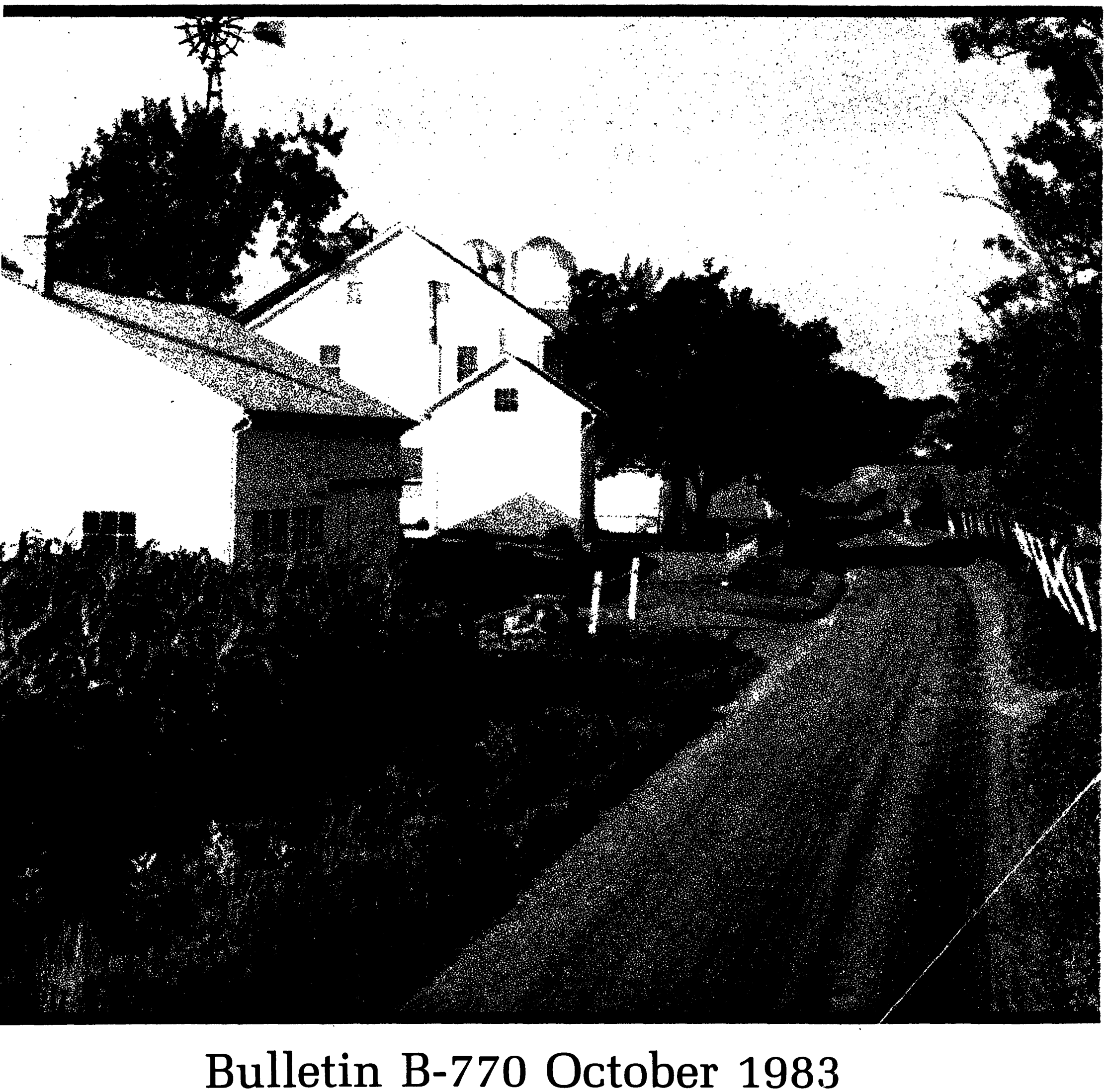
A Simulation Model for Rural Communities in Oklahoma



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CONTENTS

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A SIMULATION MODEL FOR RURAL COMMUNITIES IN OKLAHOMA

Mike Woods and Gerald A. Doeksen*

INTRODUCTION

Decisionmaking for community development takes place at various spatial and political levels in the United States. Nationwide decisionmaking is usually concerned with aggregate national economic variables such as national employment, income, and inflation. Regional decisionmaking usually occurs at the state or sub-state level with the state government or county government providing leadership. There are many community decisions, however, which are important at the municipal or community level. With population and industrial growth in rural areas, local governments are seeing changes in local job situations, government budgets, and community service requirements. The planning of community services often involves large capital investments (water systems, hospitals, schools, etc.); thus, it is important to obtain the best estimates of employment, income and population. Eddleman (1974) emphasizes the need for information when making community service decisions. Alternative policies and different courses of action need to be considered when planning for the provision, financing, and operation of public services.

To summarize the importance of community decisionmaking, particularly relating to services, three points can be noted: (1) limited resources are available to provide municipal services, (2) municipal services directly influence the quality of life, and (3) municipal services have present and long run implications (Shaffer, 1978).

One useful tool for decisionmakers in the area of community development is simulation analysis. What will be the results of, say, a change in a community's existing economic base? A simulation model would allow decisionmakers to receive some estimate of the results of various decisions and policies. Of course, to aid economic and demographic planning, the model should also provide baseline predictions or estimates based on past experience with no new impacts. For the model to be useful, it should: (1) be readily available and useable, (2) provide the most reliable estimates possible, and (3) provide information over time (Doeksen, 1979a). An important link can be developed between a community simulation model and community service budgets (i.e., fire service budgets, water system budgets, etc.). If a simulation model can be programmed to generate a reasonable estimate of the need for a particular community service,

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then such a model can greatly aid in planning for local growth (Nelson, 1979).

Rural Communities in Oklahoma

Large city governments such as Tulsa or Oklahoma City usually have their own planning staffs and other resources necessary for planning community growth. Smaller cities and towns often do not have the personnel to gather information and conduct analysis. This study will be most useful for decisionmakers in smaller communities.

Oklahoma has 77 counties. The Census of Government for 1977 lists 567 municipalities, 406 special districts, and 625 public school districts in the state. Oklahoma ranks seventeenth among states in the number of local governments with 1,675. This study is concerned primarily with local municipalities and the services they provide to the local population. The terms community, city, and municipality are often used interchangeably.

Different economic and demographic situations exist among communities in Oklahoma. Most communities are growing, but a few are declining in population. For a model to be useful, it should be adaptable to the various local settings, yet be as specific as possible for each community. The community of interest as well as the surrounding service area should be analyzed as economic boundaries often do not follow given governmental boundaries. Baseline projections measuring natural growth are needed as well as projections which measure the impact from a change in the economic base. A community simulation model should be able to provide for both needs.

Objectives

A community specific simulation model for rural communities in Oklahoma does not exist. Local decisionmakers need reliable information concerning the costs and benefits associated with growth in their communities. A simulation model for a community could provide useful baseline projections as well as impact information concerning various policy alternatives in the private and public sectors.

In general, the objective of this study is to develop and test a community simulation model. The model would utilize specific community data when available yet need not be completely reestimated for each community. Default data would be utilized when specific community data are not available

Specifically, the objectives of the study are to:

1. Develop a methodology for constructing social accounts which are applicable to specific rural communities. The social accounts include:
    - A. An Economic Account
    - B. A Capital Account

C. A Demographic Account
D. A Local Community Service Account
E. A Local Community Revenue Account

2. Develop a simulation model which will:
   A. Project output, employment, income, population, and other relevant variables in the community for future years.
   B. Relate the economic and demographic projections to the public sector. This includes community service requirements and estimates of local government revenue.
   C. Provide estimates of structural parameters such as income and employment multipliers by industry sector.
   D. Provide impact analysis of the effects on the community system of various public and private policy alternatives.

Overview of Oklahoma Social Accounts[1/]

Before a simulation model can be developed, available data must be organized into a systematic manner. A system of social accounts was developed which is the data base for the community simulation model. The Oklahoma social accounting system which describes the economic-demographic system of a community is outlined in Figure 1. The accounts included in the Oklahoma social accounting system are:

1. An economic account which describes interindustry transactions and employment and income growth;
2. A capital account which provides information on capital structure and capital expansion for the economic sectors;
3. A demographic account which utilizes an age-sex cohort survival technique to project population;
4. An account for projecting requirement levels of various community services; and
5. A community government revenue account.

Economic Account

The economic account describes the process of economic activity in a given community. This account consists of an input-output model estimated for a community. For community studies, the large expense of collecting first-hand data is often not feasible. In these cases, some estimating technique can be used to off-set the expense.

For this paper the data source utilized is the 1972 National Input-Output Table (U.S. Dept. of Commerce, 1979a; 1979b). A location quotient technique is then used to estimate a local community input-output model.[2/] The technique is a part of the program for the simulation model. In order to apply the location quotient technique, local sector output must be know. Local employment data estimated from employing the gravity model are used along with known national employment and output by sector. The national input-output

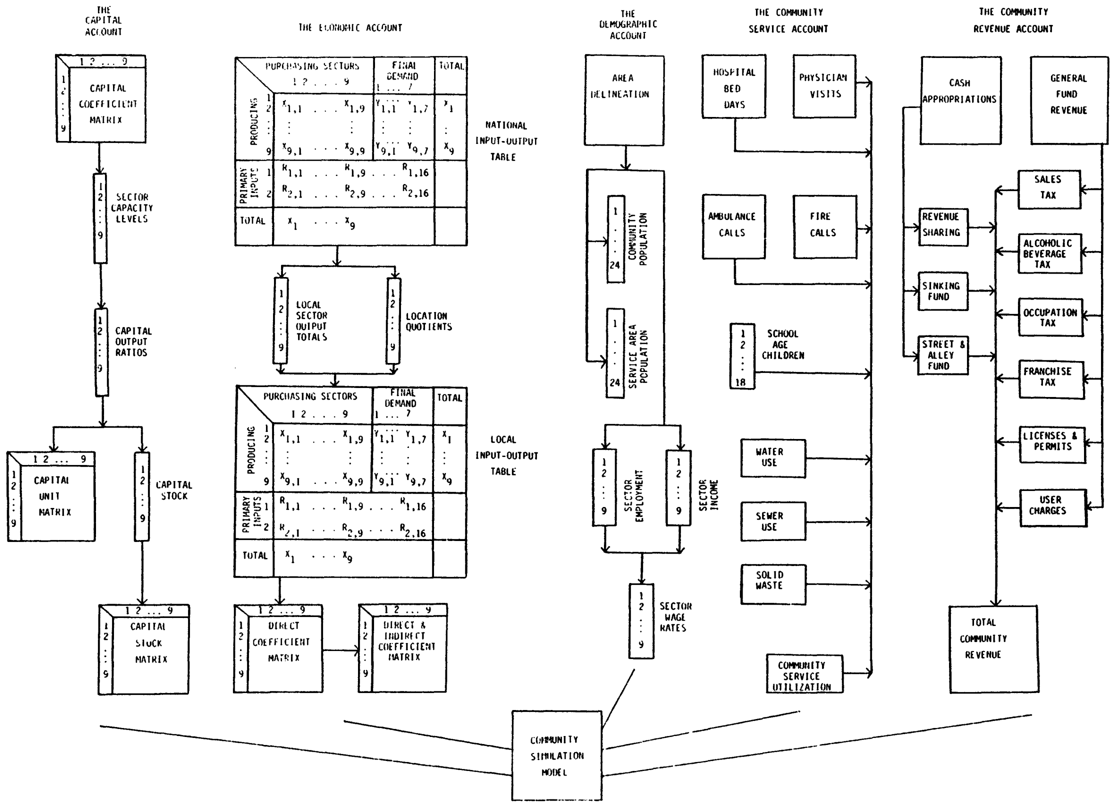

Figure 1. Overview of the Community Social Accounting System

table must be aggregated to correspond with the local data before the location quotient technique can be applied. The standard industrial classification (SIC) code was used to match the national input-output table with available local data. Table 1 presents the nine endogenous sectors.[3/] The simulation model is constructed to utilize whatever input-output table is provided in order to estimate a local table. If state or regional tables are available, these could be used as an alternative. The national table was chosen because 1972 is the most recent year for which data are available.

Table 1. Local Sector Classification and SIC Codes

	Sector	SIC
1.	Agriculture, Mining	01, 02, 07-09, 10-14
2.	Construction	15, 16, 17
3.	Manufacturing-nondurable	20-23, 26-31
4.	Manufacturing-durable	19, 24, 25, 32-39
5.	Transportation	40-47
6.	Communication, utilities, and sanitary services	48, 49
7.	Wholesale and retail trade	50-59
8.	Finance, insurance, business	60-67, 70, 72-76, 78, 79, 88
9.	Professional and related services educational, public ad. and other	80-89, 91-94

Capital Account

Several problems arise when developing a regional capital account. The definition of the region or boundary must be considered as well as the openness of the region in its relation to the national economy. Local data are often difficult to obtain and estimates based on national data are often used. However, it is useful and necessary to develop a regional capital account as this is a very important component of the overall economy. Particularly, if a system of economic accounts is to be used to predict economic growth over time in a region, the capital structure of that region and its capacity should be considered. The capital account utilized in this study is similar to that developed by Doeksen and Schreiner (1971 C).

Capital coefficients can be constructed by using direct survey techniques or through the use of a flow matrix. The use of survey techniques is prohibited in this study since the model will be applied to several different communities. Therefore, a capital flow matrix will be utilized to estimate the coefficients. The most recent data available are the 1967 national capital flow matrix for expenditures on new plants and equipment published by the U.S. Department of Commerce (1975). The flow table is an expansion of the 1967 national input-output table information on fixed capital purchases. The matrix shows estimates of transactions in new structures and equipment between producing and using industries. A more desirable table would be one that accompanies the 1972 national input-output table but this information is not available.

The initial step in estimating a capital coefficients matrix is to aggregate the capital flow table to match the nine endogenous sectors included in the model. Capital coefficients are then derived and indicate the purchases of capital goods from producing sectors per dollar of capital investment for that sector.

Capital-output ratios are defined as the ratio of total cost of plant and equipment to output at capacity. Capacity estimates developed for Oklahoma are applied to individual community output estimates. Capital-output ratios are then estimated for that community and utilized in the model.

The capital unit matrix is constructed by using the capital coefficients and the capital-output ratios. Each coefficient in this matrix shows the capital required from sector i to produce one unit of output capacity for sector j.

Capacity levels were estimated for the nine endogenous sectors included in the model. Production levels are difficult to obtain at the state level, much less the community level. Sector employment levels for the state were used as proxies for the production levels. Quarterly employment data by sector were used to chart peak employment (Oklahoma Employment Security Commission, (1979a, 1979b). Peak employment levels were determined by inspection and 100 percent capacity level of operation was assumed at each peak. Present capacity is estimated by extrapolating a line connecting peak employment.

Using capacity estimates, capital-output ratios, and the capital coefficient matrix, a capital stock matrix can be estimated. By multiplying the capital-output ratio times the estimated output at capacity, sector capital is derived. The amount of capital in a sector times that sector's capital coefficients column gives the composition of each sector's capital.

Depreciation coefficients are estimated to complete the capital account construction. Depreciation coefficients are defined as depreciation per year to total depreciable assets.

Demographic Account

The demographic or human resource account is closely aligned with the economic account. The demographic account in this model is also concerned with population data by age and sex cohorts. Population and the accompanying labor force are linked to the economic account through income and employment and also interface through the migration process. For this study, employment and income data are needed to describe the economic environment of the local community.

The methodology for interfacing the economic and demographic accounts in the simulation model follows the above description. Each year, employment requirements are compared to labor availability to determine population change and migration levels. The resulting population is then used in the cohort-survival model to determine labor availability for the next year.

Community Service Account

Once reliable population projections are available they can be used to estimate a community's level of service usage. A community can usually handle only limited usage for a given service. Capacity of a hospital is determined by the number of beds and the availability of physicians. A community's water system also has some capacity limit. As population changes and economic growth occur, the level of community service demand will vary. Estimates of capacity constraints for specific community services would be useful for both baseline and impact projections.

Several services apply to the service area population as well as the community. For this reason, the two populations were kept separate and included detail for age and sex cohort. Annual requirements such as hospital usage measured in bed days per year; clinics measured as the number of physician visits per year; ambulance services; fire protection; and school or educational services are projected for the community and the service area separately. Model projections are based on age categories and then summed to provide an aggregate figure.

As has been noted, the economic and demographic accounts are interfaced to provide annual estimates of population based on employment demand and supply. The resulting population data are in the 24 age-sex cohort detail described in the demographic account. Use coefficients are available for many community services based on age categories. For example, Dunn and Doeksen (1979) present the average annual hospital usage for various disease categories by the age cohorts less that 15, 15 to 44, 45 to 64, and 65 and above for both males and females. The population data are aggregated to match these age groups and applied to use coefficients to estimate annual bed-day usage for various disease categories. The data are then summed over disease categories to obtain a total annual figure.

A measure of the usage placed on clinics is the number of physician visits per year. Usage coefficients which indicate number of physician visits by sex and age per year are applied to the population estimate to arrive at an estimate of annual physician visits.

Another important factor in providing for rural health care is ambulance service. In order to anticipate future needs, an estimate of ambulance calls for each year is helpful. Highway accident calls and transfer calls from one hospital to another are both dependent upon local conditions, thus estimates should come from local records. Doeksen, Frye, and Green (1975) provide sources for this information. Other ambulance calls include those not associated with highway accidents or transfer calls. Heart attacks, strokes, and home accidents are examples of other ambulance calls that might be made and are a function of age.

As population and rural investments grow, the need for fire protection increases. To anticipate needs, an estimate of annual fires is useful. Childs et al (1977) provide information for estimating the number of fires in a given area. A fire frequency coefficient for population is used to estimate annual fires occurring in the community and the service area.

Since population is allocated to age-sex cohorts for each year, detailed information on the school age population within the community and within the service area would be useful. This information would permit a more accurate estimate of need for future educational services for both baseline and impact projections. The number of children in each grade category will determine the number of teachers needed and will indicate future capital expansion requirements.

Up to this point, all model estimates of service requirements are available for the city, service area, and total population. The service requirements for water use, sewer, and solid waste requirements are estimated for the city population only.

City water use estimates are derived from the number of user hookups. Hookups are estimated using the assumption of 2.62 persons per tap (Goodwin et al., 1981). Also, information on the number of commercial and business establishments is necessary.

Sewer or waste water generation is also closely related to population. Nelson and Fessehaye (1981) note that 100 gallons per person is often used to estimate daily sewage flow rates. Additional major usage from industrial establishments should also be considered.

Cities have many alternatives available to handle solid waste collection, transfer, and disposal (Fessehaye and Kuehn, 1981a, 1981b, 1981c; Kuehn, 1980). However, no matter what method of service delivery is chosen, some estimate of solid waste service need is useful. The estimate used to determine collection and disposal needs for solid waste generation comes from Goodwin and Nelson (1980). Total volume in cubic yards of solid waste collected per week is estimated as a function of the users of the system.

Community Revenue Account

For communities in Oklahoma, general fund revenue sources comprise most of the revenue for day-to-day operation. In the general fund, there are five basic sources of revenue: (1) Tax revenue including a sales tax, alcoholic beverage tax, occupation tax, and franchise tax. The sales tax level is decided on by the city voters. Generally it is 1, 2, or 3 percent. The city sales tax is collected with the state sales tax and then returned to the city. The alcoholic beverage tax is transferred from the state government and allocated based on population. Cities can also levy an occupation tax and a franchise tax. (2) Revenue from licenses and permits is another source of income. Dog tags and plumbing and electrical permits are examples of this source of revenue. As population grows, more construction in housing occurs, thus more revenue from this source. (3) User charges are a third source of revenue from the general fund. User charges such as water, garbage and other services are directly related to the level of use in many cases. The model allows projection of user charges based on population using the most recent years per capita figure. (4) Revenue from court fines is another source of funds and is projected using a per capita figure in the model. (5) A final category in the general fund is miscellaneous revenues and includes any funds not counted in previous categories. Interest revenue or rental fees for a civic center are examples of miscellaneous revenues.

Other sources of revenue include three main categories: (1) Revenue sharing, which is a direct allocation from the federal government. Revenue sharing is very difficult to predict and depends on many things including the prevailing political climate. Revenue sharing funds should be used for capital expenditures projects rather than operating expenses as the revenue is not guaranteed from year to year. (2) Another cash appropriation is a street and alley fund. Taxes on commercial vehicles, bus mileage, and gas excise taxes are ear-marked for street and alley funds and transferred from state government. (3) A sinking fund is often found in rural communities. This fund is established to retire bond indebtedness. This is usually the only ad valorem tax revenue a city or community will receive. Projections of revenue from these sources of funds vary greatly and depends on factors not included in the model. However, a per capita estimate can be made if the user desires.

Overview of Community Simulation Model[4/]

Simulation involves the development of a model that represents a real world situation over time. The Oklahoma community simulation model consists of 180 major recursive equations. Many of the equations are in matrix form including an equation for each endogenous section. Thus, the complete model contains over 1000 equations. Before an overview of the model is presented, a selected review of previous simulation models is presented.

Selected Review of Simulation and Impact Models

Many types of models and methodologies have been developed. These range from economic base analysis to complicated community simulation models. Shaffer and Tweeten (1972) present an early version of an impact model developed to measure the impact of new industry on rural communities in Oklahoma. The model provides results of private impacts, public sector impacts and school district impacts. A framework for calculating net gain (loss) to the community was also included in order to estimate reasonable "inducement" levels that communities might offer potential manufacturing employees. The model is notable because of the emphasis placed on making it usable and understandable to local leaders. The model utilizes partial budgeting techniques and is a single period tool with no dynamic time considerations. Shaffer and Tweeten note the difficulty of estimating the indirect and induced effects at the community level because there are no published rural community input-output tables. Two conclusions reached by the authors are that industrial impacts vary over different economic sectors and differ among communities.

Ford presents a computer model that is designed to describe the impacts of locating large power plants near small, isolated communities. Small towns in the western states that experience this type of impact generally go through an initial "boom" period with rapid expansion. Following the initial construction phase, economic and demographic changes tend to level off. Characteristics of the immigrating population during the construction phase are often quite different from the characteristics of the indigenous population. Public service capital and economic activity are often expanded to support the rapid population growth putting a strain on the public sector. Following completion of the energy project, a "bust" period often follows. Tax revenues decrease and the local government is left with excess capacity in the public sector. The BOOM 1 model (Ford) provides economic, demographic, public service, and fiscal projections of the proposed impacts. Yearly projections for the city of interest are provided. A series of feedback loops are utilized to provide dynamic projections from year to year.

A community level impact model was developed for use in Florida (Clayton and Whittington). The model is an *ex ante* evaluation of the impacts of community growth. Output includes employment and population changes resulting from an outside impact such as a new industry. Private sector impacts include such variables as direct, indirect and induced sales from the impact being analyzed. Public sector impacts include projection of local revenues and expenditures. A net fiscal surplus (deficit) is calculated along with a break-even property assessment ratio. City, county, and school district levels of government are included. The Florida model emphasizes user access with default data provided when local data are unavailable. This type of data availability increases the usefulness of the model and allows more timely analysis.

A model has been developed in North Dakota (Murdock, et al. 1980) which is designed specifically to measure the impact of energy developments. The model provides annual impact and baseline projections of key variables. Impacts of energy resource development can be measured for employment, population, settlement patterns, school enrollments, housing requirements, and public sector costs and revenues. Like the model for Florida, the North Dakota model relies heavily on the input-output portion of the model. Output is provided at the state, county, city and school district levels. Also, the complex process of interfacing economic projections with population growth is well documented.

Fox discusses the development of impact models from a user's viewpoint. Governments at all levels are faced with decisions that would be greatly aided by impact model forecasts. Fox emphasizes the fact that user confidence will be enhanced by more accurate and useful models, thus increasing clientele support. For users to utilize models to the best advantage, they need to understand the basic model assumptions and structures. If information is clearly communicated to the layman users, then less misinterpretation will occur. Users should be encouraged to ask as many questions as necessary to understand the model.

As can be seen from a very brief review of impact models, a wide range of methodologies exists. Some models measure energy resource development impacts, some measure the results of industrial development. Some impact models can also project baseline growth to compare to the resulting growth from some outside impact. Developing new and innovative methodologies is necessary to continually improve the models used. Adaptation of existing models provides additional checks on model validity. Model builders should utilize the 1980 Census results to improve and verify modeling efforts. It is critical for the successful utilization of all impact models to make outputs usable and understandable for decisionmakers. From the viewpoint of an Extension worker, the most useful model would be: (1) dynamic; (2) community specific; and (3) easy to adapt to each community.

To facilitate Extension application, special efforts have been made to make the Oklahoma community simulation model dynamic, community specific, and easy to adapt. The OSU model is discussed in detail in the following section.

An Overview of the Oklahoma Community Simulation Model

An aggregate overview of the Oklahoma community simulation model is presented in Figure 2.[5/] The data base for the model is the five accounts in the Oklahoma social accounting system as described above. The economic, capital, and demographic data are applied to a gravity model to estimate the conditions within the community's service area. Data from the gravity model and from the latest input-output model (either national, state, or regional) are applied to a location quotient model to derive a community input-output model. Equations which predict changes in the final demand sectors for the input-output model create the dynamic aspects of the model. The input-output model results plus data from the economic, capital, and demographic accounts project income, employment, and population data by year. Applying community service usage coefficients to that data allows for prediction of community service needs. Finally, model projections plus tax rate information are used to project community revenue. The model is run for as many years as desired. Each year's output is used as input for next year. To illustrate the model usefulness, baseline projections and impact aspects are presented for Holdenville, Oklahoma in the following section.

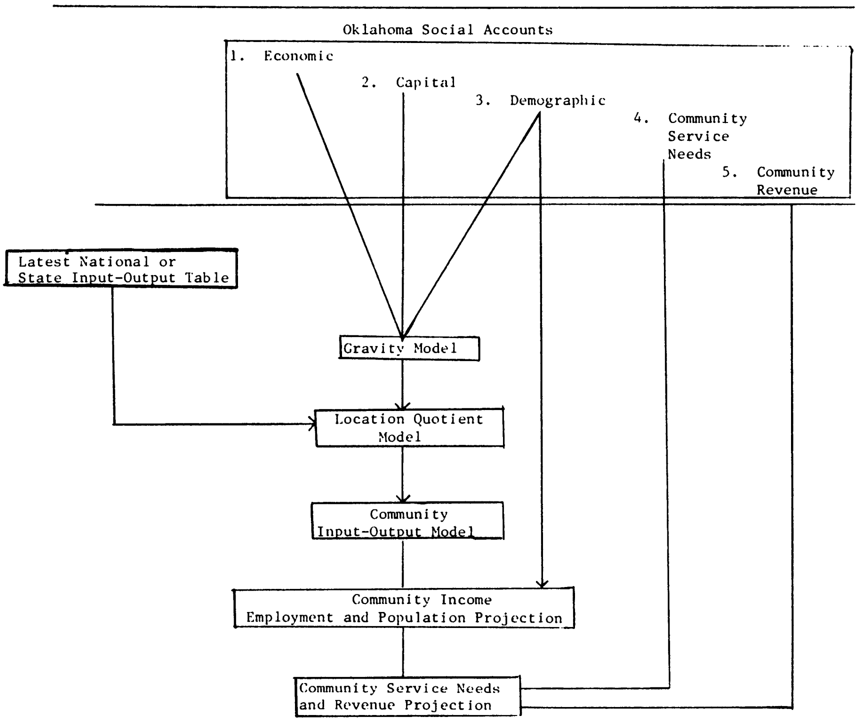

Figure 2. Overview of Oklahoma Community Simulation Model

APPLICATION OF MODEL - BASELINE PROJECTIONS

For illustration purposes, the community of Holdenville, Oklahoma was selected. Holdenville is located 74 miles from Oklahoma City and had a population of 5,373 in 1980. It is the county seat of Hughes County, which is primarily an agricultural county. The simulation model projects values of economic and demographic variables from the base year of 1972 to 1991.

Employment

Employment projections for Holdenville and the surrounding service area are presented in Tables 2 and 3. Wage and salary employment by economic sector are shown in Table 2. Data obtained form the U.S. Department of Agriculture (1980) for 1972 and 1978 are also reported. The agriculture and mining sector shows a steady increase over the simulation period. Manufacturing-nondurable sector and the communication sector both show a decline in employment over the study period with the decline leveling off after 1980. This corresponds to the reported data for these sectors and declining rates of growth were utilized for the case of Holdenville. Durable manufacturing also exhibits special characteristics. Reported data indicated that a new plant was established in this sector in 1974. Employment increased from almost nothing to over 100. The community simulation model allows the researcher the flexibility to include a sudden change in the economic base of a region.

The service sectors, including wholesale and retail trade, finance, business and professional services, as well as government, show steady growth in employment. These sectors are very dependent on the more basic (exporting) sectors, and they also exhibit independent growth following the national norm. Total wage and salary employment is projected to increase from a published figure of 1,559 in 1972 to 3,629 in 1991. The 1978 projected value for total wage and salary employment is slightly higher than the published figure.

Proprietor employment by sector is presented in Table 3. Unpublished data obtained from the U.S. Department of Agriculture (1980) are also reported for 1972 and 1978. Sector proprietor employment was not actually available. Reported total proprietor employment for 1972 and 1978 was allocated by sector based on the state relation of proprietor employment to wage and salary employment by sector. In general, proprietor employment changes in the same direction as the previously reported wage and salary employment. Two exceptions are the finance, insurance, business, and repair service sector and the educational and professional services. These two sectors show declining proprietor employment indicating an increasing proportion of employment in these sectors going for wage and salary workers. Total proprietor employment for Holdenville and the surrounding service area is projected to grow to 1133 by 1991, a slight increase from the 1972 reported figure of 1112. The projected figure and the reported figure for total employment in 1978 are very close.

Table 2. Wage and Salary Employment By Sector, Projected Value For Holdenville, Oklahoma, 1973 TO 1991

Sector	Agriculture, Mining	Construction	Manufacturing-Nondurable	Manufacturing-Durable	Transportation	Communication, Utilities, Sanitary Services	Wholesale and Retail Trade	Finance, Insurance, Business and Repair Services	Educational Services, Professional Services	Total
1972[a]	164	34	178	1	25	60	252	256	629	1599
1973	168	43	164	1	25	52	259	264	650	1626
1974	178	55	162	131	29	48	290	282	671	1846
1975	184	62	153	143	30	43	312	298	703	1928
1976	190	59	142	129	30	38	322	311	731	1952
1977	196	54	132	113	29	35	326	319	747	1951
1978	203	53	124	111	29	32	335	329	764	1980
1978[a]	209	49	123	107	22	29	371	267	775	1952
1979	211	57	120	114	29	31	348	342	783	2035
1980	220	63	117	121	30	30	365	355	803	2104
1981	229	68	115	127	30	30	385	373	832	2189
1982	240	76	113	131	31	30	409	392	865	2287
1983	250	84	112	135	32	30	435	413	904	2395
1984	261	91	110	138	33	30	463	436	945	2507
1985	273	98	109	142	34	30	493	461	989	2629
1986	286	107	108	145	35	30	525	487	1035	2758
1987	299	117	108	150	36	30	561	515	1085	2901
1988	313	128	108	155	38	30	600	545	1139	3056
1989	327	141	108	161	39	31	644	579	1198	3228
1990	343	156	109	168	41	31	693	616	1262	3419
1991	359	174	110	176	43	32	747	656	1332	3629

(a) Unpublished Data, USDA, ESCS, 1980.

Table 3. Proprietor Employment by Sector, Projected Valur for Holdenville, Oklahoma, 1973 TO 1991

Sector	Agriculture, Mining	Construction	Manufacturing-Nondurable	Manufacturing-Durable	Transportation	Communication, Utilities, Sanitary Services	Wholesale and Retail Trade	Finance, Insurance, Business and Repair Services	Educational Services, Professional Services	Total
1972[a]	543	34	6	0	10	3	133	232	151	1112
1973	536	42	5	0	10	2	132	230	150	1107
1974	544	52	5	5	11	2	143	237	148	1147
1975	543	57	5	5	11	2	148	242	148	1161
1976	538	52	5	5	11	1	147	242	147	1148
1977	534	45	4	4	10	1	143	239	143	1123
1978	531	43	4	4	10	1	142	237	139	1111
1978[a]	551	39	3	3	7	1	157	192	148	1101
1979	532	44	4	4	9	1	142	236	135	1107
1980	533	47	4	4	9	0	142	236	131	1106
1981	534	49	4	5	9	0	144	237	128	1110
1982	535	52	4	5	9	0	146	239	126	1116
1983	536	55	4	5	8	0	148	240	123	1119
1984	537	57	4	5	8	0	150	242	120	1123
1985	537	59	3	5	8	0	152	244	117	1125
1986	538	61	3	5	8	0	154	245	113	1127
1987	538	63	3	5	8	0	156	246	109	1128
1988	538	66	3	6	8	0	158	248	105	1132
1989	539	69	3	6	8	0	160	249	100	1134
1990	539	72	3	6	7	0	162	250	94	1133
1991	538	76	4	6	7	0	163	251	88	1133

(a) Total Proprietor Employment from USDA, ESCS, 1980.

In the case of employment growth over time, the model shows the result of the new plant added to the manufacturing sector in 1974 with employment increasing steadily after 1980.

Income

Tables 4 and 5 present income for Holdenville by sector in millions of current dollars. Actual income for 1972 and 1978 are reported and available from the BEA data tapes held by the USDA (1980). Also, similar information is published by the U.S. Department of Commerce (1978; 1980). Income from these sources is reported by sector but includes an aggregate of wage and salary, proprietor, and other labor income. Tables 4 and 5 present wage and salary income and proprietor income separately. They are broken out by using state data relating wage and salary income by sector to total income. Total wage and salary income in 1978 was projected to be 13.74 million dollars which compares to a published figure for 1978 of 13.89 million dollars. Proprietor income was projected to be 4.78 million dollars compared to a published figure of 5.09 million dollars.

The largest wage and salary payments projected for 1991 are in the education and professional services sector. Agriculture and mining income, on the other hand, increases rapidly in the 1970's and levels off in the last years of the simulation.

Population

Population projection is one of the useful outputs of a simulation model at the community level. Provision of local public services is a main function of local government. Population is directly related to the level of requirement for many services.

Table 6 presents population projections for Holdenville and the service area from a base year of 1972 to 1991. Total population figures are presented to preserve space. Population by age-sex cohorts are also available to model users. Various groupings of the age-sex cohorts are used to estimate service requirements for community services.

The population figures for 1970 are published census data. The figure for Holdenville is a published number while the service area population is an estimate based on rural county population. A preliminary figure from the 1980 census is also reported. As can be seen, the projected population for 1980 is slightly less than the preliminary census figures. Population projections from the Oklahoma Employment Security Commission are also reported for the years 1985 and 1990. The projected population for 1985 from the simulation model is less than the figure projected by the Oklahoma Employment Security Commission. For 1990, the simulation model projects a larger population for the community and service area.

Table 4. Wage and Salary Income by Sector, Millions of Current Dollars, Projected Values for Holdenville, Oklahoma, 1973 TO 1991

Sector	Agriculture, Mining	Construction	Manufacturing-Nondurable	Manufacturing-Durable	Transportation	Communication, Utilities Sanitary Services	Wholesale and Retail Trade	Finance, Insurance, Business and Repair Services	Educational Services, Professional Services	Total[b]
1972[a]	.31372	.22440	.91596	.00365	.23857	.60475	1.22099	.68984	3.08047	7.29235
1973	.40820	.29844	.89026	.00376	.25927	.56194	1.29433	.78044	3.36024	7.85688
1974	.55089	.40244	.93231	.89351	.33672	.56296	1.50016	.92206	3.67667	9.77772
1975	.73037	.47821	.93239	1.07395	.38875	.54964	1.67523	1.07578	4.08591	10.99023
1976	.96367	.47280	.91918	1.06214	.42199	.53406	1.79160	1.23651	4.50370	11.90565
1977	1.27177	.45444	.90494	1.03080	.45148	.52143	1.87674	1.40206	4.87933	12.79299
1978	1.35654	.47123	.90361	1.11021	.49271	.51973	1.99863	1.59794	5.28973	13.74032
1978[a]	1.76614	.42528	.89099	1.08612	.37698	.46880	2.21308	1.32495	5.33749	13.88983
1979	1.45477	.52598	.92823	1.25391	.54622	.55159	2.15309	1.83009	5.74297	14.98684
1980	1.56243	.61008	.95999	1.45951	.61107	.58924	2.33553	2.10115	6.24236	16.48134
1981	1.67916	.69521	.99631	1.68823	.68745	.63266	2.55515	2.43130	6.85679	18.22226
1982	1.80601	.81955	1.03885	1.92617	.77720	.68239	2.80958	2.82455	7.56522	20.24950
1983	1.94293	.93970	1.08549	2.18422	.88034	.73829	3.09673	3.28875	8.37505	22.53149
1984	2.09072	1.07115	1.13671	2.46525	.99756	.80068	3.41369	3.83192	9.28157	25.08923
1985	2.25037	1.21747	1.19320	2.78053	1.13129	.87052	3.76427	4.46698	10.29258	27.96718
1986	2.42312	1.38723	1.25608	3.14379	1.28502	.94922	4.15542	5.21114	11.42184	31.23283
1987	2.61030	1.58812	1.32649	3.56823	1.46303	1.03844	4.59592	6.08631	12.68933	34.96613
1988	2.81328	1.82779	1.40551	4.05605	1.67023	1.13999	5.09530	7.11913	14.11902	39.25629
1989	3.03349	2.11413	1.49423	4.65022	1.91227	1.25592	5.66389	8.34153	15.73810	44.20375
1990	3.27252	2.45652	1.59386	5.33675	2.19585	1.38858	6.31336	9.79190	17.57734	49.92665
1991	3.53214	2.86705	1.70588	6.14606	2.52922	1.54081	7.05769	11.51699	19.67251	56.56920

(a) Derived from Published Data, U.S. Department of Commerce, BEA.
(b) Column Total May Not Be Exact Due to Rounding Error.

Table 5. Proprietor Income by Sector, Millions of Current Dollars Projected Values for Holdenville, Oklahoma, 1973 TO 1991

Sector	Agriculture, Mining	Construction	Manufacturing-Nondurable	Manufacturing-Durable	Transportation	Communication, Utilities, Sanitary Services	Wholesale and Retail Trade	Finance, Insurance, Business and Repair Services	Educational Services, Professional Services	Total[b]
1972[a]	1.32245	.23182	.01944	.00008	.03330	.01098	.40524	.44355	.45814	2.92500
1973	1.49002	.28512	.01829	.00008	.03622	.00944	.41035	.47419	.47155	3.19525
1974	1.73216	.35625	.01906	.01841	.04332	.00839	.45183	.52539	.48943	3.64723
1975	1.97749	.39197	.01899	.02211	.04779	.00716	.47891	.58101	.51512	4.04053
1976	2.24588	.35858	.01862	.02185	.04952	.00596	.48570	.62889	.53681	4.35180
1977	2.55026	.31865	.01824	.02118	.05052	.00487	.48199	.67097	.54882	4.66550
1978	2.61549	.30524	.01813	.02279	.05252	.00391	.48576	.71891	.56030	4.78306
1978[a]	3.01984	.27962	.01469	.01791	.03986	.00662	.53449	.58285	.60012	5.09600
1979	2.69571	.31447	.01854	.02572	.05539	.00316	.49467	.77331	.57157	4.49523
1980	2.78124	.33634	.01908	.03012	.05887	.00233	.50661	.83305	.58229	5.14993
1981	2.87002	.35308	.01971	.03457	.06284	.00140	.52260	.90347	.59782	5.36551
1982	2.96243	.38302	.02045	.03940	.06731	.00033	.54107	.98263	.61460	5.61125
1983	3.05698	.40368	.02127	.04464	.07211	.00000	.56068	1.06979	.63180	5.86096
1984	3.15350	.42244	.02217	.05034	.07715	.00000	.58012	1.16396	.64766	6.11733
1985	3.25104	.44022	.02316	.05672	.08244	.00000	.59935	1.26521	.66138	6.38053
1986	3.35282	.45924	.02427	.06408	.08806	.00000	.61869	1.37415	.67245	6.65375
1987	3.45597	.48060	.02551	.07266	.09405	.00000	.63850	1.49168	.68044	6.93942
1988	3.56147	.50480	.02690	.08272	.10047	.00000	.65897	1.61873	.68481	7.23886
1989	3.66920	.53189	.02846	.09452	.10732	.00000	.68013	1.75608	.68477	7.55237
1990	3.77900	.56188	.03022	.10838	.11462	.00000	.70187	1.90440	.67925	7.87961
1991	3.89070	.59491	.03219	.12472	.12234	.00000	.72407	2.06428	.66690	8.22009

(a) Derived from Published Data, U.S. Department of Commerce, BEA.
(b) Column total may not be exact due to rounding error.

Table 6. Population Projections, Holdenville, Oklahoma and Service Area, 1973 to 1991

	Holdenville Population	Service Area Population	Total Population
1970[a]	5181	3460	8641
1972	5222	3534	8756
1973	5165	3521	8686
1974	5297	3636	8933
1975	5386	3723	9109
1976	5337	3715	9052
1977	5284	3702	8986
1978	5233	3691	8924
1979	5185	3680	8865
1980	5215	3724	8939
1980[b]	5373	3828	9201
1981	5276	3790	9066
1982	5362	3873	9235
1983	5457	3963	9420
1984	5557	4056	9613
1985	5662	4152	9814
1985[c]	6300	3913	10213
1986	5777	4256	10033
1987	5905	4368	10273
1988	6050	4493	10543
1989	6213	4631	10844
1990	6397	4785	11182
1990[c]	6600	4085	10685
1991	6605	4956	11561

[a] Published Census Data
[b] Preliminary Census Data
[c] Oklahoma Employment Security Commission, Population Projections.

Overall, population demonstrates a large increase in 1974-1975 which is when a new large firm began operating. Population growth levels off after 1975 and declines until 1980. From 1980 to 1991 population increases steadily, reflecting employment growth in the model within the migration constraints.

Community Service Requirements

Providing medical service is often of prime importance to rural community leaders. Information on population growth by age-sex cohort provides a useful point from which to project service requirement levels for medical services. Population information is utilized for both the community and the service area. If the service area for a particular service is different from the model estimate, then the actual service area should be used. Many medical needs are related to specific age or sex cohorts. Respiratory problems might be expected to occur more frequently with other people. The incidence of tonsillectomies is higher for children. Visits to a physician and emergency ambulance calls have also been shown to be related to population (Dunn and Doeksen, 1979). Table 7 lists bed days of service requirements for hospitals, clinics, and ambulance calls from 1973 to 1991.

Hospital bed days represents the average annual number of bed days required in a hospital for a given population. Table 7 lists bed days for the city population and the service area population separately as well as combined. The model also provides bed days estimated by population group and disease category if the user desires. For Holdenville and the service area, bed days are estimated to grow from 16,364 in 1973 to 19,853 in 1991. The obvious importance of this projection rests on the estimate of hospital capacity for Holdenville. If available hospital space will not provide 20,000 bed days per year then planning to increase capacity or solving the problem in some other way should begin well before the year 1990.

Physician visits per year are also presented for the city, service area, and combined population. The model also provides physician visits for various age groups. For the total population, annual physician visits grow from 30,744 in 1973 to 40,531 in 1991.

Ambulance calls is the final service category listed in Table 7. Other calls include all ambulance trips except those for highway accidents and transfers defined as moving a patient from one hospital to another. Highway accident calls and transfers are closely related to local conditions and model users should supply the most recent year's information. Other ambulance calls are related to population and are reported in Table 7 for the community, service area, and total population.

Table 8 lists estimates of annual fires occurring in the community, in the service area, and for community and service area combined. In 1973, fires occurring in the community are estimated to be 83 while 56 fires are estimated to occur in the service area for a total of 139 fires. By 1991, the total number of fires is estimated to grow to 185.

Table 7. Annual Hospital Bed Days, Visits to a Physician and Other Ambulance Calls, 1973 to 1991

	Hospital Bed Days			Physician Visits			Other Ambulance Calls		
	City Population	Service Area Population	Total Population	City Population	Service Area Population	Total Population	City Population	Service Area Population	Total Population
1973	10706	5658	16364	18499	12245	30744	227	108	335
1974	10954	5881	16835	18965	12659	31624	235	113	348
1975	11112	6051	17163	19271	12969	32240	240	118	358
1976	10961	6061	17022	19085	12949	32034	239	119	358
1977	10787	6057	16844	18878	12911	31789	237	129	366
1978	10609	6048	16657	18678	12874	31552	235	121	356
1979	10429	6036	16465	18486	12838	31324	232	122	354
1980	10399	6109	16508	18572	12993	31565	233	124	357
1981	10426	6216	16642	18759	13223	31982	234	127	361
1982	10497	6349	16846	19054	13515	32569	237	130	367
1983	10579	6488	17067	19368	13826	33194	239	134	373
1984	10665	6630	17295	19699	14149	33848	241	137	378
1985	10759	6777	17536	20050	14485	34535	244	140	384
1986	10869	6932	17801	20434	14843	35277	246	144	390
1987	11001	7102	18103	20865	15235	36100	249	148	397
1988	11162	7289	18451	21355	15668	37023	253	152	405
1989	11356	7489	18854	21910	16149	38059	257	157	414
1990	11588	7731	19319	22540	16684	39224	261	162	423
1991	11861	7992	19853	23252	17279	40531	267	167	434

Table 8. Annual Estimated Fires, 1973 to 1991

	Fires in City	Fires in Service Area	Total Fires
1973	83	56	139
1974	85	58	143
1975	86	60	146
1976	86	59	145
1977	85	59	144
1978	84	59	143
1979	83	59	142
1980	84	60	144
1981	85	61	146
1982	86	62	148
1983	88	63	151
1984	89	65	154
1985	91	66	157
1986	93	68	161
1987	95	70	165
1980	97	72	169
1989	100	74	174
1990	103	77	180
1991	106	79	185

Projected levels of water usage, sewage, and solid waste generation are presented in Table 9. These estimates are presented for the community only as service is usually provided within community political boundaries. Water usage is projected to grow from 168,000,000 gallons per year in 1973 to 216,000,000 in 1991. This is almost a 30 percent increase in water used and capacity constraints should be considered before actual problems arise.

Table 9 also presents the gallons of waste water or sewage generated per day. Sewer requirements grow from 519,000 gallons per day in 1973 to 664,000 gallons per day in 1991.

Solid waste generated, measured in cubic yards per week, is also presented in Table 9. This figure is projected to be 389 in 1973, growing to 498 in 1991.

In projecting the requirements for provision of educational services, the important variables is the number of school age children. Table 10 presents single-age cohorts for the ages 5 to 18 from the year 1972 to 1991. The number of school age children reflects the use of a cohort survival technique and economic growth within the model, both considered each year for projection purposes.

Table 9. Projected Requirements for Water, Sewer, Solid Waste Holdenville, Oklahoma, 1973 to 1991

	Water, Million Gallons Per Year	Sewer, Million Gallons Per Day	Solid Waste, Cubic Yards Per Week
1973	168.6	.519	389
1974	173.8	.532	399
1975	176.1	.541	406
1976	174.6	.536	402
1977	172.9	.531	398
1978	171.3	.526	395
1979	169.8	.521	391
1980	170.7	.524	393
1981	172.6	.530	398
1982	175.8	.539	405
1983	179.0	.549	412
1984	182.1	.559	419
1985	185.8	.569	427
1986	189.7	.581	436
1987	193.7	.594	446
1988	198.5	.608	457
1989	203.6	.625	469
1900	209.4	.643	483
1991	216.4	.664	498

Community Revenue

General fund revenue by source is presented for Holdenville in Table 11. For communities in Oklahoma, general fund revenue sources comprise most of the revenue for day-to-day operation. Table 11 presents projections of general fund revenue for Holdenville from 1973 to 1991 in thousands of dollars.

Table 10. Single Year Cohort, School Age Children Holdenville, Oklahoma, 1973 to 1991

Year	Age													
	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1973	64	67	70	72	70	73	70	73	72	73	70	71	69	74
1974	66	68	72	73	72	75	72	74	73	74	72	72	71	76
1975	67	69	73	75	73	76	73	75	74	75	73	73	72	77
1976	66	59	72	74	72	75	72	75	74	75	72	72	71	76
1977	65	68	72	73	72	75	72	74	73	74	71	72	70	75
1978	65	67	71	73	71	74	71	73	72	73	70	71	69	74
1979	64	67	70	72	70	73	70	73	72	73	69	70	68	73
1980	65	67	71	73	71	74	71	73	73	73	70	70	69	73
1981	66	68	72	74	72	75	72	75	74	74	70	71	69	74
1982	67	70	73	75	73	76	73	76	75	76	71	72	70	75
1983	68	71	75	76	75	78	75	77	76	77	73	73	72	77
1984	70	72	76	78	76	80	76	79	78	79	74	74	73	78
1985	71	74	78	80	78	81	78	81	80	81	75	76	74	79
1986	73	76	80	81	80	83	80	82	81	82	77	77	76	81
1987	75	77	81	83	81	85	81	84	83	84	78	79	77	83
1988	76	79	84	85	84	87	84	86	85	86	80	81	79	85
1989	79	82	86	88	86	89	86	89	88	89	82	83	81	87
1990	81	84	88	90	88	92	88	92	90	92	85	85	83	89
1991	84	87	91	93	91	95	91	95	93	95	87	88	86	92

Table 11. Projections for General Fund Revenue Sources, Holdenville, Oklahoma, 1973 to 1991, Thousands of Dollars

	Sales Tax Revenue	Alcoholic Beverage Tax Revenue	Occupation Tax Revenue	Franchise Tax Revenue	Revenue from Licenses & Permits	User's Charges				Revenue from Court Fines	Other Revenue in General Fund	Total General Fund Revenue[a]
						Police	Garbage	Cemetary	Landfill			
1973	233.814	30.992	1.033	45.454	.517	7.231	65.599	7.231	4.649	35.640	30.992	463.152
1974	273.873	31.783	1.059	46.616	.530	7.416	67.275	7.416	4.768	36.551	31.783	509.069
1975	309.003	32.313	1.077	47.393	.539	7.540	68.397	7.540	4.847	37.160	32.313	548.122
1976	343.134	32.024	1.067	46.968	.534	7.472	67.784	7.472	4.804	36.827	32.024	580.109
1977	380.104	31.704	1.057	46.499	.528	7.398	67.106	7.398	4.756	36.459	31.704	614.711
1978	419.136	31.398	1.047	46.051	.523	7.326	66.460	7.326	4.710	36.108	31.398	651.482
1978	465.556	31.108	1.037	45.625	.518	7.259	65.845	7.259	4.666	35.774	31.108	695.754
1980	519.187	31.287	1.043	45.888	.521	7.300	66.225	7.300	4.693	35.980	31.287	750.711
1981	580.554	31.654	1.055	46.427	.528	7.386	67.002	7.386	4.748	36.403	31.654	814.796
1982	650.889	32.174	1.072	47.188	.536	7.507	68.101	7.507	4.826	36.999	32.174	888.972
1983	730.460	32.742	1.091	48.021	.546	7.640	69.303	7.640	4.911	37.653	32.742	972.749
1984	820.448	33.339	1.111	48.898	.556	7.779	70.568	7.779	5.001	38.340	33.339	1067.158
1985	922.371	33.972	1.132	49.825	.566	7.927	71.907	7.927	5.096	39.068	33.972	1173.761
1986	1038.147	34.661	1.155	50.836	.578	8.088	73.366	8.088	5.199	39.860	34.661	1294.639
1987	1169.985	35.430	1.181	51.964	.591	8.267	74.994	8.267	5.315	40.745	35.430	1432.168
1988	1320.368	36.298	1.210	53.236	.605	8.469	76.830	8.470	5.445	41.742	36.298	1588.968
1989	1492.108	37.277	1.243	54.673	.621	8.698	78.904	8.698	5.592	42.869	37.277	1767.960
1990	1688.444	38.383	1.279	56.295	.640	8.956	81.243	8.956	5.757	44.140	38.383	1972.475
1991	1913.159	39.629	1.321	58.122	.660	9.247	83.881	9.247	5.944	45.573	39.629	2206.411

IMPACT ANALYSIS

One method for measuring the impact of rural industrialization is to simulate capital expansion in the appropriate economic sector. The methodology used in this study is similar to previous studies. Doeksen (1971a) determined the investment impact of a hypothetical one million dollar capital investment by industry sector. Sarigedik (1975) measured income and employment impacts of a proposed army ammunition plant on the Oklahoma economy. Ghebremedhin (1981) evaluated the impacts of increased energy production and increased efficiency in energy utilization on the Oklahoma economy. Both Doeksen and Sarigedik simulated capital investment through impacts described in the capital equations.

For this model, investment is reflected in the capital equations for final demand. It is assumed that a new plant will be established in the durable manufacturing sector. A total of 50 new jobs are created in the sector and output expansion is estimated using employment-output ratios for the initial investment year, 1982. Necessary capital expansion is estimated using capital-output ratios. The increased production is assumed exported if the sector is a net exporter and consumed in the community if the sector is a net importer. In most cases with small rural communities, it is expected that increased production from a new industrial plant would be exported.

Dynamic considerations are included in the model by utilizing rates of change for employment-output ratios and rates of change for capital-output ratios. Elements of economic growth are also included in the model via wage rate changes, population growth, and final demand growth.

Multiplier analysis provides a technique for summarizing the effect of economic change. Employment multipliers measure the total employment change generated per one unit change in direct employment in a given sector. The total employment change will vary, depending upon the time period considered. Doeksen and Schreiner (1972) break the impact of potential capital investment into three time periods: (1) Short run effects occur during the first year of the impact and include direct effects, indirect effects, and capital formation effect. The direct and indirect effects result from increased sector production. The capital formation effect includes employment generated by the initial capital investment. (2) Intermediate period effects include the direct and indirect production effects. An induced consumption effect is also included as income rises with the increased production. Also, induced capacity effects occur as output in other sectors increases. (3) The third time period considered is the long run. The initial capital formation effect is reduced to zero in the short run. Induced capacity effects decline to zero over a number of years. All that is left are direct and indirect production effects and the induced consumption effects. By analyzing employment effects (or any other change) over time; dynamic considerations are included in the model. Long run adjustments provide planners with useful information that static models do not consider.

Changes in Economic and Demographic Variables

For illustrative purposes, a new plant is assumed to be established in Holdenville in 1982. The plant creates 50 new jobs in the durable manufacturing sector along with the corresponding capital expansion. The net effect of the hypothetical expansion is presented in Tables 12 through 17. Table 12 presents wage and salary employment impacts by sector for the years 1982 to 1991. Total proprietor employment impacts are also presented. The direct employment effect in 1982 includes the 50 new jobs created in the durable manufacturing sector.

The impact on wage and salary income as well as proprietor income is shown in Table 13. Wage and salary income is increased in 1982 by 1.4 million dollars while proprietor income is increased by 151 thousand dollars. The population impact in 1982 shows a total increase in population of 388 people (Table 14). This figure rises to a high of 614 people in 1984. It should be noted that this figure includes new employees and family members for the new plant as well as for all service sector jobs that would be created. The important factor to note is that while population increases at a fast rate in the early years of the impact, the net population impact declines over the long run.

The implications of the impact on hospital bed days, physician visits, ambulance calls, and fire calls are shown in Table 15. Here again, the comparison of short run and long run impacts are noted. The number of hospital bed days, for example, reaches a high of 683 in 1984. This declines to a net impact of 276 by 1991. Thus, capital expansion effects and direct effects eventually reduce to zero and service requirements decline. Local leaders should understand that initial short run effects might not justify expanding hospital facilities or other services without first considering the long run implications.

The impact of the capital expansion on water usage, sewer and solid waste generation is presented in Table 16. In 1984 usage is more than twice the level in 1991. This again demonstrates an important concept when comparing service demand with capacity levels. Table 17 presents the revenue impact for sales tax and the total general fund. As a result of the hypothetical impact, total general fund revenue will be increased by 25,048 dollars in 1982. Sales tax revenue is the primary source of revenue for communities. The impact on sales tax revenue reaches a high of 24,104 dollars in 1984, falling to 19,274 dollars by 1991.

Multiplier Analysis

Net changes in economic and demographic variables resulting from industry expansion were presented in Tables 12 through 17. The procedure was to assume capital expansion sufficient to create 50 new jobs in the durable manufacturing sector. Table 18 presents the employment effects for the short-run, intermediate, and long run. For

Table 12. Employment Impact, Holdenville, Oklahoma

SECTOR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Agriculture, Mining	2	4	4	3	2	2	2	2	2	2
Construction	11	14	13	8	3	0	0	1	3	3
Manufacturing-Nondurable	6	6	6	5	4	3	3	3	3	3
Manufacturing-Durable	67	65	56	44	37	32	30	29	28	26
Transportation	2	3	3	2	2	2	1	1	1	1
Communications, Utilities, and Sanitary Services	1	2	2	1	1	1	1	1	1	1
Wholesale and Retail Trade	15	31	37	34	29	23	20	19	19	20
Finance, Insurance, Business and Repair Services	7	18	22	22	19	16	15	13	12	13
Educational Services, Professional Services	4	30	44	47	43	36	30	26	25	26
Total Wage and Salary	115	173	187	166	140	115	102	95	94	95
Total Proprietor	25	44	49	42	33	25	19	16	18	17
Total	140	217	236	208	173	140	121	111	112	112

Table 13. Income Impact, Holdenville, Oklahoma, Millions of Dollars

	Total Wage and Salary	Total Proprietor	Total
1982	1.42650	.15175	1.57825
1983	2.06551	.24704	2.31255
1984	2.25977	.26767	2.52744
1985	2.13682	.22947	2.36629
1986	1.90617	.18025	2.08642
1987	1.72387	.14358	1.86745
1988	1.65671	.12514	1.78185
1989	1.69825	.12063	1.81888
1990	1.80135	.12339	1.92474
1991	1.92180	.12691	2.04871

Table 14. Population Impact, Holdenville and Service Area

	City	Service Area	Total
1982	225	163	388
1983	331	241	572
1984	355	259	614
1985	317	232	549
1986	258	190	448
1987	208	154	362
1988	176	131	307
1989	161	121	282
1990	156	117	273
1991	153	115	268

Table 15. Medical and Fire Service Requirement Impact, Holdenville, Oklahoma

	SERVICE			
	Hospital Bed Days	Physician Visits	Other Ambulance Calls	Fire Calls
1982	440	779	10	4
1983	642	1177	15	5
1984	683	1261	16	6
1985	603	1122	15	5
1986	486	913	12	4
1987	388	735	9	4
1988	326	623	7	3
1989	296	570	7	3
1990	283	550	7	3
1991	276	540	7	3

Table 16. Impact on Water, Sewer, Solid Waste Use, Holdenville, Oklahoma

	Water Million Gallons Per Year	Sewer Million Gallons Per Day	Solid Waste Cubic Yards Per Week
1982	7.3	.023	17.0
1983	11.1	.034	26.0
1984	11.9	.036	28.0
1985	10.5	.033	25.0
1986	8.4	.026	20.0
1987	6.8	.021	16.0
1988	5.6	.018	13.0
1989	5.2	.016	12.0
1990	5.2	.016	12.0
1991	5.3	.016	13.0

Table 17. Revenue Impact, Holdenville, Oklahoma, Thousands of Dollars

	Sales Tax Revenue	Total General Fund Revenue
1982	15.075	25.048
1983	22.081	36.798
1984	24.104	39.895
1985	22.518	36.576
1986	19.818	31.272
1987	17.691	26.917
1988	16.853	24.689
1989	17.173	24.347
1990	18.148	25.077
1991	19.274	26.078

Table 18. Short-, Intermediate, and Long-Run Employment Impacts and Multipliers Resulting From Capital Expansion to Add 50 new Jobs by Industry, Holdenville, 1982

	Direct and Indirect Employment Effects (1)	Direct, Indirect Induced, and Capital Effects (2)	Long Run Employment Effects (3)	Short Run Production Employment Multipliers (4)	Intermediate Employment Multiplier (5)	Long Run Employment-Multipliers (6)
Agriculture, Mining	62	114	75	1.24	2.28	1.50
Construction	67	114	94	1.34	2.28	1.88
Manufacturing-Nondurable	115	247	142	2.30	4.94	2.84
Manufacturing-Durable	80	217	112	1.60	4.34	2.24
Transportation	70	269	101	1.40	5.38	2.02
Communications, Utilities, & Sanitary Services	91	388	142	1.82	7.76	2.84
Wholesale & Retail Trade	56	120	80	1.12	2.40	1.60
Finance, Insurance, Business and Repair Services	62	124	82	1.24	2.48	1.64
Educational and Professional Services	53	87	68	1.06	1.74	1.36

comparison, simulation runs were also made for the other endogenous sectors to determine effects of similar investments. The impact is measured in terms of additional employment created from 1982 to 1991.

Column 1 of Table 18 presents the direct and indirect employment effects. The manufacturing-durable sector has a direct and indirect effect of 80 jobs created and caused by the initial change in production. This includes the 50 new jobs directly created by the capital expansion. The largest direct and indirect effect occurs in the nondurable manufacturing sector with 115 new jobs created.

Direct, indirect, induced consumption, and capital effects are shown in column 2 of Table 18. The capital effect is the result of the capital expansion in the sector imported. Induced effects include the effect of income expansion and also capital expansion in other sectors as output increases. The durable manufacturing sector shows a total effect in column 2 of 217 new jobs. Large effects are also shown for the nondurable manufacturing sector, transportation sector, and communication, utilities, and sanitary services sector. This is primarily the capital effect occurring in these sectors as investment is occurring to create 50 new jobs.

In the long run, only production effects and induced consumption effects remain. Column 3 presents the long run employment effects for the individual sectors. The manufacturing-durable sector shows a long run effect of 112 jobs while the largest long run effect is in the nondurable manufacturing and communication, utilities, and sanitary services sector with 142 jobs created.

Short run, intermediate, and long run employment multipliers are presented in the final three columns of Table 18. These multipliers are computed by dividing employment effects in columns 1, 2, and 3 by the direct employment effect of 50 new jobs. The durable manufacturing sector has a short run production employment multiplier of 1.60. This means that for each new job directly created in this sector for delivery to final demand, a total of 1.60 new jobs or .6 additional jobs are created. The largest short run multiplier occurs in the nondurable manufacturing sector with a value of 2.30. The smallest short run multiplier occurs in one of the service sectors, educational and professional services, with a value of 1.06.

Intermediate multipliers are shown in column 5. Durable manufacturing has a multiplier of 4.34. This is the total change in employment resulting from a production increase of one job in 1982. In the long run, capital formation and induced capacity effects fall to zero. Only direct production and induced consumption effects are included. Column 6 presents the long run multipliers by sector. Manufacturing-durable has a long run multiplier of 2.24. This is the total employment generated in 1991 by an increase in production employment of one in 1982. The largest long run employment multiplier is in the nondurable manufacturing sector and the communication utilities sanitary services sector with a value of 2.84. The educational and professional services sector has the smallest long run multiplier with a value of 1.36.

The simulation model allows impact analysis through the use of the capital equations. Employment changes can be projected and compared to baseline results. Employment impacts are separated into direct and indirect production effects, direct capital effects, and induced capital and income effects. Other flexible features of the model include adjusting economic sectors for no growth, declining growth, or a leveling off of growth in given years. Many types of changes or impacts should be considered (any parameter in the model can be changed) thus, providing the user with a relative comparison of projections.

SUMMARY

The objective of this study was to develop and present a community specific simulation model. The model provides projections of economic and demographic variables over time. The simulation model has been designed to be available and usable for decisionmakers of rural communities.

The simulation model is built around a data base comprised of various accounts. The accounts provide the input data for the simulation equations and consist of: an economic account, a capital account, a demographic account, community service, and revenue accounts. The accounts employ various techniques and methodologies to provide yearly data for the simulation model.

A procedure to delineate a service area for local communities is utilized in the simulation model. A gravity model is employed to analyze population and distance data for the community of interest and competing communities. Employment and income values by sector are estimated through use of the gravity model.

The economic account contains a community specific input-output model estimated with the use of a location quotient technique. Final demand categories are projected over time and utilized along with the input-output model to project output yearly. This procedure is the driving force of the model.

The capital account provides information on capacity and capital expansion. The capital information allows more realistic projections over time, introducing a dynamic concept into the model. National capital relationships are utilized where necessary local data are not available. The capital equations contained in the simulation model also provide an appropriate entry point for projecting impact results. Capital expansion can be simulated over time, providing a relative comparison to baseline projections.

The demographic account uses an age-sex cohort survival technique to project population. Yearly projections are utilized to estimate the local labor force which in turn is compared to employment requirements provided by the economic account. Migration levels for the community and service area are estimated by comparing labor force data with labor demand in the community.

The community service account is comprised of age-specific usage coefficients for various community services. Levels of demand are estimated for services such as hospital bed days, ambulance, physician visits, fires, water, sewer, and solid waste based on the economic and demographic projections of the model. Community revenue by source is also estimated over time based on published community specific revenue data and model projections.

Holdenville, Oklahoma, is used as an illustrative community to describe and present model output. Employment and income projections by sector are provided for the years 1973 to 1991. Baseline projections are also provided for population change in the community and service area. Finally, community service demand and revenue projections are provided. In addition, an analysis is made of the net impact of the hypothetical industry expansion in Holdenville. Baseline projections are compared to projections following the impact for the years 1982 to 1991. The results emphasize the difference between initial short run impacts and smaller long run impacts.

Evaluation

Two important characteristics should be noted when evaluating the simulation model for rural Oklahoma communities. First, the model is community specific. This means that when the model is utilized, the community of interest is analyzed with the most applicable data. Many models of this nature take a regional approach and do not provide output for a specific community. Second, the model contains much information on community service utilization not included in previous work. Again, for a specific community, the model provides projections of user needs for such services as fire protection, health services, water, sewer, and solid waste.

In developing the simulation model interrelationships must be considered. Linking economic and demographic projections provides a methodology for determining the effect on population changes of economic activity. Feedback loops are utilized to continually update baseline projections.

Impact analysis provides a very useful output of the model. By comparing impact projections to baseline results, model users can better understand the results of various public and private policies. The impact projections are converted to useful information when related to community services and revenue. In the Holdenville example, the model demonstrates the results of capital expansion. Community service demand and community revenue both increase rapidly in the initial years. The impact is not as dramatic in the later years. Model users should better understand that long run planning has many implications. Capacity expansion in the initial impact years can lead to excess capacity in later years. The final decision of expanding (or not expanding) community service facilities is left to local leaders. The model primarily demonstrates the relationships involved in such a decision.

Ease of use and access to the model are also of primary importance. The simulation model is written in Fortran and is relatively inexpensive to run. Thus, repeated runs can be compared for various policies and assumptions. Default data are provided and the model can be run relatively easily.

Limitations

Assumptions related to the input-output model should be noted when using the model. The most restrictive assumption is that the direct coefficients are fixed. This implies that technology remains constant over time. Also, no new price or material substitutions occur. This assumption can limit the time horizon for which projections are appropriate. However, for reasonable time periods the assumption is not too restrictive. In addition, when later input-output tables become available, they can be introduced into the model. The assumption of no errors of aggregation is also related to the input-output model. Industries within a sector are assumed to be homogeneous and different from other sector industries.

A location-quotient technique is used to estimate a community specific input-output model. A nonsurvey technique such as this cannot provide data as accurate as survey based data. However, time and expense considerations lend support to the use of such a technique.

The accelerator principle is utilized to project new investment in the capital account. The assumption is that net investment is a function of the rate of change of final output. This assumption is somewhat mechanical and depends on the measurement of capacity by sector. No entrepreneur motivation or decisionmaking is included. However, the accelerator principle does provide a mechanism for projecting investment that would otherwise not be possible.

The capital account utilizes national capital flow relations. Rates of change for capital-output ratios are also obtained from national data. When using national data the assumption implied is that local conditions are similar to national conditions. This is not always the case. However, the methodology of capital expansion is considered necessary for a useful model. In this case, methodological considerations overrule data considerations, and the technique is employed using national data as default values.

Additional Research

Future work related to a simulation model for rural development should concentrate on updating the data base. More recent input-output relations are desirable given the energy and economic changes that have occurred in recent years. Community specific input-output data and capital data are desirable to provide more accurate projections.

Further work is needed to estimate commuting flows and labor force information for communities. Detailed employment data for communities is useful, especially in time-series form.

The use coefficients for community services are age-specific and often apply specifically to Oklahoma. However, these coefficients change over time and should also be continually updated. Additional work is needed in the community revenue sector. Furthermore, time series data can provide useful rates of change, and the relationships of community growth and revenue should also be closely explored. A simulation model can be evaluated by its use. Continual refinement is possible as more recent data and new methodologies become known.

Footnotes

1/ For a detailed discussion of social account, please see Woods (1981).

2/ For a computerized version of the technique, please see Mustafa and Jones (1971).

3/ For a copy of the table, see Woods (p81).

4/ For a complete listing of equations and discussion of the simulation model, see Woods (1981).

5/ For a detailed Flow Chart of model and variables see Appendix A.

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Appendix Table I

VARIABLES IN SIMULATION MODEL

Variable	Description
$(HD)_t$	Total demand for durable goods in year t
$(HHD)_t$	Column vector of sector purchases of durable goods in year t
$(PEP)_t$	Total projected population in year t
$(HN)_t$	Total demand for nundurable goods in year t
$(HHN)_t$	Column vector of sector purchases of nondurable goods in year t
$(HS)_t$	Total demand for services in year t
$(HHS)_t$	Column vector of sector purchases of services in year t
$(HHT)_t$	Column vector of total household expenditures in year t
$(XDC)_t$	Column vector of sector output at capacity level in year t
$(VN)_t$	Column vector of new plant and equipment investment in year t
$(XD)_t$	Column vector of sector output necessary to meet estimated final demand in year t
$(VR)_t$	Column vector of replacement investment by sector in year t
$(CK)_t$	Column vector of capital stock by sector at the beginning of year t
$(V)_t$	Column vector of total investment in year t
$(PCF)_t$	Column vector of composition of new investment in year t
$(CINV)_t$	Column vector of net inventory change in year t for sector j
$(FG)_t$	Column vector of federal government purchases in year t
$(FGT)_t$	Total federal government purchases in year t
$(SG)_t$	Column vector of state government purchases in year t
$(SGT)_t$	Total state government purchases in year t

Appendix Table I (Continued)

Variable	Description
$(PCE)_t$	Per capita local government expenditures by sector
$(GL)_t$	Column vector of local government purchases in year t
$(EX)_t$	Total net export demand by sector for year t
$(Z)_t$	Column vector of total final demand in year t
$(ER)_t$	Local employment requirements by sector in year t
$(EW)_t$	Wage and salary employment by sector in year t
$(EP)_t$	Proprietor employment by sector in year t
$(WS)_t$	Sector wage and salary payments in year t
$(YP)_t$	Sector proprietor income in year t
$(YT)_t$	Transfer payments in year t
$(YPT)_t$	Property income in year t
$(YO)_t$	Other labor payments in year t
$(YPI)_t$	Total personal income less contributions to social insurance
$(VA)_t$	Value added by sector in year t
$(GF1)_t$	Federal personal income tax
$(GS1)_t$	State personal income tax
$(YDI)_t$	Disposable personal income by sector in year t
$(TDI)_t$	Total disposable personal income in year t
$(ALFC)_t$	Available labor force in city in year t by age-sex cohorts
$(ALFSE)_t$	Available labor force in service area in year t by age-sex cohorts
$(PCITYP)_t$	Baseline population in city for year t
$(PSERVP)_t$	Baseline population in service area for year t
$(ALFCT)_t$	Total available labor force in city in year t

Appendix Table I (Continued

Variable	Description
$(ALFST)_t$	Total available labor force in service area in year t
$(ALFT)_t$	Total available labor force for city and service area combined.
$(ALFSC)_t$	Available labor force by economic sector in city for year t
$(ALFSS)_t$	Available labor force by economic sector in service area for year t
$(ALFS)_t$	Available labor force by economic sector for city and service area combined in year t
$(SUR)_t$	Surplus (deficit) of available labor force when compared to employment requirements by economic sector
$(SP)_t$	Surplus of available labor force as a percentage of total available labor force
$(AMIG)_t$	Net migration in year t
$(TLF)_t$	Total labor force by economic sector after net migration in year t
$(TLFT)_t$	Total labor force after net migration in year t
$(TLFCT)_t$	Total labor force after net migration allocated to the city
$(TLFST)_t$	Total labor force after net migration allocated to the service area
$(LFC)_t$	Total labor force by age-sex cohorts in year t for the city.
$(LFSE)_t$	Total labor force by age-sex cohorts in year t for service area
$(FPOPC)_t$	Population in city after net migration for year t
$(FPOPS)_t$	Population in service area after net migration for year t
$(BDYC)_t$	Annual bed days for year t by disease category for city population
$(PBD)_t$	Population in thousands for city in year t by cohort: less than 15, 15-44, 45-64, and 65 and over for males and females

Appendix Table I (Continued)

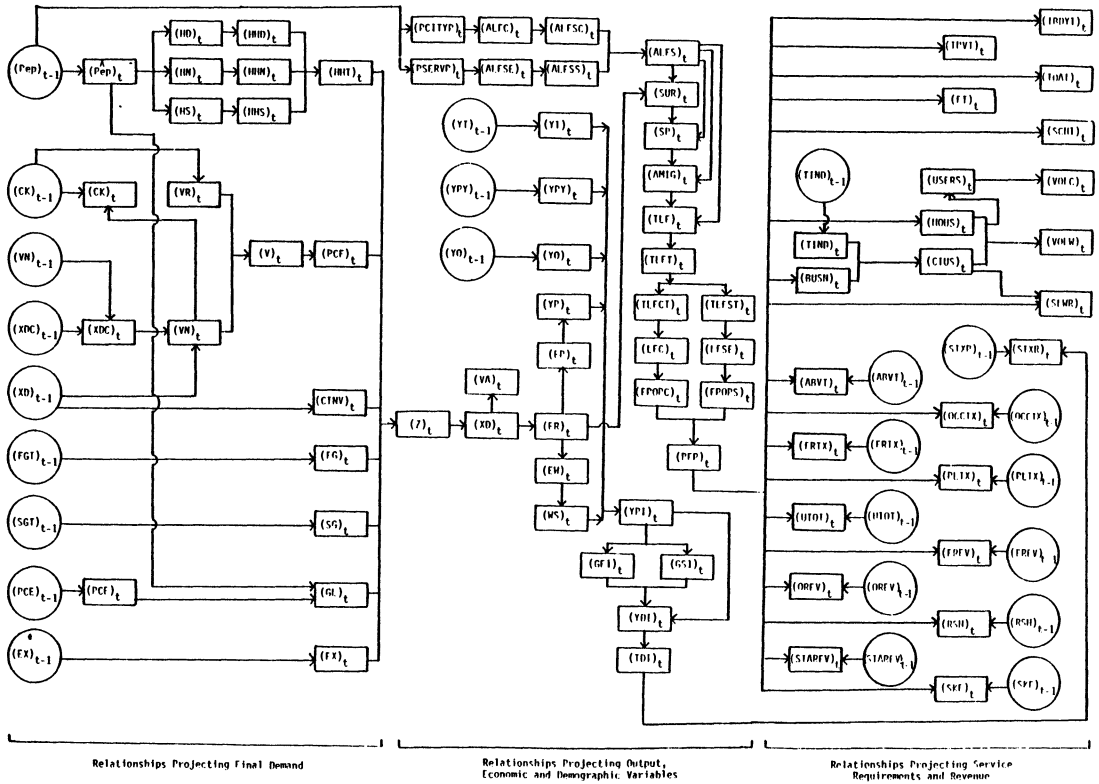
Variable	Description
$(TBDYC)_t$	Total bed days per year for city population
$(BDYS)_t$	Annual bed days for year t by disease category for service area population
$(PBD2)_t$	Population in thousands for service area in year t by cohort: less than 15, 15-44, 45-64, and over 65 for males and females.
$(TBDYT)_t$	Annual bed days for city and service area population combined in year t
$(PVC)_t$	Physician visits by age group for city population
$(PPV)_t$	Population for city in year t by cohort: less than 15, 15-44, 45-64, and 65 and over
$(TPVC)_t$	Total annual physician visits for city in year t
$(PVS)_t$	Physician visits by age group for service area population
$(PPV2)_t$	Population for city in year t by cohort: less that 15, 15-45, 45-64, and 65 and over
$(TPVS)_t$	Total annual physician visits for service area in year t
$(TPVT)_t$	Total annual physician visits for city and service area combined in year t
$(OAC)_t$	Other ambulance calls per year by age group for city
$(POA)_t$	Population in thousands for city by cohort: less than 20, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80 and over
$(TOAC)_t$	Total other ambulance calls for city in year t
$(OAS)_t$	Other ambulance calls per year by age group for service area
$(POA2)_t$	Population in thousands for service area by cohort: less than 20, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, and 80 and over
$(TOAS)_t$	Total other ambulance calls for service area in year t

Appendix Table I (Continued)

Variable	Description
$(TOAT)_t$	Total other ambulance calls for city and service area in year t
$(FC)_t$	Fires occurring in city in year t
$(FS)_t$	Fires occurring in service area in year t
$(CTOT)_t$	Total city population in year t
$(SATOT)_t$	Total service area population in year t
$(SCHC1)_t$	Number of male school age children by age cohort: less than 1, 2, . . ., 13, 14, in year t for city population
$(SCHC3)_t$	Number of male school age children by age cohort: 15, 16, 17, 18, 19, in year t for city population
$(SCHC2)_t$	Number of female school age children by age cohort, less than 1, 2, . . ., 13, 14, in year t for city population
$(SCHC4)_t$	Number of female school age children by age cohort: 15, 16, 17, 18, 19 in year t for city population
$(HOUS)_t$	Number of water user hookups in year t
$(BUSNT)_t$	Number of commercial business establishments in year t by establishment type
$(BUSN)_t$	Total number of commercial business establishments in year t
$(TIND)_t$	Total industrial establishments in year t
$(CIUS)_t$	Total commercial and industrial user hookups in year t
$(VOLW)_t$	Total annual volume of water consumed
$(VOLC)_t$	Total annual volume of solid waste collected per week for year t
$(STXR)_t$	Sales tax revenue for time period t
$(ABVT)_t$	Alcoholic beverage tax revenue for time period t
$(OCCTX)_t$	Occupation tax revenue for time period t
$(FRTX)_t$	Franchise tax revenue for time period t

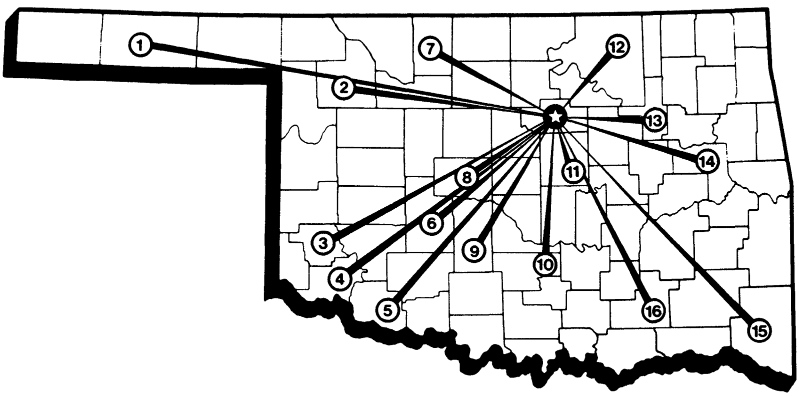
Appendix Table I (Continued)

Variable	Description
$(PLTX)_t$	Revenue from permits and licenses for time period t
$(UPO)_t$	Revenue from police service charges for time period t
$(UGB)_t$	Revenue from user charges for garbage service in time period t
$(UCE)_t$	Revenue from charges for cemetery in time period t
$(ULF)_t$	Revenue from user charges for landfill in time period t
$(OREV)_t$	Revenue from other revenue sources in time period t



Appendix Figure 1. Flow Chart of the Simulation Model for Rural Communities in Oklahoma

OKLAHOMA
AGRICULTURAL EXPERIMENT STATION
System Covers the State



Main Station—*Stillwater, Perkins and Lake Carl Blackwell*

1. **Panhandle Research Station — *Goodwell***
2. **Southern Great Plains Field Station — *Woodward***
3. **Sandyland Research Station — *Mangum***
4. **Irrigation Research Station — *Altus***
5. **Southwest Agronomy Research Station — *Tipton***
6. **Caddo Research Station — *Ft. Cobb***
7. **North Central Research Station — *Lahoma***
8. **Southwestern Livestock and Forage Research Station — *El Reno***
9. **South Central Research Station — *Chickasha***
10. **Agronomy Research Station — *Stratford***
11. **Pecan Research Station — *Sparks***
12. **Veterinary Research Station — *Pawhuska***
13. **Vegetable Research Station — *Bixby***
14. **Eastern Research Station — *Haskell***
15. **Kiamichi Field Station — *Idabel***
16. **Southeastern Oklahoma Agricultural Research and Extension Center — *Atoka***