ESTIMATION OF EMPLOYMENT MULTIPLIERS FOR PLANNING IN OZARKS NONMETROPOLITAN COUNTIES

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INTRODUCTION

Planning for regional growth and development must necessarily be contingent upon population growth or decline expected for the region in question. Ultimately, all decisions regarding allocation of resources to the process of developing the infrastructure of fixed capital assets to serve a region's population depends upon the number of people to be served. The purpose of this article is to present employment multipliers calculated by regression analysis and to describe their usage for planning in nonmetropolitan counties of the Ozarks region. Many technical questions concerning the statistical procedure have been discussed elsewhere [2, 3, 4, 8]. Thus, these questions will be only briefly reviewed herein.

POPULATION PROJECTION

In general, one might classify population projections into demographic procedures and economic procedures. Procedures emphasizing a demographic approach are primarily concerned with such variables as birth and death rates, regional outmigration and inmigration rates. Procedures emphasizing the economic approach consider primarily those regional variables presumed to affect the employment level. The economic approach assumes that people go where jobs are located. This is admittedly an oversimplification, but it appears realistic enough to merit empirical investigation with use of a model formulated on such a basis. The objective of this investigation is to calculate employment multipliers which could serve as planning standards for estimating total employment, service employment and population growth in the Ozarks nonmetropolitan areas, given changes in specified employment categories.

THE OZARKS STUDY AREA

Nonmetropolitan areas of the Ozarks states—Arkansas, Kansas, Missouri and Oklahoma—have an opportunity for economic growth. Analysis of all 372 counties in the four states indicated that 84 counties grew in employment at a faster rate than the nation from 1960 to 1970. Moreover, 296 counties had a larger share of the nation's manufacturing employment in 1970 than they had in 1960. Manufacturing was the major growth industry; and growth was diversified among several types. Many of the rapidly-growing counties were located near the center of the four-state area in the heart of the Ozarks. Many counties with only small urban communities grew at a faster pace than the nation [6]. To assure adequate community facilities, planners and other regional scientists need to estimate the total employment and population levels which will accrue to counties and multi-county areas given such growth in basic industries like manufacturing.

THEORETICAL FRAMEWORK

The economic base theory of regional growth and change has a long history of development and does not require elaboration for regional planners and scientists. Thus, comments in this article are limited to the development and use of a particular procedure designed to measure the multiplier impacts of changes in the economic base. Even though the concepts of

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economic base theory are used in developing this empirical procedure, it could be viewed primarily as a descriptive, statistical technique having substantial, practical planning implications when certain basic variables assumed in the model are known or can be inferred with some reasonable degree of accuracy.

Historically, the use of multipliers as predictive devices has been well validated and documented in economic literature. Multipliers owe most of their popularity both in applied and theoretical work to their ability to deal with "what-if" questions. These multiplier values are a simple way of stating the change in some endogenous variable that will result from a one-unit change assumed in some exogenous variable. For example, what happens in terms of total employment, population and service employment if basic manufacturing employment increases?

Much economic base analysis has historically depended upon a case study approach, using either input-output formulations requiring direct surveys of local economies, or using the simple ratio of total nonbasic to total basic employment. These two approaches are subject to at least two very serious limitations. The first, of course, is time and money cost associated with the direct survey of business firms required for input-output analysis. Smaller communities and rural counties simply do not have the money and other resources to do detailed case studies at a point in time. They are certainly unable to afford necessary updating if reasonable accuracy is to be maintained through time. In the second approach, differences among industries' impacts are averaged together.

PROCEDURES

The procedure developed in studies by the authors is feasible from a cost standpoint, provides statistically significant estimates of economic base multipliers by industrial sectors, can be updated frequently, and relies primarily upon secondary data available from standard government sources. Only a brief sketch of the detailed model will be considered. The formal theory of the economic base suggests a specification of service employment as a function of the basic employment in the N sectors of the local economy [2, 8]. If quantities of exports used as independent variables in the regression analysis were identical to final demands used in input-output analysis for respective industries [3, 4]. The resultant regression equation yields separate multipliers for each of the basic sectors instead of the more common single multiplier for total basic employment. Differences among basic sectors' impacts are thus recognized.

After various alternative regression functions were analyzed, it was determined that estimation of employment multipliers was improved by grouping counties on the basis of population levels. Of the county groupings examined, statistical tests indicated that categorization of nonmetropolitan counties into two groups improved statistical estimation. These two groups were: (1) counties with population under 20,000, and (2) counties with population of 20,000 or more. The statistical F test for differences between employment multipliers for these two groups of counties was highly significant, indicating that structural differences warranted separate groupings of county observations [5].

Such groupings should theoretically reduce variations in service employment induced by changes in basic employment because of possible differences in industry structure, scale of activities and importation of products and services. These latter variables were not explicitly specified in the regression model for the following reasons. First, stratification of counties by population size was expected to minimize variation caused by these other variables. The relatively small standard errors obtained in the regression analysis—to be discussed later—attest to the ability of the procedure for predicting impacts for groups of counties. Second, the model is not intended to predict impacts for individual county observations, but rather to provide typical standards or guidelines for planning. Standard errors of the regression coefficients can furnish estimates of the expected amount of statistical error with cross-sectional generalizations over space. The regression model provides the planner not only with the typical multiplier, but also with probable range or variability of the estimated multiplier. Third, exclusion of these other variables, coupled with stratification of county observations by population size, retained the traditional framework of economic base and input-output models.

Formally, the regression model for *each* group of counties was as follows:

$$S.E._i = b_o + b_1 B_{i1} + b_2 B_{i2} + \ldots + b_j B_{ij} + e_i$$

where

$S.E._i$ = Total service or nonbasic employment observed in the i^{th} county in 1970

B_j = Export or basic employment in the j^{th} industry in the i^{th} county in 1970

e_i = Random error variable

b_o = A constant whose value should theoretically be zero

$b_1 \ldots b_j$ = Sector multipliers for j industries.

Total employment is the summation of total service employment and employment in the basic sectors, as in the identity:

$$T.E._{\cdot i} = S.E._{\cdot i} + B_{i1} + B_{i2} + \ldots + B_{ij}$$

Several methods for indirectly determining basic employment by industry have been used by investigators desiring to avoid costs associated with direct, primary surveys. These various methods—namely, assumption, location quotients, minimum requirements, average requirements and combinations thereof—were empirically investigated in several regression models. The methods used herein represented the "best" empirical results of all methods tested, as noted by standard errors of regression coefficients and multiple coefficients of determination. These were the assumption approach and the group average method, a modification of the location quotient method.

The assumption approach, which simply allocates all employment in a particular industry to the basic category, was utilized for agriculture, mining, manufacturing and the armed forces. Logic suggests that most output from these four industries in relatively small rural areas is sold outside the producing county. For example, most raw agricultural products move outside the producing county for additional processing before retail marketing and consumption. The assumption approach does ignore the possibility of interindustry linkages among these four industries; however, from a practical standpoint, these linkages are likely minor and undetectable by indirect measurement.

For all other industries, employment could be basic or service oriented. Basic employment was determined by the group average method.[1] The following formula was used for *each* group of counties separately:

$$B_{ik} = E_{ik} - \frac{\sum_i E_{ik}}{\sum_i \sum_j E_{ij}} \cdot \sum_j E_{ij}$$

where

B_{ik} = Basic or export employment in the i^{th} county in the k^{th} industry

E_{ij} = Total employment in the j^{th} industry in the i^{th} county

i = All counties in the population group

j = All industries

k = All industries except agriculture, mining, manufacturing, and armed forces.

subject to the restriction that, if $B_{ik} < 0$ then $B_{ik} = 0$. Finally,

$$S.E._{\cdot i} = \sum_j (E_{ij} - B_{ij})$$

The group average method is essentially the traditional location quotient method, modified by using the group's distribution of employment as the norm.

An obvious and direct use of statistically determined multipliers is development of planning relationships for use by public and private decision-makers. One step in this process is to determine distribution of service employment, based on industry employment multipliers derived above. The method used was based on each group's average distribution of employment. The amount of additional employment occasioned by a unit increase in basic employment in the j^{th} industry is the regression coefficient b_j. This amount was distributed among the service industries for each group of counties, in proportion to their percentages of total employment as follows:

$$S_{kj} = b_j \cdot \frac{\sum_i E_{ik}}{\sum_k \sum_i E_{ik}}$$

where

S_{kj} = Impact of basic employment in the j^{th} industry on nonbasic employment in the k^{th} industry

k = All industries other than agriculture, mining, manufacturing, and armed forces

j = All industries

i = All counties in the population group

E_{ik} = Total employment in the k^{th} industry in the i^{th} county.

Admittedly, these individual service multipliers are not necessarily equivalent to those determined in an input-output analysis. However, they at least offer a rough indication of expected changes for individual service industries, based upon each industry's total service multiplier, as calculated in the regression analysis and the group's distribution of employment as determined by past economic forces.

[1] Note that these six industries 1 . . . k are a subset of the overall 1 . . . j industries previously defined. Hereafter where j is referred to in the text, the k mixed industries are included.

The final step involved determination of population multipliers from predicted total employment by estimating simple linear regressions of total population on total employment by county groupings as in:

$$P_i = b'_o + b'_1 T.E._{\cdot i} + e_i$$

where

P_i = Total population in the i^{th} county in 1970

$T.E._{\cdot i}$ = Total employment in the i^{th} county in 1970

b'_o = Constant

b'_1 = Population multiplier

e_i = Random error variable.

Population multipliers were approximately 2.72 and 2.12 for county groups 1 and 2 respectively. Differences in these population multipliers reflect differences in labor force participation and unemployment rates characteristic of the areas studied. Usage of these population multipliers assumes that increases in basic and service employment will require inmigration of workers whose households exhibit characteristics (especially, labor force participation) similar to the residents'. Therefore, if the preceding assumption is valid and if basic employment in the j^{th} industry increases by one employee, service employment will increase by some multiple, b_j; in turn, total population will increase by the respective multiple of 2.72 or 2.12 per unit change in total employment.

EMPIRICAL RESULTS

The analysis included a ten-industry classification for each of the two county groupings, by population. Four of these were considered totally basic in nature. The other six industrial sectors were considered to be both basic and service-oriented. Tables 1 and 2 present the results for each grouping of counties. Group 2 counties exhibited an industrial structure more oriented to secondary and tertiary activities than did group 1 counties. Coefficients determined from the multiple regression analysis can be interpreted as the most probable change in total employment, service employment, and total population in the county group expected from a one-unit change in the economic base of the j^{th} as defined. In the case of those industries where all employment is assumed to be basic, the multipliers can be interpreted as changes resulting from a one-unit change in employment in the j^{th} industry. In those industries

TABLE 1. EMPLOYMENT MULTIPLIERS FOR 249 NONMETROPOLITAN COUNTIES OF LESS THAN 20,000 POPULATION IN OZARKS STATES, 1970

Industry	Percent of Total Employment (Group Average)	Allocation to Basic Employment	Typical Change in Employment and Population per Unit Change of Basic Employment in[a]									
			Agriculture	Mining	Manufacturing	Construction	Transportation and Communication	Trades	Services	Professions	Public Administration	Military
Agriculture	17.5	All	1.000	0	0	0	0	0	0	0	0	0
Mining	1.9	All	0	1.000	0	0	0	0	0	0	0	0
Manufacturing	17.8	All	0	0	1.000	0	0	0	0	0	0	0
Construction	7.5	>G.A.[c]	.170	.175	.128	1.201	.263	.299	.296	.243	.312	.338
Transportation & Communication	4.0	>G.A.	.092	.095	.069	.109	1.142	.162	.160	.132	.169	.183
Trades	19.4	>G.A.	.444	.455	.334	.524	.685	1.779	.771	.634	.813	.881
Services	11.7	>G.A.	.268	.275	.201	.316	.413	.470	1.465	.383	.491	.532
Professions	15.7	>G.A.	.358	.367	.269	.422	.551	.627	.621	1.510	.655	.709
Public Administration	4.4	>G.A.	.100	.102	.075	.118	.154	.175	.173	.142	1.182	.198
Military	0.2	All	0	0	0	0	0	0	0	0	0	1.000
Total Employment	100.0	NA	2.433	2.468	2.076	2.690	3.208	3.510	3.486	3.044	3.622	3.840
Standard Error	NA	NA	(.064)	(.143)	(.033)	(.291)	(.361)	(.228)	(.253)	(.134)	(.310)	(.711)
t Value[b]	NA	NA	22.4	10.3	32.6	5.8	6.1	11.0	9.8	15.3	8.5	4.0
Total Population	NA	NA	6.610	6.706	5.639	7.307	8.714	9.537	9.472	8.271	9.841	10.433

[a]Includes unit change in basic employment.

[b]Note that all t values are highly significant at less than the 1% probability level. Value of t=total employment multiplier less one, divided by the standard error.

[c]See text for definition. R^2=.93

TABLE 2. EMPLOYMENT MULTIPLIERS FOR 90 NONMETROPOLITAN COUNTIES OF 20,000 OR MORE POPULATION IN OZARKS STATES, 1970

Industry	Percent of Total Employment (Group Average)	Allocation to Basic Employment	Typical Change in Employment and Population per Unit Change of Basic Employment in[a]									
			Agriculture	Mining	Manufacturing	Construction	Transportation and Communication	Trades	Services	Professions	Public Administration	Military
Agriculture	7.4	All	1.000	0	0	0	0	0	0	0	0	0
Mining	1.7	All	0	1.000	0	0	0	0	0	0	0	0
Manufacturing	19.4	All	0	0	1.000	0	0	0	0	0	0	0
Construction	6.3	>G.A.[c]	.196	.185	.105	1.176	.338	.282	.266	.189	.226	.028
Transportation & Communication	4.1	>G.A.	.129	.121	.069	.115	1.221	.185	.175	.124	.148	.018
Trades	19.5	>G.A.	.608	.574	.326	.545	1.047	1.873	.825	.584	.702	.086
Services	12.8	>G.A.	.398	.376	.214	.357	.686	.572	1.541	.383	.460	.057
Professions	18.8	>G.A.	.586	.553	.315	.526	1.010	.842	.796	1.564	.677	.083
Public Administration	4.4	>G.A.	.138	.130	.074	.124	.238	.198	.187	.133	1.159	.020
Military	5.6	All	0	0	0	0	0	0	0	0	0	1.000
Total Employment	100.0	NA	3.055	2.939	2.103	2.842	4.539	3.952	3.790	2.976	3.373	1.292
Standard Error	NA	NA	(.268)	(.345)	(.090)	(.900)	(.886)	(.399)	(.530)	(.163)	(.291)	(.038)
t Value[b]	NA	NA	7.7	5.6	12.3	2.0	4.0	7.4	5.3	12.1	8.2	7.7
Total Population	NA	NA	6.481	6.235	4.462	6.030	9.631	8.385	8.042	6.313	7.157	2.741

[a]Includes unit change in basic employment.

[b]Note that all t values except one are highly significant at less than the 1% probability level. The multiplier for construction is significant at less than the 5% probability level. Value of t=total employment multiplier less one, divided by the standard error.

[c]See text for definition. R^2=.90

where basic employment is defined as that exceeding group average employment in the j^{th} industry, the multipliers can be interpreted as changes resulting from a one-unit change in employment in the j^{th} industry in excess of the group average employment in that industry. Most sectoral multipliers were greater for group 2 counties than for group 1 counties. Smaller leakages in group 2 counties may be attributed in part to the higher level of services available in the larger counties.

Theoretical arguments for use of regression analysis in estimating impacts of employment growth have been discussed elsewhere [3]. Empirical results obtained herein bolster these arguments. For the first group of counties with populations of less than 20,000, the multiple coefficient of determination was .976; standard errors were very low; and t-values were all significantly different from zero at the five percent level. Results of the regression analysis for the second group of nonmetropolitan counties were essentially similar to those of the first. In both groups, statistical measures and tests indicated a high degree of accuracy. Computed coefficients for the second group were significantly higher and different from those for the first group as determined by a standard Chow test [5]. Finally, inspection of the simple correlation matrices for each group indicated little multicollinearity existed among independent variables. It should be noted, however, that the military employment multiplier in counties of less than 20,000 population was largely determined on the basis of a few observations.

IMPLICATIONS

Statistical results of this analysis appear to provide useful data both from a regional policy and planning standpoint. Assume the political process had deemed it prudent to influence the location of population growth dictated by market forces, for example, decentralization of industry from metropolitan areas to rural areas. Results derived from statistically determined multipliers could provide useful guidelines for such a public policy. Two major uses for the planning process appear obvious. These are, first, to make general projections of population, total employment and service employment based on rigid assumptions about expected changes in basic employment. Secondly, to determine the impact of known changes that either have or will take place in basic employment in a case study area. In both instances, planners need to be aware of actual or expected changes in basic employment before this procedure can be utilized. Such projections are required for land-use planning and budgeting of community facilities. It should be noted that this procedure is also applicable in those areas where basic employment is declining or is expected to decline.

However, declining areas may not respond immediately to decreases in basic employment, and their adjustment may include extensive periods of underemployment and over-capacity.

Several additional observations concerning usage of these multipliers for planning purposes need to be noted. First, these employment multipliers appear to be reasonably accurate estimates of the probable impact of changes in basic employment for groups of counties. As such, these standards, based upon cross-sectional analysis, may need to be modified by the planner's awareness of local unique conditions. For example, service employment multipliers are based upon group averages and as such will be in error for any particular county. Some indication of this possible error can be ascertained by examining local conditions like excess capacity in the service sectors. Also, the population multipliers will require adjustment downwards in counties having large pools of unemployed or underemployed residents. One study of four distressed rural areas, for example, indicated that 67 to 92 percent of the new or expanded manufacturing plant jobs were held by residents [7].

Second, estimates of parameters can be updated as new data become available. Such data series include the U.S. Censuses of Population and the annual employment and earnings series maintained by the Bureau of Economic Analysis, U.S. Department of Commerce. The relatively low cost and effort incurred by this procedure appear to be particularly appealing features, because empirical evidence suggests fairly rapid obsolescence of estimated multipliers. Third, this procedure can be easily tested for other areas of the nation.

Finally, additional research is needed before this procedure can be applied to metropolitan counties. Such research would include analysis of inter-county commuting impacts on work patterns and refinement of indirect methods used in allocating employment to the basic category. In this regard, distance from metropolitan areas and major trade centers might affect individual county multipliers. This possibility has been explored by Bender and others in four regions of western United States; in their opinion, however, poor results in some regions indicated the need for additional refinement of the distance variable [1, p. 21]. Grouping of counties by population size likely accounts for part of the impacts of central places.

SUMMARY

Employment multipliers derived by regression techniques can serve as a general guide for the planning of land use and community facilities. As with any generalizations, awareness of unique local conditions may necessitate adjustments in these employment multipliers. This procedure has two major advantages over case study methods like input-output studies. These are, first, the relatively low cost involved both in initial implementation and in later revisions. Determination of the amount of statistical error that can be expected with cross-sectional generalizations over space is another advantage. Ultimately, the accuracy of impact analysis will establish or invalidate usage of this procedure for deriving standards in planning. Admittedly, input-output analysis provides more detail about actual interindustry linkages and impacts than the procedure reported herein. On the other hand, this procedure is an attractive alternative, but not a substitute, to input-output analysis when frequent updating and/or cost limitations prevail.

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