THE IMPACT OF EMPLOYMENT EXPANSION ON RURAL COMMUNITY SERVICE EXPENDITURES: A SMALL AREA MODEL*

Barry Ira Shapiro, Larry C. Morgan and Lonnie L. Jones

INTRODUCTION

Considerable attention has been devoted to understanding factors that influence public service expenditures in rural communities. Much public service research has been focused on the question of whether economies of population size exist for public service delivery systems, and, if so, what are the optimum size delivery systems. Of particular concern to communities is the impact of economic growth on provision of public services. Community leaders need to know how to plan for provision of these services when facing changing economic conditions. They must be able to evaluate whether or not economic growth, especially rural industrialization, should be followed as a strategy for enhancing both quality and quantity of these services.

The functional relationships between public service costs and factors such as population, income and population density have been dominant research themes [4]. Schaffer and Tweeten have contributed to a better understanding of the impact of economic growth on community services by developing a method of measuring the net economic impact of industrialization on the public sector [7]. Their model estimates direct and indirect benefits and costs of rural industrialization to the public sector, using multipliers generated in a "from-to" model to measure the indirect effects [8].

Summers and others conclude, after reviewing almost 200 studies of non-metropolitan industrialization since 1945, that industrial expansion significantly increased a community's public service cost both directly and through induced population growth [9, pp. 97-100]. Their analysis suggests that communities should exercise great caution in attracting new industry, but the authors develop no economic criteria for analyzing the impact of new jobs on the community service cost burden.

OBJECTIVES

The primary objective of this study was to develop a simplified model linking changes in community public service operating expenditures to economic growth. Such a model would be useful to local leaders if its results could be readily applied to local conditions, if it were inexpensive to build, if necessary data are available, and if the model could be inexpensively updated. A simplified economic base model utilizing cross-sectional employment data from secondary sources has been used to estimate basic employment multipliers. These multipliers measure effect on the region's total employment of one additional job created in a sector that exports its output to markets outside the region. Once the link between changes in basic employment and total employment is established and changes in total employment are linked to population growth, the causal relationship linking impact of growth on public service costs is completed by establishing the relationship between population growth and public service expenditures. Average and marginal cost curves are derived from the estimated relationship between community public service expenditure and population. The model, therefore, provides a means of estimating the impact of changes in basic employment on average and marginal operating costs of community services.

Barry Ira Shapiro is Research Assistant, Larry C. Morgan is Assistant Professor and Lonnie L. Jones is Associate Professor, Department of Agricultural Economics, Texas A & M University.

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MODEL DEVELOPMENT

Employment Multiplier Estimation

Because of cost and technical limitations, employment multipliers often cannot be generated on a local level, but must be taken from larger area growth impact models and adjusted for local application. There are several types of regional development models currently in use. These vary in sophistication from intricate input-output analyses to aggregated sector export base studies. The more sophisticated the model, the greater the cost of building and updating it. Thus, more complex studies are usually constructed for larger regions than would be necessary with a simplified export base. This is significant, since size tends to complicate adjustment of multipliers for leakages in the disaggregation process [3].

Although all available model choices are based on export base theory or are demand-oriented, there is considerable evidence that multipliers estimated through the different procedures that are used with these models are comparable [10], providing a sufficient rationale for building a simplified export base model for a small area or region when appropriate for studying aggregated sectors. Using regression methodology, several export base studies have been done recently to estimate employment multipliers. Braschler and Kuehn [2] have estimated employment multipliers to serve as planning standards for estimating total employment, service employment and population growth in the Ozarks nonmetropolitan Areas. They note that when trying to provide general guidelines for planning, the regression model is useful since it provides the planner with both the typical multiplier and the probable range or variability of the estimate. Bender and Coltrane [1] also used cross-sectional data to develop a statistical model based on central place theory and economic base theory to test the hypothesis that multipliers are dependent on distance from regional trade centers.

This study follows the same basic statistical procedure as the above authors, with the exception that distance from a regional trade center was not deemed a necessary consideration for the study region. It is important to note also that the multipliers would be acceptable when estimated by different procedures such as Shaffer and Tweeten's "from-to" estimates, and could be incorporated into the three-step model that is presented in this paper.

Study Area

The study region consists of the twenty-five counties in Texas' Panhandle Planning Region. The region has two distinguishing characteristics; the first being that twenty-three of the counties have relatively homogeneous economic bases, are sparsely populated and are dominated by agriculture and petroleum industries. The other feature is the presence of a highly urbanized regional trade center, Amarillo, which dominates and is divided between the two other counties. County population in 1974 ranged from 1,400 to 93,300. The Amarillo SMSA includes two counties and had a population of 127,010.

Model

The functional relationship between employment and public expenditures can be expressed as a system of three equations:

$$TEMP = f(BEMP) \quad (1)$$

$$P = F(TEMP) \quad (2)$$

$$TEXP = f(P) \quad (3)$$

where

TEMP = total employment in each county, all sectors included

BEMP = employment in each export base sector, each county

P = total county population and

TEXP = a summation of each county government's expenditures, those of the dominant municipalities in that county, and those of all of the county's school districts.

Equation (1) represents the relationship between community total employment and the export base sectors. Employment data were collected from the Texas Employment Commission for the third quarter, 1974. The industry groupings or sectors used conform to the Standard Industrial Classification framework, and data were recorded unadjusted except for the agricultural sector. In this case a seasonally adjusted weighted average was used to take into account employment migration. Standard least squares regression analysis was utilized, beginning with an additive linear model regressing total employment on the basic employment of each sector. Three of the sectors, mining, manufacturing and agriculture, were considered totally basic, because of the region's economic structure.

Because petroleum production, which dominates the mining sector, is localized and not distributed evenly throughout the region, most counties had no employment listed for this sector or showed missing data, recorded as such, because of nondisclosure restrictions. Also, the manufacturing sector displayed missing data for almost half of the counties. These two sectors, which were found to be highly correlated, were combined. Another adjustment in the model concerned the number of counties included as observations. The two dominated by the Amarillo SMSA were combined as one observation because employment figures, as recorded, are not tied to place of residence and a disproportionately large number of residents in the smaller county commute to jobs in the larger county.

The employment relationships are presented in equation (4):

$$TEMP = -1044.44477 + \underset{(t = 13.7)}{4.96708\ BEMP_{M\text{-}M}} + \underset{(t = 1.7)}{1.79014\ BEMP_{AG}} \quad (4)$$

$$R^2 = .91 \qquad F = 109.0$$

where

$BEMP_{M\text{-}M}$ = basic employment in the combined mining and manufacturing sectors and

$BEMP_{AG}$ = basic employment in the agricultural sector.

The partial regression coefficients for $BEMP_{M\text{-}M}$ and $BEMP_{AG}$ are the basic employment multipliers for these sectors. These estimates of 4.97 for mining-manufacturing and 1.79 for agriculture compare favorably with those estimated by input-output methods for the High Plains region, which contains the study area and is economically homogeneous with it [5]. The basic employment multipliers represent total number of jobs created in the community as a result of one additional basic sector job.

Equation (2) makes the transition from the employment equation to the population equation. County data used to estimate this function were Census Bureau projections of 1974 population. The equation that provided the best fit, again for twenty-four observations, including a combined observation for the two that contain an SMSA is as follows:

$$P = 600.39614 + \underset{(t = 168.6)}{2.85277\ TEMP} \quad (5)$$

$$R^2 = .99 \qquad F = 28{,}412.4$$

The intercept value was not found to be significantly different from zero.

Total public service expenditures[1] in equation (3) are total annual budgeted operating expenditures and include expenditures for the county government, all school districts in the county and municipalities accounting for at least 50 percent of county population. County government and municipality expenditure data were provided by the Municipal Advisory Council of Texas and were collected from official audit reports or government records. Expenditures for school districts were obtained from the Texas Education Agency.

In equation (3), all twenty-five counties were included as separate observations since the commuting factor in the first two equations is not relevant to public expenditures within a county. Population density and income have been shown in other studies to have a significant effect on public service expenditures. For this region population density is highly correlated with population and, therefore, omitted from the equation. In the aggregate of expenditure data within a county, scaling problems may arise where there is a wide size range in public service delivery systems. A preliminary analysis of the municipal and school expenditures in the study area did not indicate serious scaling problems. Each county has a majority of its population in one or two towns. School costs per ADA (Average Daily Attendance) do not vary widely among school districts within counties. A cubic equation, similar to the firm's theoretical total cost function was found to provide the best fit of the data. Since the intercept term was not significantly different from zero, the equation was forced through the origin for simplified interpretation as follows:

$$TEXP = \underset{(t = 12.8)}{741.710P} - \underset{(t = -8.5)}{0.019626P^2} + \underset{(t = 8.9)}{0.000000173P^3} \quad (6)$$

$$R^2 = .98 \qquad F = 320.2$$

THE IMPACT OF GROWTH ON PUBLIC SERVICE EXPENDITURES

Average expenditure (AEXP) and marginal expenditure (MEXP) equations are derived from equation (6) respectively, as follows:

[1] The public services included in the analysis are water, sewage, fire and police protection, solid waste disposal, utilities, local government administration and education. No attempt is made to standardize quality or types of services between communities. A related study in the same area revealed little difference in service quality, cost and consumer satisfaction among counties with varying populations and population densities [3].

$$AEXP = 741.710 - 0.019626P + 0.000000173P^2 \quad (7)$$

$$MEXP = 741.710 - 0.039252P + 0.000000519P^2 \quad (8)$$

Due to instability of basic-service industry ratios, projections made from export base studies are legitimate only in the short-run [3]. Recognizing the added limitations of cross-sectional data, the trough of the average expenditure curve in the vicinity of a population of 57,000 cannot be strictly interpreted as an optimum point, but local leaders responsible for public service delivery systems can expect decreasing average costs when adjusting to population growth changes in the downward sloping portion of the average expenditure curve (Figure 1).

Since local government officials typically make public service pricing and output decisions based on per capita costs, the average expenditure equation (7) was chosen as the criterion for evaluating impact of additional basic jobs on community public expenditures. To link basic employment in the mining-manufacturing and agriculture sectors, identified as sources of economic growth for the region and, hence, population growth to average expenditures, partial chain derivatives of equation (7) with respect to equation (4) for both $BEMP_{M\text{-}M}$ and $BEMP_{AG}$ are taken. They yield:

$$DAG = -0.100228 + 0.0000018P \quad (9)$$

and

$$DMM = -0.278102 + 0.0000049P \quad (10)$$

where

DAG = the change in average community service expenditures (AEXP) with respect to a change in agricultural employment and

DMM = the change in average community service expenditures (AEXP) with respect to a change in mining-manufacturing employment.

The relationships indicate that employment expansion in agriculture has less impact on average community service expenditures than the same

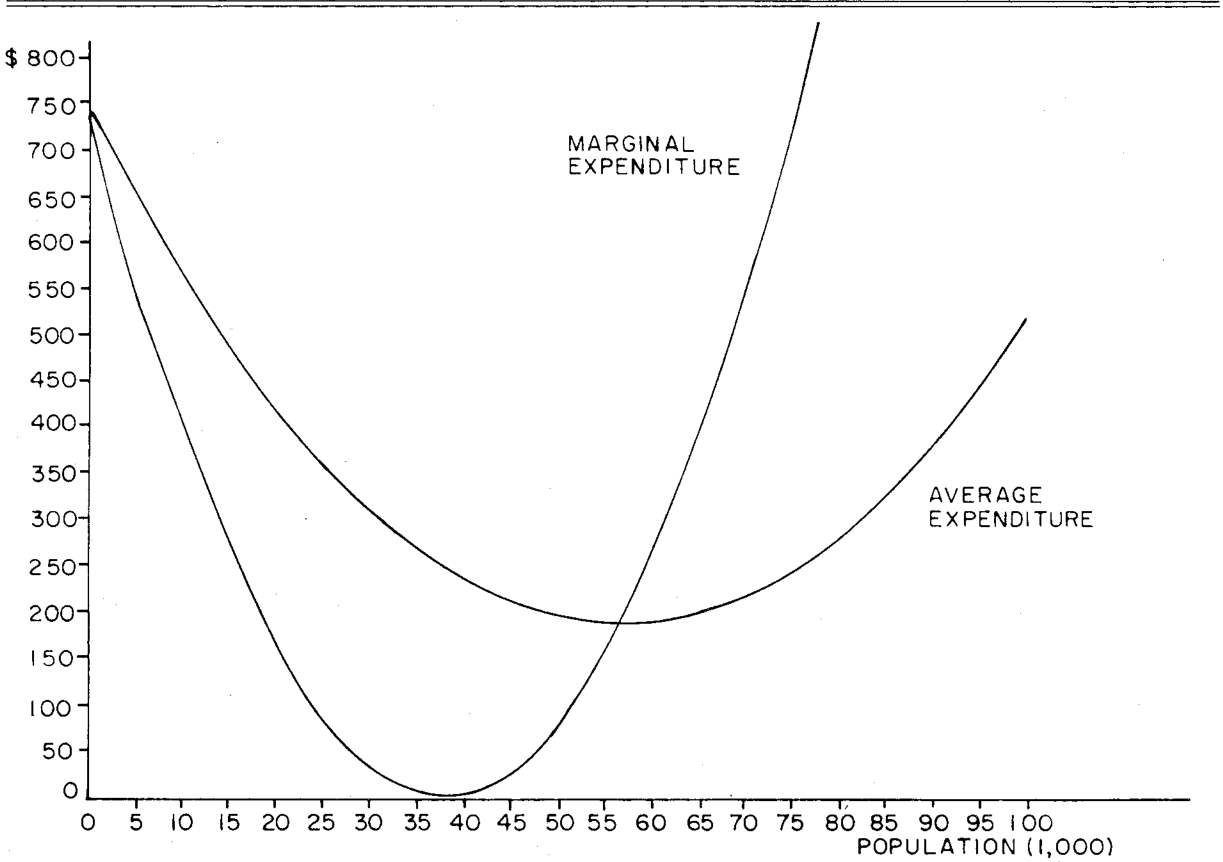

FIGURE 1. MARGINAL AND AVERAGE COMMUNITY SERVICE EXPENDITURES IN TEXAS PANHANDLE, 1974

amount of employment expansion in the mining-manufacturing sector (Figure 2).

CONCLUSIONS

Results of this study indicate that per capita community service operating expenditures in the study region decline from about $563 for a community of 10,000 to a minimum of $186 for a community of 57,000. At a population of 10,000, the decrease in average community service expenditure due to one additional job in agriculture is 8.2 cents, and 22.9 cents in manufacturing-mining. No attempt has been made to justify population as a proxy for community service output, but population continues to be a major variable in rural development policy analyses.

A comparison of the aggregated sector employment multipliers derived by use of the simplified small-area export base model with those provided by a regional input-output model for the same area proved favorable. However, the leakage problem associated with the multipliers still exists. Part of the effect, which is the result of commuting patterns, is accounted for in our simplified model by agglomerating major population centers in each county when considering operating expenditures. The major rationale for the approach used here is that a simple generalized model which is applicable to regional economic policies concerning the role of industrial development in planning community public services can be developed at low cost.

In contrast to Summers' conclusion that rural industrialization creates significant increases in community service expenditures [9], results here suggest rather sharp declines in average and marginal expenditures as population increases for this region. This difference may be explained by the inclusion of lumpy capital investments in the studies Summers considers. Our model for the Panhandle region indicates sharper declines in per capita expenditures for industrial expansion than for agricultural expansion, for populations under 57,000 as additional jobs are created in industrial and agricultural sectors. For larger communities in the region, industrial expansion tends to increase per capita expenditures at a greater rate than agricultural expansion.

Williford and others have studied the impact of ground water depletion in the study area and concluded that long-run water depletion will place a greater burden in providing public services on the region's smaller communities [11]. Their results are particularly useful in view of these latest findings, since rural Panhandle communities facing declining water supplies may alleviate part of the increased per capita expenditure burden by developing industrial

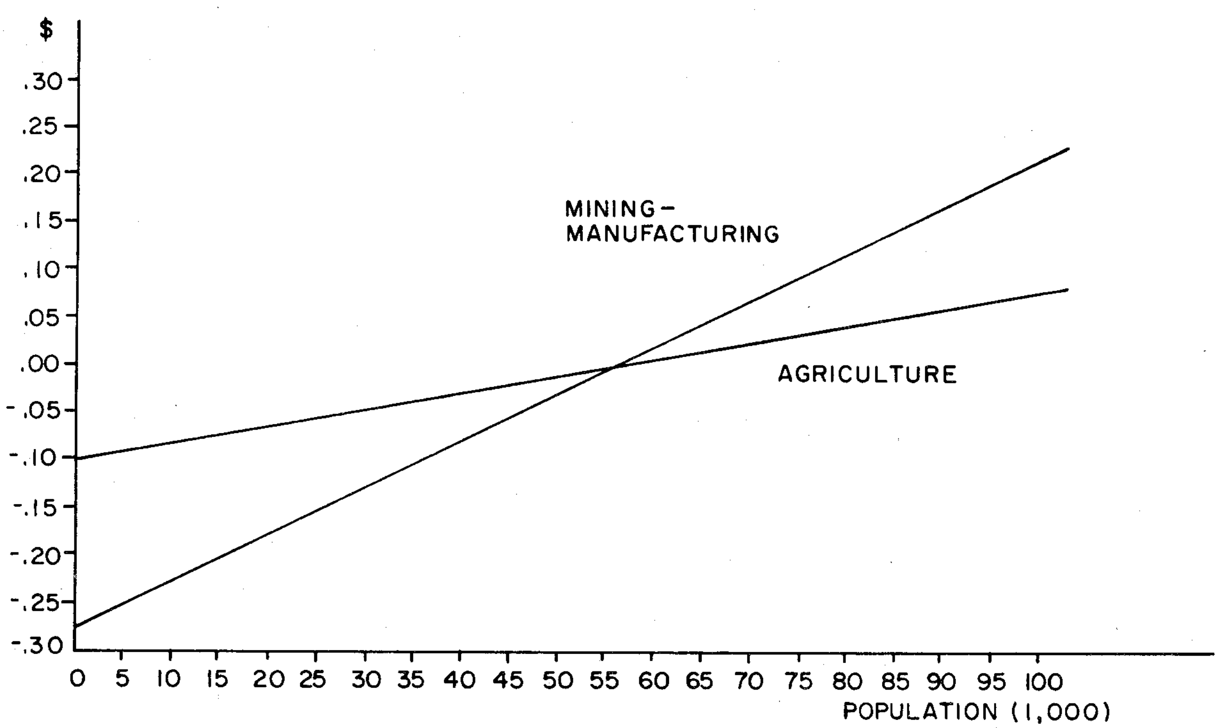

FIGURE 2. CHANGE IN AVERAGE COMMUNITY SERVICE EXPENDITURE DUE TO ONE ADDITIONAL JOB IN AGRICULTURE OR MINING MANUFACTURING SECTORS

bases that are not water-intensive.

Results of this study suggest that, in spite of data limitations, the model may make a valuable contribution to regional rural development efforts. If the applicability of such a model to other rural regions can be shown, it provides a means of gaining quick insights into current efforts to cope with increasing industrialization, population growth and natural resource extraction without resorting to more expensive and time-consuming models.

Although this model includes an export base employment equation, it should be stressed that employment multipliers from input-output models or other models could also be used. Since the relationship between total employment and population can be easily estimated, major emphasis should be placed on estimating the impact of population changes on community public expenditures.

REFERENCES

[1] Bender, Lloyd D. "Predicting Employment in Four Regions of the Western United States," Economic Research Service, USDA, Technical Bulletin No. 1529, November 1975.

[2] Braschler, Curtis and John A. Kuehn. "Estimation of Employment Multipliers for Planning in Ozarks Nonmetropolitan Counties," *Southern Journal of Agricultural Economics*, Volume 8, No. 1, July 1976, pp. 187-192.

[3] Jones, L. L. and L. C. Morgan. "Consumer Responses to Rural Public Service Problems in Great Plains States," Texas Agricultural Experiment Station, Texas A & M University, Technical Article No. 13071, January 1977.

[4] Jones, L. L. and Paul H. Gessaman. "Public Service Delivery in Rural Areas: Problems and Decisions," *American Journal of Agricultural Economics*, Volume 56, No. 5, December 1974, pp. 934-945.

[5] Osborn, James E., *et. al.* "An Input-Output Model Analysis of Texas High Plains Labor Employment Potentials to 1980," Texas State Office of Information Services, Technical Report T-1-116, August 1973.

[6] Richardson, Harry W. "An Approach to Metropolitan Employment Forecasting," *Review of Regional Studies*, Spring 1972, pp. 1-20.

[7] Shaffer, Ron and Luther Tweeten. "Economic Changes from Industrial Development in Eastern Oklahoma," Oklahoma State University Agricultural Experiment Station Bulletin B-715, July 1974.

[8] Schreiner, Dean and George Muncrief. "Estimating Regional Information Systems for Efficient Physical Planning with Application to Community Service Planning in South Central Oklahoma," Oklahoma State University Agricultural Experiment Station Journal Article No. 2313, June 1971.

[9] Summers, Gene F., *et. al. Industrial Invasion of Nonmetropolitan America*, New York: Praeger Publishers, Inc., 1976.

[10] Williamson, R. B. "Predictive Power of the Export Base Theory," *Growth and Change*, Volume 6, No. 1, January 1975, pp. 3-10.

[11] Williford, G. H., *et. al.* "The Impact of the Declining Groundwater Supply in the Northern High Plains of Texas and Oklahoma on Expenditures for Community Services," Texas Water Resources Institute, Texas A & M University, Technical Report 71, June 1976.