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MODELING SOCIO-ECONOMIC IMPACTS AND GROWTH IN RURAL COMMUNITIES

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Abstract

Rural communities are facing similar economic and social challenges to those of large cities. Decreasing resources during a period of expanding need taxes the ability of local leaders to meet the challenges of community growth or change. These leaders often have difficult problems to deal with yet no resources or technical help are available to assist in addressing these problems. This paper presents models that have been developed to assist local decision makers in planning for future needs in their communities. The models cover a wide range of methodologies and serve different needs that rural communities might have. The models have all been used as part of Extension programs addressing community economic issues.

Introduction

Local decision makers are faced with a tremendous challenge as the 1980s unfold. Beale notes that for the first time in over 160 years, the U.S. population growth rate was higher in rural and small-town communities than in metro areas (U.S.D.A., 1981). This growth in rural area increased financial problems as urgent service requirements sometimes outgrew available revenues.

At the other extreme, some areas experienced no growth or actually declined. Communities falling in this category have difficulty providing an adequate level of service with a declining tax base. These communities need to be as efficient as possible in allocating scarce resources.

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Impact models are tools developed by economists, sociologists and other scientists to assist communities in anticipating growth and decline. The models address issues such as direct and indirect impacts of growth, timing of impacts, service requirements, existing service capacity and revenue expectations. These models provide information for decision-making--they do not make the economic trade-offs less painful--they do point out what alternatives are available and what positive/negative impacts are associated with each alternative.

The objectives of this paper are:

1) To present three impact models developed for use in community decision-making.

2) Analyze the models in terms of methodology, application, appropriate use, and other relevant issues related to model development.

3) Discuss the use of these models in developing an Extension Community Development program.

Modeling Packages Developed for Social and Economic Analysis

Several models have been used in Texas and Oklahoma by Extension Specialists and researchers. These models all have unique characteristics and uses. The following discussion presents a review of the three models.

Industrial Impact Model. Shaffer and Tweeten (1972) developed an early version of an impact model designed to measure the impact of new industries on rural communities in Oklahoma. The model uses partial budgeting to determine the net gain (loss) to the community resulting from an outside impact. Primary or direct effects of a new industrial plant are considered as well as secondary impacts measured by multipliers. The model contains three sectors: private, municipal government, and school district. Benefits and costs are accounted for in each sector. Two conclusions reached by the authors are that industrial impacts will vary over different economic sectors and impacts will differ among communities.

A related industrial impact model (IIM) has been developed for Texas (Reinschmiedt et al.). The model was innovative for several reasons. Impacts are analyzed for four sectors: private, municipal government, county government, and local school district. The model is computerized allowing rapid response to various user assumptions. A complete user package has been developed which describes the model in detail. Input data needed and form of output are covered in depth. A questionnaire is provided to potential users which asks for input data and indicates where this information might be found. This allows a great deal of user-researcher interaction--the result is a client who understands what went into the model. This interaction makes use and understanding of the model more likely (Woods and Jones). Extension Specialists can meet with clientele and discuss the model or collect much of the data over the telephone. At this time computer analysis is conducted at Texas A&M although micro-computers may allow the computer runs to be conducted in the field. Response to a request has been as quick as one week from the initial client contact.

Table 1 presents a summary of IIM results for an FAA Flight Service Station in a West Texas town of 3,000 people. All values are in 1983 dollars. Table 1 is a summary of overall gains (losses). In fact, detailed tables are provided for all four sectors analyzed--showing income and costs associated with the impact examined.

The private sector accounts for direct, indirect and induced wages and salaries associated with the proposed plant. Leakages associated with employees spending outside the community and county are included. Private sector costs include any location incentives or income losses from plant employees whose previous jobs went unrefilled.

The municipal sector counts revenues from property tax levies resulting from the industry and any new residents. Also sales tax revenues and municipal service revenues are included. Costs to the municipal government include increases in utility cost provision, municipal service costs, and cost of services consumed by in-commuters.

The local school district counts as revenues property taxes levied against the new industry and any new homes, state and federal transfers for new students associated with the industry and any indirect revenues from increased economic activity. Costs accounted for include instructional expenses for new students, new capital outlays required and any indirect expenses associated with new students. The issue of excess capacity is highlighted in this sector. Table 1 notes that school costs outweigh revenues. This is because new teachers would be required to meet student needs if the children of new employees are considered. Often this is not the case and schools can absorb the additional children associated with economic development and in-migration.

The county sector also includes an accounting procedure for analyzing revenues and costs within its boundary. All sectors have a low, intermediate and high estimate of net impacts. This range of estimates emphasizes the sensitivity of model analysis to various assumptions such as to wage and salary estimates, expected in-migration, and number of additional children added to the school system. This range of values provides further information for the local decision maker. In Texas the private sector typically has been found to capture the largest share of net gain while the government sectors gain less, break even, or even suffer a net loss. Of course, the question of excess capacity is important in determining this outcome. Also, the net gain (loss) to the public sectors is quite sensitive to the level of taxable investment made by the proposed industrial plant and the taxable jurisdiction within which the plant is located.

TABLE 1

GENERAL SUMMARY OF INCOME, COSTS AND
NET IMPACT ON THE COMMUNITY ECONOMY
CASE STUDY OF A PROPOSED AUTOMATED
FLIGHT SERVICE STATION, 1983*

	Low Estimate	Intermediate Estimate	High Estimate
Private Sector			
Income	$1,986,239	$1,986,239	$1,986,239
Costs	1,222	3,278	5,333
Net Impact	1,985,016	1,982,961	1,980,906
Municipal Government			
Income	$ 347,458	$ 806,721	$1,417,334
Costs	265,505	531,990	885,475
Net Impact	81,954	274,732	531,859
School District			
Income	$ 359,237	$ 414,101	$ 473,015
Costs	729,428	794,442	859,455
Net Impact	(370,192)	(380,341)	(386,440)
County Sector			
Income	$ 24,454	$ 31,568	$ 36,762
Costs	48,125	48,125	48,125
Net Impact	(23,671)	(16,557)	(11,363)

*Source: Woods, Jones, and Cross, 1983.

Community Impact Model. A model has been developed in Oklahoma for use in analyzing community level impact questions (Woods, Doeksen, Nelson, 1983). The Community Impact Model (CIM) has four sections: an economic account, a capital account, a demographic account, and a government account. The economic account contains the final demand equations which are the driving force of the model. Also included is a community-specific input-output model and a gravity model. The gravity model is employed to determine the service area of a community. A location quotient technique is applied to a regional or state input-output model to derive a community specific input-output model. CIM is made dynamic through the use of equations which predict final demand over time.

The capital account allows for simulation of investment and its effects on the economy. The demographic portion of the model contains a cohort-survival population projector which includes age specific birth rates, death rates and migration levels. Net migration to the community is an "equalizer" which matches available jobs in the economic sector. The government sector estimates the need for services based on community service usage coefficients.

CIM is computerized with default data when specfic local data are not available. Annual projections are provided and include the following:

Economic
- employment by industry sector,
- income by industry sector,
- detail for wage and salary versus, proprietor employment and income,

Demographic
- population by age-sex categories,
- population for community and service area,

Service
- hospital bed days,
- physician visits,
- ambulance calls,
- estimated fires,
- water requirements,
- sewer generation,
- solid waste generation,
- school age children,
- community revenue by source.

Tables 2, 3 and 4 present a partial summary of information provided by CIM. Due to space limitations, only selected output for selected years are presented.

Table 2 presents selected employment projections for Holdenville, Oklahoma. Total employment is projected to grow from 2,104 in 1980 to 3,419 in 1990. Detailed sector projections show this growth to occur primarily in the mining, manufacturing and service sectors. The second column in Table 2 shows total impact employment (baseline employment plus net impact employment) growing from 2,477 in 1982 to 3,531 in 1990. This impact is the result of a hypothetical plant being located in Holdenville

TABLE 2

SELECTED EMPLOYMENT PROJECTIONS,
HOLDENVILLE, OKLAHOMA

Year	Baseline Employment	Impact Employment	Net Employment Change
1980	2,104	---	---
1982	2,287	2,427	140
1985	2,629	2,837	208
1990	3,419	3,531	112

and providing 50 new direct jobs. The third column shows the net employment change resulting from the plant. Employment grows rapidly in the construction years for the plant then levels off in the long run including only direct, indirect and induced jobs resulting from the plant.

Table 3 presents the population change resulting from this employment growth. Baseline population projections and population change resulting from the new plant are included. The 1980 census population for Holdenville was recorded to be 5,373, slightly higher than the estimated value of 5,215 for the year 1980.

Table 4 presents sample results of some of the more useful information provided by CIM. Community service requirements are projected annually. This information allows community decision-makers to more efficiently plan for future needs. By comparing needed requirements to known capacity levels, the community can anticipate future problem areas and begin planning for adequate service provision. Table 4 presents baseline projections for selected years, however, CIM also provides impact projects as model output.

The first column in Table 4 presents estimated hospital bed days required by year. Detailed population characteristics are used to generate demand estimates based on the incidence of various ailments for each age-sex subgroup (Dunn and Doeksen, 1980, p. 59). Total annual hospital bed days summed across age groups and ailments are projected to grow from 10,399 in 1980 to 11,588 in 1990.

Column 2 of Table 4 shows estimated fires occurring annually based on research conducted for rural Oklahoma communities (Childs, et al.). Water requirements per year are presented in Column 3 of Table 4. These estimates are based on water consumption patterns in rural Oklahoma communities considering both household and industry use (Goodwin, et al., 1979). The final column of Table 4 shows projections of solid waste generation. These estimates are shown in cubic yards per week and again based on research for rural Oklahoma communities (Goodwin, et al., 1980).

TABLE 3

SELECTED POPULATION PROJECTIONS,
HOLDENVILLE, OKLAHOMA AND SERVICE AREA

Year		Baseline Population	Impact Population	Net Population Change
1980				
	City	5,215	-----	-----
	Service Area	3,724	-----	-----
1982				
	City	5,362	5,587	225
	Service Area	3,873	4,036	163
1985				
	City	5,662	5,979	317
	Service Area	4,152	4,384	232
1990				
	City	6,397	6,513	156
	Service Area	4,785	4,902	117

TABLE 4

SELECTED SERVICE REQUIREMENTS
HOLDENVILLE, OKLAHOMA, BASELINE

	Service			
Year	Hospital Bed Days	Fires	Water (Million Gallons/Year)	Solid Waste (Cubic Yards/Week
1980	10,399	84	170.7	393
1982	10,497	86	175.8	405
1985	10,759	91	185.8	427
1990	11,588	103	209.4	483

As can be seen from Table 4, detailed research for various community services are used in CIM. A complete discussion of the community service analysis conducted for Oklahoma is available from Doeksen and Nelson (1981). This example emphasizes a close link between community impact models and community service analysis. Accurate economic and demographic projections can be used in conjunction with community service analysis to provide a useful planning tool. If shortages or needs show up with a particular service, for example sewage service, then a detailed analysis for that service could be conducted.

Texas Assessment Modeling System. Recent changes in the national and world energy situation have increased interest in alternate energy sources and United States energy reserves. One source of energy is large scale lignite mines and coal-fired power plants. Texas is estimated to have 12.2 billion tons of strippable lignite and over 100 billion tons of deep basin lignite (Murdock, et al., 1979). Development of lignite reserves often affect rural communities--large scale power projects bring with them large impacts. The Texas Assessment Modeling System (TAMS) was developed to provide projections of economic, demographic, fiscal and social impacts of energy projects (Murdock, et al., 1979). The model projects local and regional impacts of lignite development projects in Texas. The present geographical coverage of TAMS includes 53 counties and over 300 cities and school districts in the East Texas lignite belt.

TAMS consists of six components or submodels. These are an economic module, a cohort-survival demographic module, an economic-demographic interface module, a residential allocation module, a service requirements module and a fiscal impact module.

The economic module estimates the level of business activity by economic sector based on final demand projections. The Texas state input-output model was used to derive technical coefficients for the six council of government regions in the study area. Employment requirements by sector and development phase are derived using the estimates of business activity and appropriate technical coefficients. The demographic module provides projections of area population by age-sex categories as well as estimates of the available labor force. The interface module compares projections of employment requirements to projections of the available labor force to determine the level of net migration occurring. Employment requirements are met through a sequence of priorities for job filling by both the indigenous and impact population. A distinction is made between baseline, construction, permanent operating, and indirect jobs. The residential allocation module provides estimates of the settlement patterns of the in-migrating new workers based on potential communities within the study region. The service module provides estimates of the increased service needs associated with population change. The fiscal impact module provides projections of changes in public sector costs and revenues resulting from the impact. The modules provide output at the regional, county, and municipal levels. A detailed description of TAMS is provided in Murdock, et al. (1979).

Outputs available from TAMS at the regional, county and municipal level for each year of the project period include: business activity, personal income, employment by type, population total, population by age and sex, housing demand by type, school enrollments by grade level, criminal justice service requirements, medical service requirements, public sector costs by type, public sector revenue by source and net fiscal balance. A user manual is available which describes the output options available to the user, describes the interactive program, and details key parameters that may be altered by the user.

TAMS is a computerized model using an extensive data base for the study regions involved. Detailed economic and demographic data are stored within the model and used when appropriate. The model is notable for the complex interfacing procedure matching available labor force with employment. It is important to distinguish between the various phases of a large scale project--construction versus operating. The model accounts for this and notes construction workers will have different characteristics from permanent operating employees (age, family size, number of children, etc.). Another distinctive output is the net fiscal balance which indicates the relationship between project related costs and project related revenues. A negative net fiscal balance indicates project related costs exceed revenues during the year while a positive fiscal balance has the opposite implication.

Extensive use of TAMS by Murdock, Jones and others have emphasized several factors. First, the impact during the construction phase will peak at a much higher level (more employment and in-migration) than the long-run permanent operating level. This difference can often mean several hundred jobs and thousands of people with a large scale project. Also emphasized is that much of the construction expenditures do not affect the local economy but occur for large, high-technology machinery in distant industrial cities. Timing is another key factor. Large scale projects usually pay for themselves but the anticipated revenue often is collected several years after the project begins--with in-migration and accompanying service needs occurring immediately. These needs would be highest during the construction phase and these workers are not always permanent members of the local community. Finally, the term "inter-jurisdictional mismatch" is introduced. Often the mine and plant are located in one taxable jurisdiction while the resulting in-migrating population locates in another jurisdiction. These types of problems must be addressed by a rural community, particularly when a large-scale project magnifies the impact. TAMS does an excellent job of addressing these issues and providing useful planning information. It should be noted that TAMS also provides baseline information that can be used by local decision makers even when no impact project is being analyzed.

Modeling Rural Community Growth and Decline

Three models developed for use in Oklahoma and Texas have been presented in this paper. There are several issues that arise when addressing the topic covered here.

Methodology. The three models presented rely on different methodologies and sometimes different combinations of similar methodologies. The industrial impact model (IIM) uses a single time period partial budgeting approach. IIM considers the net benefits (costs) associated with a new industry during the first full year of operation. Dollar benefits (costs) are identified in the private sector, municipal government, local school district, and county government sector.

The community impact model (CIM) and the Texas Assessment Modeling System (TAMS) on the other hand provide annual projections. Methodologies used include location quotients, input-output models, cohort-survival models and other techniques. Complex procedures are used because more detailed information is desired. Detailed information on industry sector employment, age of the baseline or impact people, and level of community service requirements can be very useful in decision-making.

Type of Output. Annual projections versus a single time period analysis is the obvious difference between IIM and both CIM and TAMS. This has to do with the data requirements each model requires as well as the methodologies used. Other models not reviewed here might provide output in five-year increments. No one method may be right--the local needs must simply be matched with the model that provides the desired output. Annual projections will generally be preferable. Considering growth and change over time allows consideration of capital investment and expansion, capacity constraints, and timing of expected needs within the community. Information provided should include obvious demographic variables such as population and labor force. The level of detail is dictated by the local needs. CIM and TAMS both provide economic, demographic, community service and revenue information. TAMS provides this information at the regional, county and municipal level. CIM provides this information only at the community level. IIM provides information for the county, city government, school district and private sector, but for only a single time period.

Data Requirements. The types of output provided are closely related to data requirements for the various models. IIM requires data on the four sectors mentioned for the most recent year available. Historical data are often necessary as input for TAMS and CIM, at least to determine various growth rates. TAMS relies on a very large data base covering the model region. Actual user input data supplied for TAMS relates primarily to specific energy project characteristics and some alterable parameters. The computerized data base contains detailed demographic and economic information. CIM, on the other hand, requires the individual user to supply much of the demographic data--it is usually available from secondary sources. Many of the input requirements of IMM relate to expected ranges of values (new residents, new school children, new homes) so that sensitivity analysis can be supplied. This can be done by the researcher but local opinions are extremely useful.

Computerization. When developing impact models for rural communities, the question of computer use is an important one. Computers are desirable for two main reasons. First, the obvious advantage is care of data manipulation and computation. Detailed analysis can be conducted with little effort on the user's part. Of course, this assumes the ground work has been laid in terms of model validation and consistency checks. The second advantage of a computer relates to rapid response. Several runs can be made using varying assumptions.

All three models presented in this paper are computerized. TAMS and IMM have interactive programs available allowing users to respond to prompting questions. CIM is in interactive form in Oklahoma and is run in the batch mode in Texas. Because of the large data base and large region included in the study area TAMS requires more computer storage than the other programs.

An impact analysis can be calculated for a community by hand. In many cases this may be entirely adequate. However, large data bases and complex methodologies often make a computer not only desirable but necessary.

Growth versus Decline. Much work has been done in the area of modeling rural community growth. Past trends are used to project future growth. Impacts on the local economy are seen as additional growth. But what about communities that are experiencing a declining economic base (and declining population) or communities that lose an industry important to the local economy? Do the models developed for analyzing growth work equally well with decline? The answer is a negative one unfortunately. Because of capital investment and excess capacity levels the "down-side" will not necessarily be a mirror image of the "up-side". The models discussed here need additional work to be able to address this issue of community decline and projecting what will occur. The "boom-bust" cycle many rural energy communities experience is also a part of this problem. Including capital investment as the CIM capital account does is a possible step in this direction. This will be an area of challenge for researchers in the years to come.

Developing an Extension Program

All the factors mentioned in the previous section are important when planning an Extension program in this area. Methodology alternatives, output desired, data requirments, computer requirements are all important factors to consider. The ultimate decision will depend upon the planned use of the model and the available resources. An adequate research base is necessary to successfully dsevelop these types of socio-economic models. Therefore, Extension and Research personnel should interact and work together as closely as possible.

The primary reason local leaders request assistance in impact analysis is to access a particular issue that has arisen. Providing the economic and social information improves decision-making capabilities. Working through such a project can also be seen as an educational program. By encouraging local leaders to take part in data collection and working closely with them in interpretation, the local leaders will not only understand the impact issues but also will have a better understanding of their local economy.

Nelson and Doeksen (1984) discuss the opportunities and payoffs in rural development work in a recent paper. They discuss both Extension and Research activities. Several points the authors list related to a successful rural development program are particularly relevant for impact/growth modeling.

The following is a partial list of the caveats listed by Nelson and Doeksen that seem to be especially relevant for the modeling efforts discussed in this paper:

1. Keep the project practical by addressing real problems identified by real decision makers. You can do this by listening to local decision makers as they describe their problems to you.

2. Present results straightforwardly as possible, directing them toward the problem at hand. As professional economists, we need to be responsible for appropriate methodology and theory; however, the local decision makers are more interested in the practical results of a study.

3. Be imaginative in cultivation and utilization of nonconventional data sources. Carry this further and be imaginative in applying the tools of economic analysis (economic base analysis, location quotients, input-output, simulations, etc.). Every local problem will have a little different emphasis or concern. It is up to you to identify the appropriate data, methodology and model to address that specific problem.

Summary

Three models used in Texas and Oklahoma have been briefly described in this paper. IIM, CIM and TAMS all have specific applications and instances when each would be the best model to use. When modeling the social and economic make-up of rural communities many techniques and methodologies are available. The issue is not which model is best but which model best solves the local problem at hand. Researchers, Extension Specialists, and others should be able to work with a community to identify the best model to address their specific needs.

Some general guidelines are that a good model should be flexible--and able to fit local situations. The model projections should be as accurate as possible and should be available on an annual basis. Of course, for the information to be used it should be provided to decision makers as quickly as possible.

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