AN ECONOMETRIC APPROACH TO INPUT-OUTPUT ANALYSIS FOR RURAL AREAS

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Introduction

In years to come, agriculture will likely face increasing public environmental concerns, exhaustive land supplies, relatively higher wage rates and energy shortages which restrict output. Against this backdrop, private investments will result in greater urbanization. Greater resource planning efforts, including zoning, will be made by federal and state agencies who may not understand completely the total importance of agriculture in rural areas.

It is important, therefore, to have available an accepted and understandable macro-economic model describing the complex interaction of all important economic variables in a rural economy. Such a model should have broad policy analysis uses. The impact of agricultural policy on farm income, the occurrence of drought, freezes and crop disaster frequently call for mobilization of policies affecting the general economy of an area. Activating the Small Business Administration in Georgia during 1977 to cope with drought induced business loss in the small towns of South Georgia is but one example.

Objectives and General Procedure

The general objective of a recent study in Georgia was to provide insight into non-farm impacts that can be expected as a result of altering farm income. Specifically, the objectives were to:

1. Develop a structural model for simulating major economic flows in the non-farm rural Georgia economy.

2. Evaluate impacts of a current marketing quota proposal on

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the economy of the peanut production area.

The agricultural sector of Georgia can be divided into geographical sub-areas by types of production. This study attempts to isolate that combination of counties which accounts for over 90 percent of the peanut allotments in Georgia, hereafter referred to as the peanut production area of Georgia. This includes 56 rural counties with contiguous county borders, including Jefferson in the North and Seminole and Grady along the Florida line. Counties in the metropolitan area of Albany were excluded.

Review of Literature Related to Area Modeling

A two sector model developed by Tolley and Smidt in 1964 emphasized a set of relationships that determine interactions between the agricultural and non agricultural sectors of the national economy. The model explains the adjustments between agriculture and the rest of the economy resulting from growth in the U.S. economy.

More recent studies linking agriculture to the total U.S. economy include the Wharton agricultural model by Chen and a model by Roop and Zeitner which is compatible with the Wharton model. A number of feedback effects exist on a national scale that are not observed in a rural area the size of South Georgia; thus, a somewhat simpler model may be indicated.

Probably the most used approach to aggregate models for states and smaller areas has been the regional input-output model (See Miernyk).

Langley, for example, constructed the first input-output (I-O) study of Georgia in 1969. His model consisted of 14 sectors, 12 of which were agribusiness sectors. The other sectors were farming and all-other industry. Schaffer et al. constructed the largest Georgia I-O table in 1970 containing 50 sectors. Concern with regional economics at the substate level in Georgia resulted in I-O models of the Coosa Valley region by Liu and the counties of the Heart of Georgia Area Planning and Development Commission by Joncker. Thus, I-O models have been constructed in Georgia for different levels of aggregation over regions and over sectors. Effects of variation in the number of sectors in an I-O model have been explored by Doeksen and Little. In a simulation study involving aggregated versus disaggregated models, they found that multiplier estimates were comparable among different levels of aggregation.

A principal problem in all of these studies has been the high cost of constructing transaction tables describing economic flows in the model. One hundred thousand dollars has been estimated by Schaffer as the minimum cost of constructing an acceptable I-O model for the State. Even at this cost the process would consist mainly of adjusting a national I-O table to Georgia conditions.

Several adjustment techniques have evolved to use I-O coefficients in sub-regions of an area which may have existing current model. Morrison and Smith in a recent review of techniques concluded that a simple location quotient technique appeared to be appropriate. The location quotient technique is very inexpensive and can be used with ordinarily available secondary data sources. One example of the inexpensive nature of this technique is a varient available from the Bureau of Economic Analysis (BEA). For approximately $1,000, BEA will compute an I-O table for areas as small as one county.

Accuracy of the simple location quotient (LQ) method, however,has been questioned. Miller and Liu compared estimates from a location quotient model with location quotient results corrected by surveys of regional imports and exports and concluded that there were significant errors in the unadjusted LQ method. Survey techniques for adjusting existing models have also been devised and recommended by Czamanski, et al.

Specific Hypothesis Related to Area Modeling

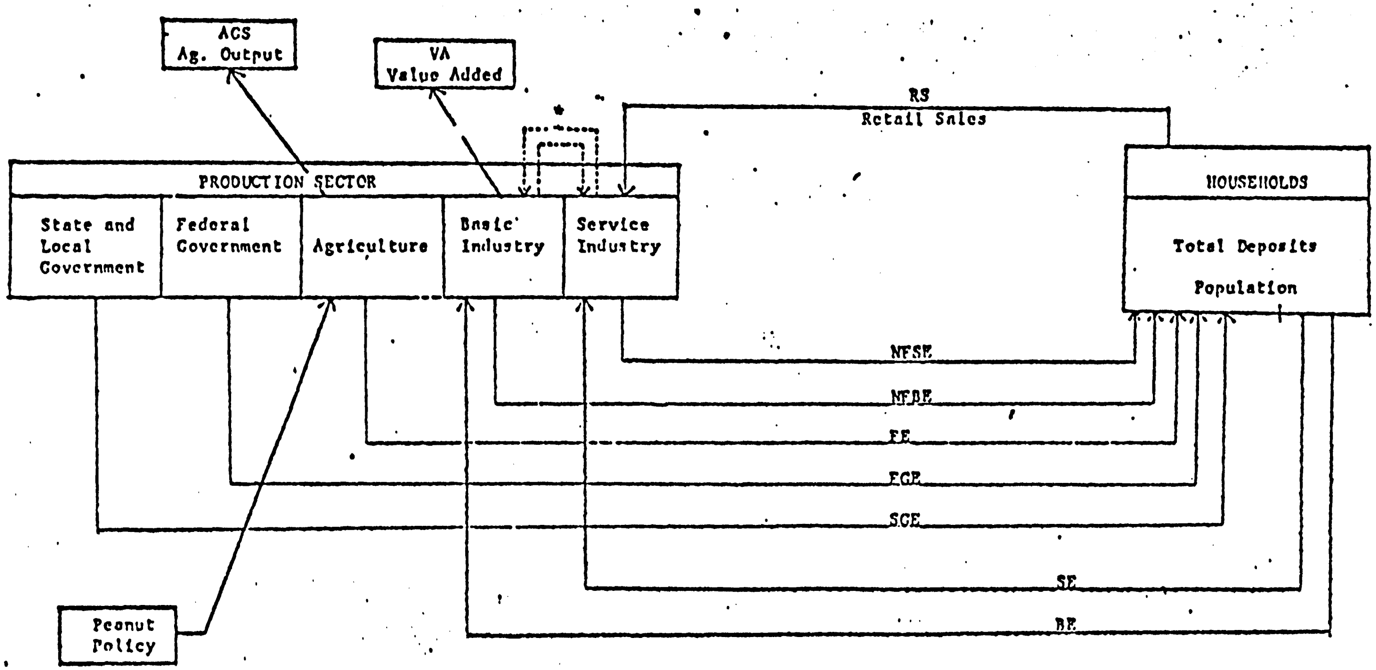
As the major importance of I-O models is to estimate the aggregate impacts or multipliers of exogenous changes occurring in a single sector of the economy, there remains a possibility that such multipliers can be estimated by econometric techniques applied to available aggregate data. Of greatest appeal would be the ability to estimate reliable multipliers for sub-state areas from current secondary data. Recent work seems to suggest the following points: 1) The LQ method is inexpensive, uses secondary data, but is possibly unreliable. 2) Survey adjustments to simple LQ models improve reliability, but periodic surveys to update results may prove expensive. 3) Interest in multiplier analysis for regions as small as counties is evidenced by requests for such studies by BEA. 4) While detail available for planning is sacrificed in models with few sectors as opposed to models with many sectors, estimates of multiplier impacts are not significantly different among levels of aggregation. Thus, a simple econometric model describing flows among only a few sectors might produce useful results.

Conceptual Model

Survey of recent work suggests a possible comparison between the major economic flows of a rural area outlined in Figure 1 and similar transactions in a simple I-O table. While space does not permit a complete comparison with I-O, the conceptual Figure, like I-O, suggests an eocnomy that is closed with respect to interaction between agriculture, basic industry, service industry and households. It is open with respect to exports from the area and imports. An important characteristic of a small area economy is that while the equilibrium flows among sectors are simultaneously determined, many of the inter-industry flows may be negligible. Agriculture's purchases from itself for inputs used in production are typically small in relation to total purchases; agriculture's purchases from basic indusrty are, on the other hand, significant. Energy, fertilizer, insecticides and mechanization have been at the forefront of agricultural growth. But in a small rural area, few, if any, of these basic industires exist. Most of farmers' purchases of these items are imports filtered through local service industries such as petroleum wholesalers, fertilizer dealers and general farm supply stores. Thus, principal payments of agriculture in a rural area are for local services, imports of primary inputs and earnings from farming paid to households (farmers) in the area.

Basic industry as defined here includes mining, manufacturing, contract construction, or in general, industries in the Standard Industrial Classification (SIC) codes 10-49, excluding agriculture. Basic industry would, of course, be the primary buyer of most agricultural products. But again, in rural areas, agricultural outputs such as beef, hogs, cotton, corn, soybeans, etc. are likely to move through a service industry buyer and from there into regional, national or world markets before eventually being utilized by basic industry. Local basic industry in Georgia predominately includes poultry processing, meat packers, sawmills, feedmills, vegetable processors and oil mills. Local basic industry purchases from other basic industry are expected to be almost non-existent with the exception of contract construction. Liu, for example, in a survey of Coosa Valley industry found it common for many firms in that area to export 100 percent of total output to firms outside the area. Local basic industry might be expected to purchase some local services and most of their employment from local households.

Local households, as an endogenous sector, would be expected to purchase very little, if any, goods from local agriculture and local manufacturing. Most of their incomes spent locally will be for goods purchased through



SE = Service Employment
NFSE = Service Earnings
NFBE = Base Earnings
BE = Base Employment
FE = Farm Earnings
SNFI = Simulated Net Farm Income
FGE = Federal Government Earnings
SGE = State Government Earnings
AGC = Agriculture Cost
RS = Retail Sales

* dashed lines are potentially important flows for which current data do not exist

Figure 1. Major Economic Flows in An Aggregate Factor Market Model For Rural Areas

wholesale and retail trade and other service industry. The extent to which retail trade centers dominate a given rural area is largely an empirical question.

Specific transaction data are not available as secondary data to describe some of the flows discussed above. As indicated by previous studies, our current data systems are not designed to collect data of this type. A great amount of data is collected, however, that records results of the major flows. Thus, it may be possible to specify a set of simultaneous flow relationships based on economic theory and results of prior I-O studies that will approximately describe aggregate impacts of the same type found by I-O. Some elementary hypothesis suggested by the discussion are 1) Total earnings of labor in the local economy and total personal income should be key performance variables to measure total impacts of outside stimulants to the economy. 2) Farm earnings are probably not endogenously related to other earnings in the local economy, but are probably related almost entirely to national price level, farm output and efficiency. 3) Total basic employment is probably not dependent on the local economy. The principal determinant is most likely national demand for output from these industries. Level of wages is probably not a function of local employment but a function of industry wide conditions. 4) Service industry employment and earnings are, however, simultaneously determined along with the local level of retail sales and personal income and population to be served. 5) In addition to the exogenous determination of base employment and wage levels, base employment is also attracted to population centers and in some areas where agricultural processing is important, basic employment will be functionally related to agricultural output. 6) In a complex economy, service employment is an indirect function of the level of base employment, but this may not be very important in rural areas. Also, service employment is expected to be related to the level of agricultural output insomuch as much of the input to agriculture passes through service industries. 7) Local retail sales are a function of local personal income. While not all local income is expended locally, a major portion will be in many areas. Local retail sales are no doubt related to incomes in other areas, and this hypothesis can be empirically tested. 8) Local personal income is endogenoulsy determined as a function of local earnings from employment and from holding capital wealth. 9) Total local earnings are the sum of endogenously determined earnings from agriculture, basic industry, service industry, and exogenously determined earnings of federal and state government workers. Functional descriptions of these relationships are developed in equations 1-8 which specify the structural model and some of the available data for modeling the local economy.

Theoretical Relationships of Variables*
in the Structural Model

1. <u>Earnings</u> = <u>farm earnings</u> + <u>base earnings</u> + <u>service earnings</u> + Federal government earnings + state & local government earning

2. <u>Farm Earnings</u> = f(simulated net farm income)

3. <u>Base Earnings</u> = f(<u>base employment</u>, wage structure)

4. <u>Service Earnings</u> = f(population, <u>service employment</u>)

5. <u>Base Employment</u> = f(value added by manufactures, population, type of firms in manufacturing)

6. <u>Service Employment</u> = f(farm purchases of input, <u>total retail sales</u>)

7. <u>Total Retail Sales</u> = f(<u>personal income</u>, savings)

8. <u>Personal Income</u> = f(<u>Earnings</u>)

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*Endogenous variables are underlined.

Results

Anderson has developed methodology and equations for this model using readily available secondary data. Linear equations in Table 1 were fitted by two-stage and ordinary least squares using cross-sectional data from counties and aggregations of counties within the peanut production area. The equations were estimated using data for 1969 and 1974. Structural coefficients were generally significant and homogeneity tests indicated many model coefficients were stable over time. The presecence of dummy intercept and slope shifters in Table 1 account for differences between the two years.

The matrix of multipliers from this model is rather rich in it's implications and only some of the high points are noted here, Table 2. For example, the multiplier effect of government spending on personal income was 2.39. Perhaps importantly, the multiplier effect of a new dollar of simulated net farm income was 5.6 times more powerful than a new dollar of value added (2.04 to .36) in increasing personal income. Much of this difference can be traced to the impact that farm income has on service employment. Here, a new dollar of farm income is about 5 times more powerful than a new dollar of value added, Table 2.

To date, the model has proven useful in evaluating the total loss in income and employment resulting from new peanut legislation in Georgia and has provided the basis for a series of seminars of the effect of drought in Georgia. Requests have been made by users to expand the model. One explanation for the apparent acceptance of the model is that is uses data series that are generally understood by the business community. Considering the number of alternative models and practical problems that can be attacked by the approach, the conceptual model should prove useful in many rural areas.

Table 1. Estimated Parameters of an Aggregate Factor Market Model for Rural Georgia, 1969-1974[1/]

Variables	Estimated Parameter	Units	Standard Deviation	Level of Significance[2/]	R^2
Endogenous Variables are Underlined					
Equation (1) Dependent variable - Farm Earnings		thou. dollars			.78
Intercept	-1761.98		998.6	*	
Simulated Net Farm Income (SNFI)	.000852	dollars	.00005	**	
Dummy Shifter for 1969	6667.4	no.	959.5	**	
Equation (2) Dependent Variable - Base Earnings		thou. dollars			.87
Intercept	-985.0421		761.6		
<u>Base Employment</u>	5406.380	thou. employees	330.4	**	
Dummy for High Wage Structure	1680.1928	no.	1167.5		
Dummy Wage and 1969 Interaction	2037.0014	no.	17.95	**	
Equation (3) Dependent Variable - Service Earnings		thou. dollars			.98
Intercept	-483.6997		476.3		
<u>Service Employment</u>	5961.9047	thou. employees	298.0	**	
Population	85.3956	thou. no.	42.0	*	
Population Dummy & 1969 Interaction	39.7018	no.	17.95	*	
Equation (4) Dependent Variable - Base Employment		thou.			.85
Intercept	-.3484016		.150	**	
Value Added by Manufacturers	.0281365	thou. dollars	.004	**	
Population	.0692632	thou.	.007	**	
Dummy for Presence of Poultry Processor	.2077754	no.	.122	*	
Dummy for Firms with High Level of Employment	.4805526	no.	.131	**	
Equation (5) Dependent Variable - Service Employment		thou.			.98
Intercept	-.0277307		.060		
Farm Cost Index	.1880229	no.	.040	**	
<u>Total Retail Sales</u>	.0579396	millions dollars	.002	**	
Dummy for Retail Sales and 1969 Interaction	-.0033781	no.	.001	*	
Equation (6) Dependent Variable - Total Retail Sales		million dollars			.90
Intercept	-1.531036		2.10		
<u>Personal Income</u>	.4925785	million dollars	.028	**	
Time Deposits per Capita	-7.3958199	mil./thou. dollars	2.08	**	
Personal Income Dummy and 1969 Interaction	.1886920	no.	.028	**	
Equation (7) Dependent Variable - Personal Income		million dollars			.97
Intercept	7.983317		1.83	**	
<u>Total Earnings</u>	.00169854	thou. dollars	.00003	**	
Total Earnings Dummy and 1969 Interaction	.0005894	no.	.00004	**	

1/ 1974 data was deflated to a 1969 base

2/ ** significant over the range (.01 - .001 probability)
* significant over the range (.10 - .01 probability)

Table 2. Matrix of Multipliers for the Peanut Production Area of Georgia Showing the Number of Employees or Number of Dollars Change in a Column Variable given a Permanent One Unit Change in a Row Variable

		Endogenous Variables							
		Total Earnings	Farm Earnings	Base Earnings	Service Earnings	Personal Income	Total Retail Sales	Service Employment	Base Employment
		-- UNITS --							
Exogenous Variables	Units	Thou.$	Thou.$	Thou.$	Thou.$	Thou.$	Thou.$	Number	Number
Federal Spending	Thou. Dollars	1.4064	0	0	.406475	2.3889	1.17672	.068178	0
St. & Loc. Spending	Thou. Dollars	1.4064	0	0	.406475	2.3889	1.17672	.068178	0
Population	Thou.	646.78	0	374.463	272.317	1098.56	541.12	31.3526	069.263
Net Farm Income	Thou. Dollars	1.1995	.8529	0	.346682	2.037	1.0036	.05815	0
DUMPOU 1/	No.	1579.91	0	1123.31	456.598	2683.48	1321.82	76.58	207.775
DUMEMP 2/	No.	3654.09	0	2598.05	1056.04	6206.48	3057.18	177.132	480.553
DUMW 3/	No.	2363.14	0	1680.19	682.955	4013.8	1977.11	114.553	0
Value Added	Thou. Dollars	.213948	0	.152117	.0618315	.363391	.17899	.010371	.0281365
Savings Per Capita	Mil./Thou. Dollars	-3593.18	0	0	-3593.18	-6103.01	-10402.0	-602.69	0
Farm Cost Index	Dollars	1576.62	0	0	1576.62	2677.89	1319.07	264.449	0

1. DUMPOU is a dummy variable representing poultry processing.

2. DUMEMP is a dummy variable representing firms with employment greater than 450.

3. DUMW is a dummy variable representing high wage structure.

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