Musgrave uses the term "non-rivalness in consumption" for Samuelson's notion of "consumption externality." Samuelson expands on his definition of "consumption externality" by relating it to the difference between private and public goods. The usual approach is to think of two poles representing pure private and public goods and a continuum of various degrees of private and public goods between the poles. (A private good can be further defined as one which once consumed by one person is not available to others for consumption.) Samuelson argues that this is not the case at all. He claims that there is a knife-edge pole of the private domain because of the "consumption externality" associated with these goods.

two or more persons preference functions simultaneously."¹⁶

Most goods and services provided by local governments are not pure public goods and therefore are divisible to some degree. By discussing why some goods and services are provided by a local government rather than privately, even though they are divisible, we will establish the concepts of private and public goods and services that will be used in the remainder of the theoretical analysis.¹⁷

"To 'explain' local government spending in terms of economic theory, therefore, it is necessary to find out why such individuals chose to 'purchase' certain goods and services for purposes of consumption through the auspices of local government rather than in some other way. Why, then, are educational services, police and fire protection, traffic controls, and so on purchased by individuals through the political jurisdictions known as local governments. Or, to put the question the other way around, why do individuals not purchase such goods and services as bread, shoes, houses, and hair cuts through local governments?"¹⁸

Two dominant reasons emerge to explain why local governments provide goods that could be provided privately. First, many goods can be obtained for lower costs through group or community actions.

¹⁶Ibid., p. 102.

¹⁷The discussion of why some goods are provided publicly is from James Buchanan and Marilyn Flowers, "Local Government Expenditures: An Overview," Management Policies in Local Government Finance, eds. J.R. Aronson and Eli Schwartz (Washington, D.C.: International City Management Association, 1975), pp. 25-41.

¹⁸Ibid., p. 27.

"When men and women can secure goods at a lower cost by acting in a group rather than independently, they have a valid economic reason for forming groups."¹⁹

These cost savings consist of both monetary and non-monetary savings. Monetary savings occur because of the efficiency of joint consumption. Non-monetary savings are due to a minimization of the external effects associated with providing certain goods. These external effects include the duplication of sewer and water lines, treatment plants, etc., which would result if several firms were providing these goods.

The second major reason local governments provide goods is because it is difficult to enforce the exclusion principle when goods are provided privately by voluntary arrangements between individuals.

"By 'exclusion' economists mean the prevention of certain individuals from consuming or enjoying goods without necessarily having contributed towards their purchase."²⁰

Many different relationships exist between the relative efficiency of joint consumption and the relative inefficiency in exclusion which explain why particular goods and services are provided by local governments. For example, some goods and services provided by local governments, such as mosquito control, have

¹⁹Ibid.

²⁰Ibid.

no proven efficiencies of joint consumption but are nonexcludable. Other goods and services provided by local governments, such as fire protection, may have large efficiency gains from joint consumption as well as some nonexcludability features. Finally, local governments provide certain goods and services because of equal benefits from joint consumption and nonexcludability, such as police protection.

"While relative efficiency of joint consumption and relative inefficiency in exclusion explain why many goods and services are provided by a local government, local governments provide other goods that are neither nonexcludable nor efficiently consumed through joint consumption."²¹

Many of these goods and services, such as water, sewage, etc., are financed by direct user charges.

In discussing welfare changes, private goods will be equated with those purchased in the market place and public goods with those purchased from the local government. Since most goods provided by local governments are divisible and excludable to some degree, this divergency from the approach of Samuelson's analysis of pure public goods poses no problems.

Income Constraint

The total number of private and public goods and services a

²¹Ibid., p. 28.

community can consume is limited by its budget constraint.

The community budget constraint represents the total amount of income that is available to a community for purchasing private and public goods. (The budget constraint of the local government is less than the community budget constraint.) Many decisions by local government officials rely on the amount of monies a community can generate in the form of tax revenues, etc. As population growth occurs, the community budget constraint enlarges. Population growth may also expand the budget constraint of the local government. This is significant because many public goods that might be financially impractical for a smaller community become feasible as the budget constraint of the local government expands.

The community budget constraint consists of the summation of all individual budget constraints and intergovernmental revenues. To simplify the analysis, the income of each individual is assumed to equal his monetary income in each year. This means that other sources of income, such as accumulated assets or ability to borrow, will not be included in an individual's budget constraint. Intergovernmental revenues consist of state and federal shared revenues and grants. State shared revenues are a function of the population level while state and federal grants and federal revenue sharing are highly variable items, dependent on many

variables inherent in the operation of state and federal governments.²² Assuming each individual spends his entire income in each year on private and public goods in an attempt to gain as much satisfaction as possible, the community's budget constraint can be written as follows:

$$B^i = \sum_{i=1}^s (P_1 X_1^i + \dots + P_n X_n^i) + \sum_{i=1}^s (P_{n+1}^i X_{n+1}^i + \dots + P_{n+m}^i X_{n+m}^i) + R(p) + R(g)$$

where $i = 1 \dots s$ denotes the number of individuals in the community, $P_1 \dots P_n$ are the prices of private goods, $P_{n+1} \dots P_{n+m}^i$ are the prices of public goods to individual i , $X_1^i \dots X_n^i$ are the private goods available to individual i , $X_{n+1}^i \dots X_{n+m}^i$ are the public goods available to individual i , $R(p)$ are state shared revenues, $R(g)$ are all other intergovernmental revenues, and B^i is the total community budget constraint for i individuals.

In the community budget constraint, individual i pays the same price for private goods as all other individuals but is charged a different price than other individuals for public goods. This is because private goods are purchased independently in the economy whereas many public goods often are purchased collectively. The amount each individual pays for public goods is primarily

²²Paul Bolton and others, Bozeman Area Growth Study, op. cit., p. 46.

dependent on his level of income and the amount of taxes he is obligated to pay. Because of this, some individuals pay more for public goods than others while everyone pays the same prices for private goods. Also, different individuals have different private and public goods available for consumption depending on such factors as their income level.

The inclusion of intergovernmental revenues in a community's budget constraint changes the slope of the budget constraint. The budget line does not shift in a parallel manner because all intergovernmental revenues must be spent on public goods thereby decreasing the price of public goods relative to the price of private goods. Figure 1 shows the effect of intergovernmental revenues on the community's budget line.

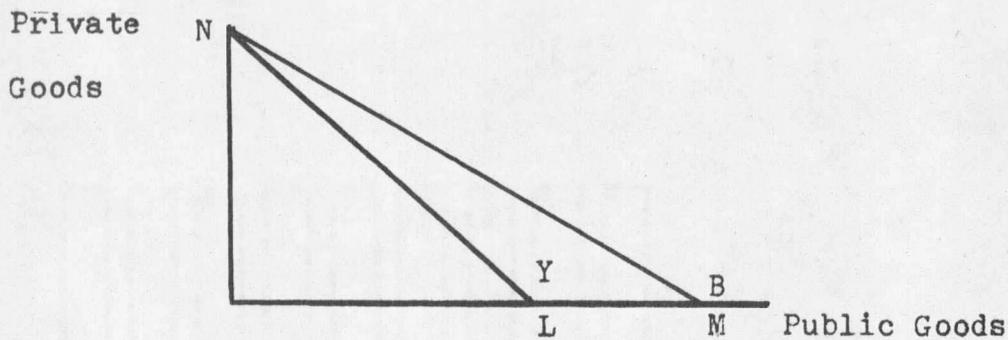


Figure 1: Affect of Intergovernmental Revenues on the Community Budget Constraint

In Figure 1, Y is the summation of individual incomes and B is the summation of individual incomes plus intergovernmental revenues. The community can still only afford to purchase N private goods but can increase its consumption of public goods from L to M public goods.

Social Indifference Curves

A social indifference curve is a locus of combinations of private and public goods from which the community derives a given level of satisfaction.²³ The use of indifference curve analysis depends on the following three assumptions:

1. Communities want more than they have of many goods;
2. There is some amount of a good that is sufficient to induce a community to give up some of another good; and,
3. A community's marginal evaluation of a good declines as the amount it has of that good increases.²⁴

These assumptions result in a series (map) of indifference curves, each of which represents a given level of satisfaction. While a community is indifferent to choosing among points on a

²³Robert Awk, Microeconomics: Theory and Applications (New York: John Wiley and Sons, Inc., 1976), p. 447.

²⁴Charles Baird, Prices and Markets: Microeconomics (New York: West Publishing Company, 1976), pp. 16-18.

