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Estimation of Industry Labor Income Multipliers for County Groupings in Missouri

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DONALD F. SCOTT * AND CURTIS BRASCHLER**

INTRODUCTION

This report covers results of continuing research into the delineation of quantifiable factors affecting regional growth and/or decline. Much of this work has involved testing cause and effect hypotheses concerning the relations between changes in a region's economic base and changes in the total level of economic activity in the region.

All of the research previously reported has concentrated upon employment as a measure of economic activity.[1] This study was an effort to determine whether measures of income would provide results of similar merit to measures of employment as an indicator of change in regional activity.

The concept of regional growth and/or decline is not easy to define or describe. It means many different things to different investigators. It implies a process whereby a region (however defined) becomes a more "viable" unit overall within a larger integrated system. For the purposes of this study, regional growth will be defined as a process by which the absolute level of economic activity of a region as measured by the sum of wage and salary disbursements, proprietors' income, and other labor income increases over time.

Regional growth and change has received more attention by federal, state, and local governmental agencies in recent years because of the drastic shifts in population and employment from rural to urban regions. The importance of regional growth cannot be overstated. Much of the economic well-being of people is determined by forces influencing these shifts in population and employment.

A number of theories have been suggested by economists in attempts to explain and understand regional growth. The result has been the adaptation of the Harrod-Domar and the Neoclassical aggregate growth models to a regional framework, and the development of sector theory, location theory, and economic base theory as theories of regional growth. It is not the purpose of this study to present a detailed discussion of each theory. The interested reader may refer to references 1 and 6.

THEORETICAL FRAMEWORK

This study uses as its theoretical framework the concept of the economic base. The concept of the economic base has been tested empirically within the context of the Leontief input-output model and also by single equation general

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[1]See references 1, 2, and 3.

linear models. The advantages of the input-output model are its exposition of the inter-industry linkages, the development of the endogenous sector multipliers, and the flexibility allowed in terms of aggregating or disaggregating the final demand sectors to generate the final demand multipliers. The use of the input-output model for conducting case study analyses is somewhat limited, however, because of the substantial costs involved in obtaining primary data to test the model empirically. In addition, the condition of fixed coefficients (constant returns to scale) imposed by the static nature of an input-output model limits the usefulness of the multiplier estimators in making long run projections.

The general linear models which have been used to test the export base theory, which is a special case of the economic base theory, have been derived either directly or indirectly from the Leontief input-output model or from a variation of the basic Keynesian aggregate demand model. In either case, the level of economic activity (however measured) has been assumed to be a linear function of the exports of the producing sectors that have been included in the model. It has been shown that where sector definitions coincide and the same unit of measurement is used, multipliers derived from a general linear model have the same interpretation as the multipliers derived from an input-output model, although they may not be numerically consistent (1, p. 457).

The advantages of the general linear model are: first, it can be estimated using statistical techniques and consequently the parameters which are estimated can be subjected to statistical analysis; second, the model can be estimated at relatively low cost assuming secondary data are available; and third, because of the low cost factor, it is possible to continually update the parameter estimated and this in turn allows a certain amount of dynamic adjustment to be interjected into the analysis. The fact that the model can be constantly updated also means that any negative effect of the constant returns to scale assumption which is at least implicitly made in dealing with a general linear model is minimized.

The disaggregation of broadly defined producing sectors into finer industry detail which characterizes many input-output studies is generally not considered, however, in the specification of the general linear model. In addition, the framework of a general linear model does not provide the accounting system for measuring the flows of inputs and outputs between sectors that an input-output model provides.

STATEMENT OF THE PROBLEM

Either sales or employment have been used as the unit of measurement in most export base analyses. It should be noted, however, that there is not one single unit of measurement that is most appropriate. Sales, employment, value added, or income could all be used. Each measures a significant economic magnitude, and theoretically, all should give consistent results. Income has not been used because until recently reliable regional income data have not been available on a disaggregated basis in terms of either producing sectors or geographical or political units.

The use of income as a measure of economic activity in regional analysis has considerable merit. It provides a basis for economic planning in the public and private sectors and in this regard it is possibly the most important measure of economic activity. Income also provides a basis for making inferences with respect to welfare considerations as they relate to a single region or several regions taken together.

One of the primary objectives of an export base model, whether it be an input-output model or a general linear model, is the delineation and quantification of the economic forces responsible for regional economic growth. In considering different regional delineations, considerable differences in the economic structure of various regions may arise. A region that is defined to encompass the geographical boundaries of a state or a large metropolitan area would exhibit a much more diverse and interdependent economic structure than one defined to encompass an area with a relatively small population and a relatively low level of economic activity. Such a region is also more likely to possess the necessary resources (capital and human) to conduct economic analyses and planning programs. The smaller the region and the less complex the economic structure of that region, the more important are aggregate relationships in considering economic development.

There is a need, therefore, to develop frameworks for analyzing small regional economies that will be useful in determining the economic forces contributing to their growth or decline. Such procedures must provide information that will form the basis for economic planning while at the same time minimizing the cost of obtaining that information. In addition, the people using such information are not likely to be highly trained economic analysts. Their main concern is likely to be the effect of different policy proposals on the aggregate level of regional economic activity.

PURPOSE AND OBJECTIVES

The purpose of this study was to estimate a linear economic base model which specified the economic base to be the exports of the endogenous sectors defined in a given region, and to utilize a unit of measurement which provided an estimate of income.

The specific objectives of the study may be stated as follows:

1. to specify an export base model which has validity as a predictive tool, and to estimate that model using income data;
2. to obtain parameter estimates of a linear export model at various points in time in an attempt to determine if meaningful trends develop in the export labor income multipliers over time;
3. to compare the estimates of the export labor income multipliers derived in the same time period for the two groups delineated in this study to determine if the criteria used to delineate a group provide a meaningful

framework for delineation of significantly different structures between the two groupings.

4. to compare the parameter estimates of a linear export base model where employment has been used as the unit of measurement with parameter estimates of a similar model where the unit of measurement is an estimate of labor income.

DATA AND METHODOLOGY

Two groupings within the state of Missouri were delineated based on 1970 county population data. Those counties with a population less than 15,000 persons comprised one grouping which was referred to as Group I. Group II was defined to include counties with a population equal to or greater than 15,000 persons, but excluded seven counties which either bordered or included metropolitan or densely populated areas. The city of St. Louis was also excluded from the analysis. It was assumed that those counties excluded from the Group II delineation exhibited a greater degree of economic interdependence between producing sectors than was the case for the counties included in Group II.

The procedure used in this study to delineate groups incorporated aspects of two of the traditional bases used to delineate groups. The homogeneity principle was incorporated into the analysis by grouping counties on the basis of population. Although it was possible that the economic structure of individual counties within a grouping differed, the service components of those counties were assumed to be similar. It was assumed that the use of the county as a geographical focal point would provide a policy orientation for the analysis.

The procedure used in this study to delineate groupings may be criticized since counties in a given group are not all contiguous in the sense that they represent a particular geographical region of the state. As discussed above, counties that were assigned to a given group were not necessarily homogeneous in terms of economic structure and this introduced a variability factor into the study.

The Bureau of Economic Analysis (BEA) has developed a set of income accounts which contain estimates of total personal income at the county level and earnings estimates disaggregated on a broad sector basis on a where-earned basis at the county level. Total earnings are defined by the BEA to include total wage and salary disbursements, other labor income, and proprietors' income. Total earnings is personal income less property income, transfer payments plus social insurance contributions. Total and sector earnings at the county level formed the unit of measurement used in this study.

The sectors defined by the BEA correspond roughly to the division sectors specified in the Standard Industrial Classification Manual. The sectors used in this study were those defined by the BEA:

Farm

Federal Government
State and Local Government
Manufacturing
Mining
Contract Construction
Transportation, Communication, and Public Utilities
Wholesale and Retail Trade
Finance, Insurance, and Real Estate
Services

Disclosure rules prohibit the BEA from publishing estimates of sector earnings at the county level where there may be only one or a few firms within a county in a particular sector. It was determined that in many instances the absolute dollar value of the sector earnings that were not published was substantial. Such an inference was possible because control totals published by the BEA allowed one to determine the total amount of sector earnings not published because of disclosure rules. It was decided that an estimate of sector earnings should be made in those instances where none was published by the BEA. In an attempt to weight the sectors in a realistic manner, annual total earnings in the various sectors as published by the Bureau of the Census for the state of Missouri were utilized. The following formula was used in allocating sector earnings that were not published to the jth sector of the ith county:

$$(1) \quad \frac{TE_j}{\sum_{j=1}^{m} TE_j} TSE^{nr}_i$$

where TE_j = Total earnings in the jth sector in the state of Missouri in the nearest census year and $j = 1, \ldots, m$, where m represents the number of sectors in which earnings estimates were not reported;

TSE^{nr}_i = total sector earnings that were not reported in the ith county

The Bureau of Economic Analysis does not make a distinction between export earnings and locally oriented earnings. Two indirect procedures, the assumption approach, and a derivative of the location quotient approach were used to estimate export and locally oriented earnings.

For the purpose of this study, it was assumed that all of the earnings in the Farm, Federal Government, and Manufacturing sectors were export earnings. The output of the Farm and Manufacturing sectors was assumed to require further processing before it became available to the ultimate consumer. Decisions with respect to Federal Government expenditures were assumed to be made with little input from the county level.

The export earnings of the remaining sectors were estimated using a derivative of the location quotient approach previously developed and referred to as the Group Average Requirement (GA) (1, pp. 462, 463). Before this procedure is described, consider the following notation:

(2) TLI_{ijk} = total labor income (total earnings) in the ith county of the jth sector of the kth region; $k = 1, 2$; $i = 1, \ldots, 60$, if $k = 1$, and $i = 1, \ldots, 47$, if $k = 2$; $j = 1, \ldots, 10$;

(3) $TLI_k = \sum_i \sum_j TLI_{ijk}$ = total labor income (total earnings) in the kth county grouping and the subscripts are as defined in (2);

(4) $TLI_{jk} = \sum_i TLI_{ijk}$ = total labor income (total earnings) in the jth sector of the kth group and the subscripts are as defined in (2);

(5) $TLI_{ik} = \sum_j TLI_{ijk}$ = total labor income (total earnings) in the ith county of the kth group and the subscripts are as defined in (2).

The group average requirement procedure provided an expected value of the locally oriented labor income expected in each sector of each county. It was assumed that the counties included in a given group were homogeneous with respect to locally oriented labor income generated in each sector. The proportion of the total labor income in a given group which was accounted for by each sector was determined, and these proportions were then considered to be the expected value of the locally oriented labor income in each of the sectors within all counties included in that group. Mathematically, the group average requirement (GA) of the jth sector of the kth region was defined as follows:

$$(6) \quad GA_{jk} = \frac{\sum_i TLI_{ijk}}{TLI_k} = \frac{TLI_{jk}}{TLI_k}$$

To determine the locally oriented labor income of each sector in a given county within a group, the total labor income of that county was allocated on the basis of the group average proportions for each sector of that group. The export labor income (ELI_{ijk}) of each sector of each county (with the exception of the Farm, Federal Government, and Manufacturing sectors) was then determined by subtracting from the observed sector labor income the locally oriented labor income. Mathematically, the export labor income of the jth sector of the ith county and kth group was defined as follows:

(7) $ELI_{ijk} = TLI_{ijk} - (GA_{jk})\ TLI_{ik}$

The group average requirement procedure by definition gave rise to negative sector export labor income in some of the counties. The negative values implied import substitution, and since the export base theory ignores import substitution it was assumed that where negative values were obtained, all of the labor income was locally oriented. In other words, the values of the export labor income observations which were used in this study were either positive or zero.

Four years were selected for analysis in this study. The years 1950, 1959, 1965, and 1970 were selected so that both long term and intermediate term effects on the county economies could be taken into account. It was assumed that one-year time intervals would be too short in terms of observing changes in the economic structure, and that at least a five-year interval would be necessary to observe a permanent change.

Two linear models (referred to as Model I and Model II) were specified and estimated for both regions. Model I was a linear model which specified that total labor income in a given county was a function of the export labor income of each of the endogenous sectors specified previously. That is:

(8) $TLI_{it} = f(ELI_{1t}, \ldots, ELI_{10t})$
where TLI_{it} = total labor income of the ith county measured in current dollars for time period t;

ELI_{jt} = export labor income of the jth sector measured in current dollars for time period t.

Model II was a first difference model which specified that the change in total labor income in a given county over a specified time interval was a function of the change in the export labor income of each of the endogenous sectors specified previously over the same time interval. That is:

(9) $\Delta TLI_i = f(\Delta ELI_1, \ldots, \Delta ELI_{10})$
where Δ = the change in the observed variable from time period t-1 to time period t.

It was hypothesized that a first difference model would aid in establishing the cause and effect relationship implied by the export base theory. In addition, a first difference model has been considered by some to be a more useful model than one similar to Model I for the purpose of extrapolation (5, p. 94).

Both Model I and Model II were estimated for both groups using cross-sectional multiple linear regression models. The regression model specified to estimate Model I was the following:

(10) $TLI_{ik} = B_0 + B_1\ ELI_{1ik} + B_2\ ELI_{2ik} + \ldots + B_{10}ELI_{10ik} + E_{ik}$
where TLI_{ik} = total labor income in the ith county of the kth region and the subscripts are as defined in (2);

B_0 = constant term which was assumed to be zero;
B_j = the export labor income multiplier of the jth sector which was assumed to be $\geqslant 1.0$ and the subscript is as defined in (2);
ELI_{ijk} = the export labor income of the ith county, jth sector, and kth group, and the subscripts are as defined in (2);
E_{ik} = a random error term, and the subscripts are as defined in (2).

Within the cross-sectional multiple linear regression framework, Model II was specified as follows:

(11) $\Delta TLI_{ik} = B_0 + B_1\Delta ELI_{1ik} + B_2\Delta ELI_{2ik} + \ldots + B_{10} ELI_{10ik} + E_{ik}$
where Δ = is as defined in (9) and the time intervals that were specified were 1970-1965, 1965-1959, and 1959-1950; all of the other variables are as defined in (10) although no assumption was made with respect to the value of B_0.

In an attempt to determine the stability of the export labor income multipliers of Model I over time, and in an effort to determine the appropriateness of the county classes that were made in this study, tests of equality of the regression coefficients were made. The following tests were made using procedures outlined by Fisher (4, pp. 363-364):

1. The Model I regression coefficients of both groups were tested over time. Equality of the regression coefficients over time would tend to indicate some stability in the labor income multipliers over time.
2. The Model I regression coefficients were tested for equality across groups for each time period. In delineating the two groups used in this study, it was assumed that differences in the economic structure or relative sizes of the sectors warranted such a distinction. It was assumed, therefore, that inequality of the regression coefficients over groups indicated that there were differences in the economic structures of the two groups.

STATISTICAL RESULTS

The results of estimating Model I for both groups for each time period are presented in Tables 1 through 8. Three statistics, the multiple coefficient of determination (R^2), the "t" value of the individual parameter estimators, and the standard error of those estimators are of primary importance.

The multiple coefficient of determination (R^2), which provides some indication of the ability of the model to explain a specified relationship was no less than .97 in all cases.[2] In other words, the variation in total labor income

[2]The multiple coefficients of determination are somewhat overstated because the dependent variable, total labor income, included export labor income. Part of the fluctuation in total labor income is export labor income so that the R^2's are artificially increased.

TABLE 1

RESULTS OF ESTIMATING MODEL I FOR THE REGION I COUNTIES
1970 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average[b]
State and Local Government	1.79	0.63	1.25	.15
Mining	1.12	0.16	0.75	.03
Contract Construction	1.01	0.59	0.02	.04
Transportation, Communication, and Public Utilities	1.49	0.49	1.01	.03
Wholesale and Retail Trade	2.32	0.42	3.15[a]	.15
Finance, Insurance, and Real Estate	2.42	0.80	1.77[a]	.03
Services	1.97	0.27	3.64[a]	.10
Farm	1.62	0.07	9.13[a]	.28
Federal Government	1.57	0.64	0.88	.05
Manufacturing	1.82	0.10	8.42[a]	.15
Constant ($\hat{\beta}_o$)	642.07	605.62	1.06	
$R^2_{y.1...10}=.98$				

[a]Statistically significant at the .05 level.

[b]The sector group averages may not sum to 1.0 due to rounding.

TABLE 2

RESULTS OF ESTIMATING MODEL I FOR THE REGION I COUNTIES
1965 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average
State and Local Government	2.91	0.78	2.45[a]	.11
Mining	2.00	0.54	1.84[a]	.01
Contract Construction	1.43	0.49	0.89	.05
Transportation, Communication, and Public Utilities	1.87	0.49	1.79[a]	.04
Wholesale and Retail Trade	2.03	0.36	2.87[a]	.18
Finance, Insurance, and Real Estate	3.15	1.16	1.85[a]	.02
Services	2.18	0.42	2.82[a]	.09
Farm	1.60	0.06	10.70[a]	.35
Federal Government	3.31	0.81	2.85[a]	.04
Manufacturing	1.80	0.11	7.08[a]	.11
Constant ($\hat{\beta}_o$)	-810.35	528.31	-1.53	
$R^2_{y.1...10}=.98$				

[a]Statistically significant at the .05 level.

TABLE 3

RESULTS OF ESTIMATING MODEL I FOR THE REGION I COUNTIES
1959 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average[b]
State and Local Government	2.13	1.06	1.06	.08
Mining	1.56	0.17	3.36[a]	.02
Contract Construction	1.60	0.35	1.67	.05
Transportation, Communication, and Public Utilities	1.81	0.31	2.57[a]	.06
Wholesale and Retail Trade	2.06	0.34	3.08[a]	.18
Finance, Insurance, and Real Estate	5.20	1.76	2.39[a]	.02
Services	2.14	0.46	2.46[a]	.09
Farm	1.58	0.07	8.36[a]	.35
Federal Government	3.11	0.98	2.17[a]	.04
Manufacturing	1.61	0.08	7.49[a]	.12
Constant ($\hat{\beta}_o$)	-214.50	395.28	-0.54	
$R^2_{y.1...10}=.97$				

[a]Statistically significant at the .05 level.

[b]The sector group averages may not sum to 1.0 due to rounding.

TABLE 4

RESULTS OF ESTIMATING MODEL I FOR THE REGION I COUNTIES
1950 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average[b]
State and Local Government	.93	.99	.08	.06
Mining	1.31	.16	1.99[a]	.02
Contract Construction	2.87	.63	2.96[a]	.03
Transportation, Communication, and Public Utilities	2.06	.19	5.71[a]	.07
Wholesale and Retail Trade	2.23	.36	3.41[a]	.14
Finance, Insurance, and Real Estate	2.43	1.29	1.11	.01
Services	1.70	.38	1.81[a]	.06
Farm	1.38	.04	8.51[a]	.51
Federal Government	4.55	.97	3.65[a]	.02
Manufacturing	1.27	.08	3.31[a]	.07
Constant ($\hat{\beta}_o$)	-310.58	264.74	-1.17	
$R^2_{y.1...10}=.98$				

[a]Statistically significant at the .05 level.

[b]The sector group averages may not sum to 1.0 due to rounding.

TABLE 5

RESULTS OF ESTIMATING MODEL I FOR THE REGION II COUNTIES
1970 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average
State and Local Government	2.90	0.38	5.04[a]	.15
Mining	1.20	0.33	.60	.01
Contract Construction	1.20	0.17	1.15	.07
Transportation, Communication, and Public Utilities	3.32	0.77	3.01[a]	.05
Wholesale and Retail Trade	2.81	0.88	2.05[a]	.16
Finance, Insurance, and Real Estate	1.47	0.81	0.58	.03
Services	3.13	0.70	3.05[a]	.12
Farm	1.75	0.22	3.48[a]	.12
Federal Government	1.09	0.03	2.64[a]	.11
Manufacturing	1.91	0.12	7.90[a]	.18
Constant ($\hat{\beta}_o$)	2499.94	2302.55	1.09	
$R^2_{y.1...10}=.99$				

[a]Statistically significant at the .05 level.

TABLE 6

RESULTS OF ESTIMATING MODEL I FOR THE REGION II COUNTIES
1965 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average[b]
State and Local Government	2.14	0.32	3.61[a]	.12
Mining	1.23	0.26	0.88	.01
Contract Construction	1.89	0.23	3.86[a]	.06
Transportation, Communication, and Public Utilities	2.62	0.43	3.78[a]	.05
Wholesale and Retail Trade	2.12	0.56	1.99[a]	.18
Finance, Insurance, and Real Estate	2.17	0.42	2.80[a]	.04
Services	3.65	0.72	3.70[a]	.11
Farm	1.50	0.09	5.47[a]	.16
Federal Government	1.13	0.03	4.07[a]	.10
Manufacturing	2.02	0.06	17.44[a]	.16
Constant ($\hat{\beta}_o$)	3355.37	1130.17	2.97[a]	
$R^2_{y.1...10}=.99$				

[a]Statistically significant at the .05 level.

[b]The sector group averages may not sum to 1.0 due to rounding.

TABLE 7

RESULTS OF ESTIMATING MODEL I FOR THE REGION II COUNTIES
1959 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average
State and Local Government	2.34	0.33	4.08[a]	.09
Mining	1.16	0.47	0.35	.01
Contract Construction	2.42	0.24	5.87[a]	.06
Transportation, Communication, and Public Utilities	2.01	0.24	4.13[a]	.08
Wholesale and Retail Trade	2.86	0.49	3.83[a]	.19
Finance, Insurance, and Real Estate	1.13	0.59	0.22	.04
Services	2.47	0.57	2.58[a]	.10
Farm	1.48	0.09	5.16[a]	.17
Federal Government	1.12	0.02	4.71[a]	.10
Manufacturing	1.98	0.08	12.90[a]	.16
Constant ($\hat{\beta}_0$)	2817.53	781.92	3.60[a]	
$R^2_{y.1...10}=.99$				

[a]Statistically significant at the .05 level.

TABLE 8

RESULTS OF ESTIMATING MODEL I FOR THE REGION II COUNTIES
1950 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value	Sector Group Average
State and Local Government	1.83	0.54	1.53	.07
Mining	0.80	0.65	-0.31	.01
Contract Construction	2.36	0.35	3.84[a]	.05
Transportation, Communication, and Public Utilities	1.86	0.25	3.47[a]	.12
Wholesale and Retail Trade	3.16	0.53	4.05[a]	.18
Finance, Insurance, and Real Estate	2.14	1.40	0.82	.02
Services	3.15	0.58	3.72[a]	.09
Farm	1.35	0.07	4.97[a]	.30
Federal Government	1.91	0.59	1.53	.03
Manufacturing	1.86	0.13	6.68[a]	.13
Constant ($\hat{\beta}_0$)	1995.84	676.79	2.95[a]	
$R^2_{y.1...10}=.99$				

[a]Statistically significant at the .05 level.

explained by the regression on the export labor income variables for each group was almost completely explained in each of the time periods analyzed.

The "t" values of the individual regression coefficients with the exception of the constant term were computed under the null hypothesis that the export multipliers were equal to 1.0 versus the alternative that they were greater than 1.0. The "t" value related to the constant term was computed under the null hypothesis that B_0 was equal to zero versus the alternative that it was not equal to zero. Most of the "t" values were significant. This fact, coupled with the relatively high R's, established the statistical significance of the overall model as a predictive model, and the individual regression coefficients as reliable indicators of the individual effects of the exogenous variables on the dependent variable.

The estimated standard error of the regression coefficient provides an indication of the range in the absolute value of a given estimator if repeated samples were taken and the parameter were estimated over and over. It may be interpreted as an indicator of the degree of certainty that can be attached to the estimate of the export multiplier. In this respect, the relatively low standard errors of the export multipliers of both the Farm and Manufacturing sectors were of particular significance since those two sectors combined accounted for a relatively large proportion of total labor income in both groups over time.

The results of estimating Model II for both groups for the three time intervals are presented in Tables 9 through 14. From a statistical standpoint, the results of estimating Model II for both groups were generally consistent with the results obtained from estimating Model I. In each instance, the multiple coefficient of determination was quite high. With the exception of the 1970-1965 time interval, most of the "t" values were significant.

In comparing the sector labor income multipliers of both models over time, the Model II multipliers were generally smaller than their Model I counterparts. The differences may have been the result of the time intervals selected for estimating Model II. In selecting the time intervals, it was implicitly assumed that those intervals reflected the length of the adjustment process. The selection of the beginning and ending time periods is important in considering first differences. Had the time intervals been shorter and possibly more realistic in terms of the adjustment process, the Model II multipliers may have been more compatible with the Model I multipliers.

The stability of the multipliers over time for both groups was tested statistically by testing for the equality of the full set of regression coefficients between time periods. The results, which substantiated the stability of the multipliers over time, are presented in Table 15.

In an effort to determine whether the county groupings used in this study were meaningful from the standpoint of obtaining different parameter estimates, the full set of multipliers of both groupings in each year were tested for equality. The results of the tests are presented in Table 16. In each year except 1970, the

TABLE 9

RESULTS OF ESTIMATING MODEL II FOR THE REGION I COUNTIES
1970-1965 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value
State and Local Government	0.19	0.52	-1.57
Mining	1.12	0.12	1.06
Contract Construction	0.95	0.28	-0.18
Transportation, Communication, and Public Utilities	1.34	0.33	1.03
Wholesale and Retail Trade	1.45	0.27	1.66
Finance, Insurance, and Real Estate	1.77	0.41	1.88[a]
Services	1.55	0.18	3.12[a]
Farm	1.29	0.13	2.29[a]
Federal Government	0.92	0.50	-0.16
Manufacturing	1.41	0.09	4.84[a]
Constant ($\hat{\beta}_0$)	1330.01	164.64	8.08[a]
$R^2_{y.1...10}=.98$			

[a]Statistically significant at the .05 level.

TABLE 10

RESULTS OF ESTIMATING MODEL II FOR THE REGION I COUNTIES
1965-1959 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value
State and Local Government	0.66	0.72	-0.47
Mining	1.42	0.17	2.52[a]
Contract Construction	1.76	0.25	3.02[a]
Transportation, Communication, and Public Utilities	2.47	0.45	3.27[a]
Wholesale and Retail Trade	1.62	0.28	2.23[a]
Finance, Insurance, and Real Estate	2.25	0.81	1.54
Services	1.28	0.38	0.74
Farm	1.39	0.06	6.60[a]
Federal Government	2.18	0.88	1.34
Manufacturing	1.36	0.13	2.83[a]
Constant ($\hat{\beta}_0$)	513.06	224.13	2.29[a]
$R^2_{y.1...10}=.97$			

[a]Statistically significant at the .05 level.

TABLE 11

RESULTS OF ESTIMATING MODEL II FOR THE REGION I COUNTIES
1959-1950 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value
State and Local Government	0.19	0.69	-1.18
Mining	1.15	0.30	0.50
Contract Construction	1.52	0.25	2.04[a]
Transportation, Communication, and Public Utilities	1.16	0.23	0.71
Wholesale and Retail Trade	1.83	0.34	2.46[a]
Finance, Insurance, and Real Estate	3.03	1.17	1.74[a]
Services	1.58	0.29	2.01[a]
Farm	1.16	0.08	2.18[a]
Federal Government	2.55	0.69	2.25[a]
Manufacturing	1.62	0.11	5.87[a]
Constant ($\hat{\beta}$o)	825.34	164.56	5.02[a]
$R^2_y.1...10=.93$			

[a]Statistically significant at the .05 level.

TABLE 12

RESULTS OF ESTIMATING MODEL II FOR THE REGION II COUNTIES
1970-1965 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value
State and Local Government	2.78	0.32	5.54[a]
Mining	0.74	0.49	-0.52
Contract Construction	1.12	0.11	1.10
Transportation, Communication, and Public Utilities	0.93	0.84	-0.09
Wholesale and Retail Trade	2.39	0.60	2.30[a]
Finance, Insurance, and Real Estate	1.62	0.91	0.69
Services	2.08	0.77	1.40
Farm	1.15	0.25	0.60
Federal Government	1.01	0.04	0.33
Manufacturing	2.11	0.18	6.00[a]
Constant ($\hat{\beta}_o$)	1394.05	825.66	1.69
$R^2_y.1...10=.97$			

[a]Statistically significant at the .05 level.

TABLE 13

RESULTS OF ESTIMATING MODEL II FOR THE REGION II COUNTIES
1965-1959 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value
State and Local Government	2.04	0.32	3.23[a]
Mining	1.23	0.20	1.16
Contract Construction	1.50	0.35	1.42
Transportation, Communication, and Public Utilities	2.26	0.45	2.80[a]
Wholesale and Retail Trade	1.62	0.33	1.88[a]
Finance, Insurance, and Real Estate	3.27	0.33	6.99[a]
Services	4.77	0.55	6.85[a]
Farm	1.50	0.11	4.51[a]
Federal Government	1.23	0.12	1.96[a]
Manufacturing	1.74	0.12	6.41[a]
Constant ($\hat{\beta}_o$)	1428.29	443.57	3.22[a]
$R^2_{y.1...10}=.98$			

[a]Statistically significant at the .05 level.

TABLE 14

RESULTS OF ESTIMATING MODEL II FOR THE REGION II COUNTIES
1959-1950 LABOR INCOME DATA

Sector	Export Labor Income Multiplier ($\hat{\beta}$)	Standard Error of $\hat{\beta}$	t Value
State and Local Government	2.11	0.34	3.27[a]
Mining	1.23	0.38	0.62
Contract Construction	3.08	0.51	4.07[a]
Transportation, Communication, and Public Utilities	2.13	0.32	3.56[a]
Wholesale and Retail Trade	1.82	0.41	1.99[a]
Finance, Insurance, and Real Estate	1.27	0.48	0.56
Services	0.66	0.51	-0.68
Farm	1.06	0.19	0.30
Federal Government	1.11	0.02	6.79[a]
Manufacturing	1.91	0.05	18.49[a]
Constant ($\hat{\beta}_o$)	1691.05	402.24	4.20[a]
$R^2_{y.1...10}=.99$			

[a]Statistically significant at the .05 level.

TABLE 15. RESULTS OF TESTING FOR THE EQUALITY OF THE FULL SET OF MULTIPLIERS OVER TIME FOR EACH REGION

Null Hypothesis: Equality of Multipliers Between Time Periods	F Statistic	Reject Null Hypothesis
Region I		
1970 = 1965	1.02[a]	No
1970 = 1959	1.43[a]	No
1970 = 1950	5.91[a]	Yes
Region II		
1970 = 1965	0.883[b]	No
1970 = 1959	1.597[b]	No
1970 = 1950	1.741[b]	No

[a]At the .05 level, the critical value of F (11, 98) ≃ 1.883.

[b]At the .05 level, the critical value of F (11, 72) ≃ 1.926.

TABLE 16. RESULTS OF TESTING FOR THE EQUALITY OF THE FULL SET OF MULTIPLIERS ACROSS REGIONS

Null Hypothesis: Equality of Multipliers Across Regions	F Statistic	Reject Null Hypothesis[a]
1970 Region I = Region II	1.430	No
1965 Region I = Region II	3.305	Yes
1959 Region I = Region II	4.551	Yes
1950 Region I = Region II	5.313	Yes

[a]At the .05 level, the critical value of F (11, 85) ≃ 1.903.

full set of multipliers was not equal between groups so that, in general, there were differences in the effect of similar exogenous export forces on the two groups defined within the state of Missouri.

It is important to consider the existing resource base of the group when using export base multipliers. It is especially important to consider the existing and potential labor force. An assessment must be made of the extent of unemployment and underemployment in a group. In addition, the competition for existing labor resources in a group must be considered.

A comparison of the labor income multipliers provides an indication of which sectors have the greatest impact on total labor income.[3] The absolute size of the sector multipliers may be somewhat misleading, however, from the standpoint of overall growth and development. The relative importance of sector in terms of the overall export base is a major consideration in the analysis of the sector's impact on growth. The multiplier value itself provides no indication of the cyclical nature of industries in a given sector. Inferences with respect to economic welfare may be completely misleading if based solely on the size of the multiplier. A relatively large multiplier does not necessarily reflect high wage and salary levels per worker. Instead, it may reflect substantial employment linkages between sectors characterized by low wages and salaries per worker.

ECONOMIC CONSIDERATIONS

The value of Model I from an economic standpoint can be assessed on the basis of its performance relative to the export base theory which underlies the model. From the standpoint of the export base theory, the results from estimating Model I for the Group I counties verified the export base concept in general. The "t" value of the constant term for each year was not significant so that the null hypothesis could not be rejected. This was consistent with the theory which required that the constant term be equal to zero. The regression coefficients on the exogenous variables had the correct sign, and were equal to or greater than 1.0 except for the State and Local Government multiplier for 1950. The fact that the "t" values were not always significant did not necessarily lessen the value of the model. All of the sectors which were defined for use in this study

[3]It should be pointed out that multipliers of industries where exports were determined by assumption are not directly comparable to those industries where exports were determined by group average requirements. The multipliers as computed can be interpreted as follows: (a) for those associated with industries where exports were determined by assumption the computed regression coefficient is interpreted as the increase in total labor income resulting from a one unit increase in income in the jth sector, (b) for those multipliers calculated for industries where exports were determined by the group average procedure the multipliers can be interpreted as the increase in total labor income resulting from a one unit increase in labor income in the jth sector in excess of the group average requirement. Thus, multipliers for the latter industries are overstated relative to the former industries. The group average multipliers can be deflated by dividing them by $1 + GA_{jk}$ if direct comparison between these separate categories is desired.

were assumed to rely on some export oriented activity with substantial interindustry linkages. Sectors such as State and Local Government and Contract Construction may have very little interindustry linkage. This could explain the insignificant "t" values obtained in certain of these industries.

When analyzed within the context of the export base theory, the results pertaining to the Group II counties generally conformed to the theory. The sector multipliers had the correct sign in all instances although the multiplier of the Mining sector was not significant in each time period, and the same was true of the "t" value of the Finance, Insurance, and Real Estate sector in each time period except 1965.

The most important departure of the results related to the Group II counties from the export base theory were the "t" values of the constant term which were significant for all time periods except 1970. In other words, the constant term was hypothesized to be equal to zero to be consistent with the theory. The null hypothesis was rejected for the years 1950, 1959, and 1965. These results indicate that there were other economic factors besides export activity determining the level of total labor income in the Group II counties. In reality, there was little doubt that this was the case. It may be argued, however, that the sector multipliers are more important than the constant term since the regional economist would be primarily interested in the effect on a regional economy of specific changes in the structure of that economy rather than generalizations concerning the overall economy.

Export base multipliers have generally been considered short run in nature. Previous work using employment suggests that export base multipliers have value as long run predictors (3, p. 20). The results of this study also suggest that export base multipliers have potential value as intermediate and long run predictors of changes in economic activity.

The use of income data in estimating the export base model presented in this study provided a useful data base. As was pointed out in a previous section, little if any empirical work related to the export base theory has been undertaken using income as the unit of measurement. The most serious limitation of income data is the fact that they are most often reported in current dollars, and tend to be less stable than some other units of measurement. Some adjustment for price level changes may be necessary in using income data bases in export base studies.

The delineation of county groupings for the purpose of analyzing regional economic growth generally causes some conceptual problems and always affects the results of regional analyses. In simplest of terms, groupings are difficult to define. The approach used in this study does have some appeal. There were differences in the multiplier values across groups, and in general the multipliers related to the Group II counties were larger than the multipliers for the Group I counties, which is consistent with the export base theory.

A COMPARISON OF LABOR INCOME AND EMPLOYMENT MULTIPLIERS

One of the objectives of this study was to compare estimated of export base multipliers derived using employment data and labor income data. Both employment and labor income are important indicators of the level of economic activity. They are directly related to one another, and generally, they have moved in the same direction. For this reason, it was expected that the employment and labor income multipliers would generally follow similar trends over time.

The employment multipliers that were used for the comparison were estimated previously using the same county delineations as those used in this study. In the previous study employment multipliers were estimated for a linear export base model for the years 1950, 1960, and 1970 using employment data published by the United States Bureau of the Census. The major difficulty encountered in attempting to compare the multipliers of the two studies was the fact that the sector definitions were not the same. In addition, census data on employment are in terms of place of residence whereas the data used in this study are in terms of place of work. This further complicates a meaningful comparison.

The employment and labor income multipliers for both county classifications are presented in Table 17. In making comparisons between these multipliers three observations can be made. First, the trends in the employment and labor income multipliers were not generally consistent over time. For the Group I counties, the multipliers of the Farm, Manufacturing, and Services sectors exhibited similar trends while the multipliers of the other sectors did not. For the Group II counties, similar trends in the multipliers of the Farm and Mining sectors and the Public Administration and State and Local Government sectors were observed.

The continued relative reduction of the primary industries of Agriculture, Mining, and Manufacturing as sources of basic employment suggests that theoretically the employment multipliers of these basic industries should increase over time. This was established empirically by previously cited research (1, 2, and 3). A consistent trend of this type was not determined in this study for the labor income employment multipliers. This inconsistency between the two measures may well result from greater short-term variations in income than is true for employment. More research is required before such a conclusion could be made unequivocally.

In attempting to explain the differences in the trends of the two types of multipliers two other factors may be cited. First of all, the labor income multipliers were estimated using dollar data while employment may be considered a "real" measure and not as susceptible to fluctuation as is dollar data. And second, differences in the sector definitions may have been great enough to cause the divergences and made comparisons virtually meaningless.

A possible explanation for the fact that the employment multipliers were generally larger than the labor income multipliers is that the effect of commuting

TABLE 17. A COMPARISON OF LABOR INCOME AND EMPLOYMENT MULTIPLIERS FOR SELECTED TIME PERIODS

	Region I Multipliers						Region II Multipliers					
	1970		1960-1959[a]		1950		1970		1960-1959[a]		1950	
Sector	Lab. Inc.	Employ.	Lab. Inc.	Employ.	Lab. Inc.	Employ.	Lab. Inc.	Employ.	Lab. Inc.	Employ.	Lab. Inc.	Employ.
State and Local Govt.[b]	1.79	1.34	2.13	0.88	0.93	2.03	2.90	3.99	2.34	3.32	1.83	1.58
Mining	1.12	2.75	1.56	2.03	1.31	1.48	1.20	3.18	1.16	2.33	0.80	2.09
Contract Const.	1.01	2.64	1.60	1.43	2.87	1.90	1.20	0.39	2.42	-0.38	2.36	6.64
Trans., Com., and Pub. Util.	1.49	2.94	1.81	2.45	2.06	1.98	3.32	4.15	2.01	2.58	1.86	3.00
Whol. and Ret. Trade	2.32	2.50	2.06	3.01	2.23	2.74	2.81	5.55	2.86	4.68	3.16	3.33
Fin., Ins., and R. Estate[c]	2.42	3.53	5.20	2.55	2.43	1.99	1.47	3.36	1.13	2.52	2.14	2.05
Services[d]	1.97	2.49	2.14	3.84	1.70	2.29	3.13	2.51	2.47	2.48	3.15	2.12
Farm	1.62	2.28	1.58	1.83	1.38	1.50	1.75	3.25	1.48	1.87	1.35	1.55
Federal Government[b]	1.57	1.34	3.11	.88	4.55	2.03	1.09	3.99	1.12	3.32	1.91	1.58
Manufacturing	1.82	1.99	1.61	1.76	1.27	1.55	1.91	2.20	1.98	2.16	1.86	1.66

[a]Labor income multipliers are estimated for 1959. Employment multipliers are estimated for 1960.

[b]All government activity was combined into one sector in the employment study.

[c]The employment study defined a Business Services sector that was more encompassing than the Finance, Insurance, and Real Estate sector defined in the income study.

[d]The employment study defined an Education and Related Services sector that was less encompassing than the service sector defined in the income study.

patterns was more important in biasing the labor income multipliers downward than was the case for the employment multipliers. Labor income was reported on a where-earned basis rather than on a where-spent basis, while employment was reported by county or residence rather than by county of employment (2, p.23). Commuting, therefore, would introduce a downward bias into both types of multipliers. In the employment study, it was found that commuting was not an important factor affecting the employment multipliers (2, p.23). The same generalization, however, may not be possible with repsect to the labor income multipliers.

SUMMARY AND CONCLUSIONS

The purpose of this study was to specify and estimate a linear export base model using a unit of measurement which provided an estimate of income. The approach used in this study to analyze regional growth can be viewed as both an alternative and a complementary approach to other procedures that have been used by regional planners and scientists.

Two groups were defined within the state of Missouri based on 1970 county population data. A cross-sectional multiple linear regression model was used to estimate the export labor income multipliers for both groups for the years 1970, 1965, 1959, and 1950. The model was tested for stability over time for both groups, and it was also tested over space to determine if significant differences existed between the groups defined in this study.

Comparisons between employment and labor income multipliers were made. The fact that both units of measurement measure significant economic magnitudes suggested that similarities would exist between the multipliers.

The following conclusions seem justified on the basis of the results obtained from this study:

1. Estimation of the model for both groups within the State of Missouri established the predictive value of the model and provided an empirical verification of the export base theory.
2. When considered within the overall framework of the export base model estimated in this study, the labor income multipliers of both regions have potential value as intermediate and long run predictors of changes in economic activity.
3. The delineation of groups based on county population provides a meaningful framework within which to analyze economic growth of relatively small geographical regions.
4. When considered within the context of the export base theory, the employment multipliers in general were more consistent with the theory than were the labor income multipliers. This was especially true over time where the behavior of the employment multipliers was less erratic than the behavior of the labor income multipliers.

5. Further research using the procedure outlined in this study is warranted. Such efforts might initially be directed at analyzing multi-county regions in which the counties are all located in a specific geographic region. Further research is also needed in refining the indirect techniques used to estimate export activity.

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