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MINNESOTA ENERGY-ECONOMIC INFORMATION SYSTEM

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Emergence of energy resource planning and development as a critical concern of state government has lead to renewed interest in state economic systems modeling within the context of energy and economic impact forecasting. In Minnesota, inter-agency support is being sought for a unified impact forecasting system for government operations and planning. A first-stage effort in developing and implementing an extensive regional input-output modeling capability for state and local government impact analysis and forecasting is being completed.

The energy-economic impact forecasting system presented here is a modular approach to both economic modeling and information systems development. A set of eleven modules--market, investment, demand, production, (input-output), employment, value added, labor force, population, household, fiscal, and ecologic--provides the data base and programming routines for simulating the state (or a substate regional) economy. An additional set of government function modules, including energy and environmental management, provides an auxiliary data base and forecasts for state and local government agencies. This series of data modules and related computer programs, locally called SIMLAB, is organized as a readily accessible regional impact simulation s

The energy-economic forecasting component in SIMLAB makes use of a statewide data base and computer modeling capability but it is not part of the Minnesota Regional Energy Information System (REIS). SIMLAB depends on annual (and later some quarterly) data for energy-economic impact forecasting. The Minnesota REIS monitors actual energy network flows for a given region in the State. It does not provide energy-economic impact forecasts even when completed in 1977 (1). SIMLAB, thus, must complement the day-to-day and week-to-week energy network monitoring capability of REIS.

Related environmental and economic impact forecasts prepared by SIMLAB (or planned for SIMLAB when fully implemented) include water quality and quantity and,also, sanitary and hazardous waste disposal facility requirements of the Minneapolis-St. Paul Metropolitan Area; use of alternate transportation modes for shipment of Minnesota industry output of toxic materials (which may be shipped via the Great Lakes); industry production and household expenditure effects of a shutdown of four regional refineries (which are dependent on Canadian crude oil supplies); local fiscal and ecologic effects of industry expansion and related public facility construction; urban-regional infrastructure requirements of population redistribution and industry relocation; and personal and business income effects on Minnesota of national market and policy changes. The SIMLAB data output is available for use in special studies, such as the regional energy allocation priorities prepared by the Minnesota Energy Agency and the statewide revenue forecasts prepared by the Minnesota Department of Finance.

Future development of the SIMLAB forecasting system will be sensitive to the widely expressed concerns about the shortcomings of large-scale data systems (4). Instead of large-scale incomprehensibility, SIMLAB seeks easy access and quick response time for the information system user, use of state government data files for periodic update of system data base, user participation in computer simulation of alternative future scenarios for state or region, and periodic validation and evaluation of output data for relevance in public decision making. Management information systems concepts and procedures are being applied in the preparation and utilization of the data base and computer programs in SIMLAB.

System performance is judged, in part at least, by its usefulness as a demonstration model for improving both individual and public understanding of (1) the workings of a state or regional economy, and (2) the statewide and regional economic impacts of energy-related and other environmental and fiscal constraints on projected resource development. Forecasting accuracy is important, too, but it is only one of several considerations in SIMLAB development and decision application. Improving and updating the system data base from already available data files, for example, is a constant concern in SIMLAB management and operation. A series of user and operator manuals are being prepared, therefore, to achieve the desired continuity in system development.

The use of a common data base and computer models in special-purpose information systems is demonstrated in SIMLAB. Each of the special-purpose impact forecasts and studies cited earlier depends, in part, on proficient use of a regional or statewide input-output model. Rather than developing separate and distinct input-output tables for each study, a computerized two-region input-output model, which has been developed already for precisely these purposes, is used (2).

The two-region input-output model depends, first, on the U.S. input-output model and related data base. A corresponding data series is prepared for Minnesota (or a substate region). Minnesota (or a substate region) and the rest-of-the-U.S. thus make up a two-region input-output system.

Secondary, or non-survey, data are used almost entirely on the preparation of the input-output tables for Minnesota (we include, of course, so-called "primary" data from existing agency data files, e.g., state sales and income tax data, in this definition of secondary data). The use of non-survey data is predicated on the high cost of undertaking and processing industry and household surveys. The Minnesota two-region input-output model was built, therefore, to reduce time and cost requirements of detailed primary and secondary data preparation and to utilize information already gathered for U.S. and other large area input-output models. It helps, also, to identify and establish industry linkages between large and small area economies (by isolating individual inter-regional, inter-sectoral flow components) and to provide a balanced small-area input-output table by integrating the inter-regional, inter-sectoral flow components in the two-region table.

The two-region, interactive input-output model is introduced as one set of elements in the regional development simulation model. The entire series of models, data base, and related computer programs, including the input-output component, make up the simulation laboratory.

Two energy-related components are developed in SIMLAB--one for short-term impact analysis, the other for long-term development planning. The short-term analysis depends, in part, on a conventional inter-industry model and associated impact vectors in quantifying the effects of energy supply curtailment and location of new energy conversion-transmission facilities on the state's economy, population, and environment. An optimizing routine, as presented earlier by the authors, is added now to show possible changes in energy end-use pattern that minimize certain potential impacts of impending fuel supply curtailments (9).

The long-term component is based on a comprehensive and structured approach in deriving energy and infrastructure requirements for continued growth of the state's economy. The first stage links the state's economy with the U.S. economy on a sector basis and provides a first measure of energy requirements by end-use category. Both intermediate and final demand sectors are included among the end uses. A module on interfuel substitution, which is being prepared in the Minnesota Energy Agency, transforms the end-use requirements into primary fuel and electricity demands by major users (10). The environmental and infrastructure modules are used to evaluate and constrain the otherwise emerging pattern of energy use. Finally, a series of statewide or regional socio-economic and environmental indicators are derived for each year of the simulation period.

Use of SIMLAB to prepare scenarios of alternative energy futures for Minnesota and its substate planning and development districts is demonstrated by the simulation of statewide and regional energy and economic impacts of alternative market and policy assumptions. Statewide economic growth is critically constrained by the availability of, and access to, needed energy resources. Thus, imminent crude petroleum and natural gas cutbacks are related to the conversion of certain energy-using facilities to coal.

Both the short-term and long-term energy-economic impact forecasts can be prepared by the SIMLAB user. Alternative national market and policy projections and assumptions are introduced into the market and institutional modules to provide alternative bases for regional investment and final demand forecasts. The production, employment and related input-output type modules enter into the computational procedures for simulating specific industry or sectoral, as well as economy wide, impacts of the exogenous events introduced initially in SIMLAB. Both ecologic and fiscal impacts are derived subsequently for use in the assessment of their local environmental and governmental implications. Unique in the operation of SIMLAB is its accessability to the generalist and its adaptability to recalibration, retuning and updating for impact forecasting purposes.

MODULAR ORGANIZATION

Arrangement of the individual modules in SIMLAB into a recursively interactive economic impact forecasting system is illustrated schematically in figure 1. The central position of the input-output module is represented by the Production Module which converts nationally-linked market and investment input data into regional production-related output variables for later use in the energy and ecologic components of the total forecasting system.

Economic and Demographic Modules

The external market orientation of production in a particular region, like the State of Minnesota, is introduced immediately into the computational sequence. Investment, as well as the experienced resident labor force, serve as additional constraints on total regional production. The entire series of variables, coefficients and parameters, and multiple-variable equations in the core modules is summarized in a series of three tables, which are discussed briefly with reference to the nine-module core sequence in the computer simulation model.

Market Module

Projected gross output in the U.S., together with projected annual percentage change in industry gross output, the regional market share, and the percentage annual change in regional market share, provide the input data for projecting future regional industry exports (tables 1 and 2). This set of computer input data is used in a particular mathematical form to produce the given computer output variable (table 3).

Price data are represented as input parameters rather than input variables in the Market Module. External price relationships enter directly in the derivation of year-to-year consumption changes (see equations 33 and 34 in table 3). End-use energy price changes thus enter into the derivation of projected changes in energy. Only the induced production effects of energy price changes are derived. A similar data base is needed for the intermediate demand sectors to derive the direct production effects of energy input price changes.

Use of variable prices in the Market Module requires a recomputation of the distribution of intersectoral purchases each year. This step in the computational procedures is excluded in the accompanying tables.

Investment Module

The Investment Module includes one set of critical capacity constraints on the production system. These constraints relate to production itself and the conditions for remuneratively productive activity. Thus, traditionally, the critical investment has been output-increasing (or cost-reducing). Recently, however, investment in pollution abatement facilities and practices has become important, along with investment in regional infrastructure (i.e., water supply, wastewater treatment, transportation and other basic community facilities).

Part of output-increasing (or cost-reducing) investment is simply replacement of existing capital stock, i.e., buildings, equipment and technology. This investment depends, at least partly, on the rate of facility obsolescence and depreciation and, thus, the rate of accumulation of depreciation allowances is one measure of facility replacement.

For output expansion, additional investment is necessary. Demand-related increases in industry output may be restricted by lack of expansion investment.

The gap between industry output demanded, XD, and industry output supplied, XO, is viewed as a key indicator of expansion investment requirements. A positive output gap (i.e., $XD - XO > 0$) denotes a positive investment gap. Additional expansion investment is required to reduce the gap.

Pollution abatement investment is entered explicitly because of its increasing importance in determining future production. In the private sector, new processes are being installed for reducing liquid and gaseous waste emissions. (In the public sector, as part of regional infrastructure, new sanitary and hazardous waste disposal facilities are being established). Recycling practices, which are being instituted to economically utilize solid wastes (or even to establish a solid waste recovery industry for converting wastes into new energy sources), also incur additional investment requirements for regional industry output.

Both replacement and expansionary investment is required in pollution abatement. Again, a positive industry gap (where the output supplied is restricted, in this case, by environmental standards) correlates with a positive investment gap (in this case, pollution abatement investment). Additional investment in pollution abatement facilities and equipment relaxes the environmental constraints on production.

Investment in regional infrastructure includes all other investment, primarily public, which is a prerequisite for a viable regional economy. In SIMLAB, investment in energy and transportation systems is required to relax the two critical regional infrastructure constraints on industry output and population growth. In addition to the criterion of a positive investment gap defined earlier, a time lag in the build-up of construction workforce and material supplies is introduced into the sumulation process.

Demand Module

Current and capital components of the final demand sector are identified for the regional household and government sectors. Residential, industrial, commercial and public construction, as well as consumer and producer equipment purchases are included in final purchases, except for exports (and imports). Differentiation of industry output into current and capital accounts is needed in the two-region input-output model to obtain a data base for a corresponding differentiation among final purchases in the given region.

Current final purchases are affected by current price and income levels. Price and income elasticity coefficients are used with specified changes in price and income levels to obtain current final purchases.

Capital final purchases are based on the Investment Module output variables, and related Demand Module input parameters. For the business sector, the investment limit coefficient (INVLIM), which is a prescribed level of the ratio of business income to capital stock, is the pivotal private investment criterion. Gross private capital formation occurs when business income is equal to or greater than the level determined by the prescribed investment limit coefficient.

Public capital outlays similarly are determined by corresponding data outputs of the Fiscal Module (presented later in this paper). Public capital outlays are dependent on public revenues and bonding capacities, which involve certain trade-offs and, hence, politically-sensitive decisions within the public sector.

Production Module

Industry gross output and interindustry sales and purchases for the given region are derived from secondary sources. The two-region input-output model is used to perform the base-year allocation of U.S. industry gross output. Subsequent year-to-year shifts in the U.S. industry allocation are expressed by changes in the market share coefficient for each export industry.

New technical coefficient and interdependency coefficient matrices are derived each year to forecast demand-induced gross output changes for the following year. Thus, the gross output patterns are modified by input substitution and relative output price changes.

Employment Module

Labor input requirements of production, by occupational category, are specified in the Employment Module. Output per worker is matched with projected industry output demand (i.e., XD), in the derivation of total labor input requirements. Projected increases in output per worker thus reduce the labor requirements of a given level of industry gross output.

Each industry requires a certain distribution of labor skills which is represented by nine occupational categories. Lack of needed occupational skills in the resident labor force imposes another critical constraint on regional production. In-commuting, in-migration and occupational mobility help reduce a positive employment gap; they relax the employment constraint on production.

Value Added Module

Business and household income sectors are part of the Value Added Module. An indirect tax sector is included, also, which thus adds this form of government income to total production outlays.

Household income is represented by employee compensation in the form of wage and salary payments and proprietorial income. (Property income is added in later modules.) Employee compensation per worker is related to output per worker. Changes in output per worker bear a certain relationship to change in employee compensation per worker. The occupational distribution of industry employment is a primary factor in accounting for industry differences in employee compensation.

Business income is a residual entry once both indirect taxes and depreciation allowances are deducted from the initial allocation of value added to business income. The residual business income is roughly equivalent to gross business profits. The level of business profit relative to total assets is a measure of the output expansion potential of the industry.

Labor Force Module

Employment relates to population in the Labor Force Module. Participation of the resident population in the resident labor force depends on local employment opportunities, and, also, its age and sex composition. The percentage of the total population in each age group which participates in the labor force is being modified significantly because of increasing employment of women. Labor force participation is changing because of occupational and geographic mobility. Both sources of change are included in the computer simulations. Finally, the level of unemployment is included as a factor affecting labor force participation.

The level of in- and out-commuting is a critical variable in the Labor Force Module. It determines the immediate adjustment of (1) the resident labor force to external employment opportunity and (2) the resident production system to external labor supply.

Population Module

The simple demographic model of starting population, plus births and in-migration, and minus deaths and out-migration, is used to derive the Population Module output data. The migration component of this module, together with the commuting component of the Labor Force Module, are the two critical determinants of an employment gap. The migration process yields a final population adjustment to a supply-demand imbalance in the resident employment structure.

Household Module

The distribution of personal income is presented, finally, in the Household Module. An income distribution is obtained for each occupational category of the employed labor force and, also, for the unemployed labor force. The income distribution of the labor force is translated into an income distribution of (1) total population and (2) total households. To obtain total personal income, therefore, property income is added to the employee compensation derived for the occupational categories.

Personal consumption expenditures and personal income taxes are derived for household sector, by income class. Personal savings are shown, finally, as a residual entry in the household income account.

Fiscal, Ecologic and Institutional Modules

Two additional modules--Fiscal and Ecologic--are included in the expanded version of the current computer simulation program to interface the nine core modules and the energy, transportation and other institutional (primarily governmental) modules. In the Fiscal Module, local and state government revenues and expenditures are introduced into the economic impact forecasting system. In the Ecologic Module, the waste emissions of each production and consumption sector are estimated and projected. The two modules thus introduce detailed quantification of certain processes and activities which, except for recent studies by Isard (3) and Miernyk (7), have been neglected in regional economic impact forecasting.

The government/institutional modules include functional areas identified earlier in the government expenditure categories of the Fiscal Module. They relate local and state government programs to core module inputs and outputs. Thus, the core modules provide the "intervening" variables which transform an initial fiscal impact into subsequent changes in economic and demographic performance variables.

SHORT-TERM IMPACT FORECASTING

A 35-sector input-output model of the Minnesota economy has been prepared to forecast short-term impacts of industry growth and energy resource reallocation (9). Illustrated, first, are the output employment multipliers for the 35 industry groups (table 4). The data are used in forecasting economic and environmental impacts of supply curtailment and facility location.

Supply Curtailment

A drastic decline in one or more of the principal energy sources is imminent in the next three to five years. In 1972, estimated fuel use in Minnesota among the 35 industry groups was 775,000 trillion BTU, of which natural gas, residual oil, and distillate oil accounted for 70 percent of total.

The 35-sector input-output model is used in its traditional role in energy impact forecasting in the derivation of direct and indirect effects of the petroleum refinery shut-down in a recent study on the environmental-economic impacts of Canadian crude oil curtailment (6). Shut-down of the four regional oil refineries, which are almost wholly dependent on Canadian crude oil shipments, would result in a direct loss of 900 jobs and $14 million in reduced payroll. The total (direct and indirect) effects would result in a loss of 4,500 jobs, $47 million in payroll, and over $400 million in total sales (in 1972 dollars). The total effects would be even lower, of course, if the local supply sources are not replaced by other supply sources which provide the same product at the same price as it would occur without the refinery shutdown.

An alternative optimizing procedure (in which efficiency prices are derived by minimizing resource use) is available to derive the industry-wide effects of energy price increases (9). For example, prices of Minnesota petroleum products were projected to increase 50 percent in 1975 if the price of crude oil were increased 27 percent by federal import policy. The projected overall price change, which includes simultaneous increases in prices of all other inputs, shows a Minnesota-wide inflation of 0.8 percent (as the result of an initial 27 percent increase in crude oil price).

Facility Location

Short-term impact forecasting is used also in public facility location. First, however, implementation of the fiscal and ecologic modules is essential. In addition, a high degree of place specificity is required.

The Minnesota Land Management Information System (MLMIS) provides a high degree of place specificity in its computerized land use data base for facility impact analysis (8). A 40-acre plot in the statewide data base is assigned a particular land use classification; related data from local sources are recorded, also, on a 40-acre scale. Thus, detailed mapping of the geographic distribution of particular substate fiscal and ecologic variables in SIMLAB is feasible. A research proposal was prepared recently to seek external funding for the extension of a related gaming-simulation approach to sanitary and hazardous waste disposal facility location in Minnesota.

LONG-TERM IMPACT PROJECTION

The SIMLAB program is uniquely suited for long-term impact projection. A recently completed data base study for Northeast Minnesota and Douglas County, Wisconsin (designated as the Head-of-the-Lake, or HOTL, Region) illustrates a series of roles for a regional development simulation laboratory in the planning applications of a user-oriented, computer-interactive decision information system (5). Surveys of both capital expenditure and energy utilization were undertaken which supplemented secondary data sources used in projecting future industry investment and export expansion.

Energy-Economic Assumptions and Projections

First, alternate economic scenarios for the HOTL Region are presented in the demonstration study for the target-year 1980. The alternate scenarios are based on currently available national economic projections and given relationships between the U.S. and the HOTL Region economies. Projected levels of energy utilization and capital expenditures are compared with the expected levels based on the business surveys cited earlier. Both an energy requirements and a capital requirements gap are identified in these comparisons.

National Economic Projections

Growth of the U.S. economy is manifested by expanding requirements for the industry output originating in the HOTL Region. For the 1970 - 80 period, all but two industry groups are projected to expand in total market requirements (Table 5). Projected annual change in national market requirements (in column 6) vary greatly by industry because of differences in both intermediate and final demand requirements. Thus, given the regional share of a particular industry market (in column 7), the national growth is translated into proportional regional growth. However, the regional share of each industry is likely to vary from its 1970 level (as indicated in column 8).

Labor productivity is important, also, in accounting for regional economic growth. Output per worker levels are projected to increase substantially over the 1970 - 80 period (as shown in columns 3, 4, and 5). The projected levels again are based on U.S. employment and output projections prepared by the U.S. Bureau of Labor Statistics for its economic growth studies. The projected U.S. productivity rate, i.e., the projected annual change in output per worker, has been revised slightly downward for use in the demonstration study (as shown in column 6).

When the annual growth in demand for regional industry output lags behind the annual growth in regional industry employment, a decline occurs in total industry employment. Thus, the interaction between market growth and productivity has important consequences for the Region. SIMLAB of course provides for this interaction and makes possible a systematic appraisal of both market and productivity (i.e., technological and labor-reducing investment) impacts upon industry output and employment.

Alternative Future Scenario

Two alternative futures have been simulated for use in the study. The simulated baseline alternative corresponds with the baseline 1980 projection based solely on the regional input-output model. Because of differences in the derivation of the two baseline projections, the simulated baseline is identified as Baseline Projection II. Historical rates of change are incorporated into both regional baseline projection series.

The simulated growth alternative incorporates current perceptions about investment, output and employment levels in the remainder of the 1970 decade. Two sets of changes are introduced. First, increasing levels of industry investment in the HOTL Region triggered an expansion of the construction industry. In the alternative growth projection, export-related construction activity was increased 300 percent.

At the same time, closure of part of the primary metal industry in in the Region reduced employment by 40 percent. This plant shut-down and employment cutback is represented by the alternate employment projection for 1972.

In addition, the rate of change in the regional market share for the construction industry was increased substantially from practically zero-growth to an annual rate of 2.6 percent. Because of a large projected increase in output per worker, however, total employment in the construction industry declined slightly by 1974.

A second stage of market changes was instituted in 1974. First, the annual change in the regional market share of the iron mining industry was increased by 50 percent (to 10.9 percent). During this period, output per worker increased 4 percent annually, which again worked counter to the market expansion by reducing total employment requirements nearly 30 percent for the given 1974 level of industry output. Labor productivity gains thus will significantly temper the total employment impacts of the large projected capacity expansion in the iron mining industry.

Finally, the regional share and the annual change in regional share for the construction industry were increased again to account for increased construction activity in iron mining industry. Thus, for the 1975-80 period, the projected market share was increased 100 percent and the projected change in market share was increased 300 percent.

<u>Projected Industry Output and Employment</u>

In both projection series--Baseline II and Growth II--total industry output in 1980 is substantially larger than in 1970. For some industries, output is projected to double or nearly double; e.g., iron mining, construction, and services.

Employment shows markedly different patterns of change from output. In the baseline projection, total employment grows by seven percent while in several industries employment declines; for example, agriculture, construction and manufacturing.

In the growth projection, the total employment change is more than twice the baseline projection. Agriculture employment again is projected to decline but substantial increases are projected, not only in mining and construction, but also in the service industries. Growth in the economic base thus triggers a "ripple" effect through the output multiplier which is felt subsequently throughout the regional economy and, especially, in its service industries.

Projected Population and Expenditures

Expanding industry output and employment has immediate impacts on population, income and expenditures. New jobs open for those qualified, including persons residing outside the region. By in-migration the existing population profile of the region is modified. Generally, in-migration results in a younger population and labor force (while out-migration increases the average age).

Associated with the expanded levels of industry and population activity are a host of related events and indicators--births, deaths, migration, personal consumption expenditures, personal income per capita, and employment (table 6). For the study region, the high level of construction activity is a major factor in accounting for the reduced levels of unemployment. By the same token, short-term cutbacks in construction add immediately to unemployment levels.

Projected Investment and Energy Utilization

Industry expansion is a function of investment. Most industry is involved in investment to maintain and to expand production. In the current simulation, however, the two types of investment are not differentiated, nor is the total level of investment, in terms of production capacity and its utilization, included in the data base. Rather, the increase in gross output is related directly to the equivalent facilities and related capital stock required for production. In short, existing capacity is viewed as being fully utilized, which, of course, is the case for only a few industries, such as iron mining in 1974.

Projected output levels for 1974 and 1980 provide the base-year and target-year comparisons with the survey findings on capital expenditures cited earlier (Table 7). Except for iron mining, pulp and paper products manufacturing, and electric utilities, projected capital requirements for the 1975 - 80 period greatly exceed anticipated capital expenditures. Most businesses are unlikely to expand facilities until warrented by a sustained high level of market demand. Expected increases in capital outlays in several basic industries are sufficiently large, however, to severely tax existing facilities as a result of the expansion in construction and related population. Especially vulnerable are the energy-producing and distributing facilities as well as public facilities, such as schools and hospitals.

Projected Energy Requirements

The regional economic data base and computer simulation model are used, finally, in deriving estimates and projections of industry energy requirements. Only intermediate (not final) demand requirements are specified.

The Baseline I projection series (which involves 10-year rather than a one-year simulation period) shows substantial increases in energy requirements, given 1970 energy use patterns. The Baseline II and Growth II projection series show slightly different growth patterns in energy requirements because of the one-year simulation period and the year-to-year interaction of large-scale development within the regional economy. The 50-percent expansion in total energy requirements shown in the high level projection series simply illustrates the critical importance of energy supplies to the expansion of the resource-based industries.

Importance of Energy Constraint

Future curtailment of natural gas and petroleum supplies would reduce industry output substantially below projected 1980 levels. Specific industry impacts would depend on the energy allocation plans in effect at the time of the energy shortages. Application of alternative energy allocation criteria, e.g., minimum unemployment vs. maximum gross production, would result, of course, in widely different impacts.

The preceding demonstration of the input-output system for regional simulation and projection is intended to show the potential uses of the models and data series developed in this study for energy impact analysis. Impact of alternative energy allocation plans are determined for each industry and for the entire region with the computer simulation and related capabilities. These determinations are the particular concern of the current phase of the HOTL Region study; they will be presented in subsequent reports under the current study program.

Differences in the two sets of projections pertain to energy sources (with gasoline being excluded from the Baseline I projections) and industry coverage (with selected industry estimates being based on the energy utilization survey). The selected industry survey represents actual energy utilization for the 1972 and 1973 calender years. The survey data are primary rather than secondary and they are based on actual records of energy purchases of the major energy-using establishments in the region.

Both computational procedures and data sources thus provide for differences in regional economic projections. Because of the critical nature of energy constraints in regional economic development, these differences must be reconciled in the preparation of both the projection methodology and the projection data base.

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Figure 1. MINNESOTA ECONOMIC IMPACT FORECASTING SYSTEM

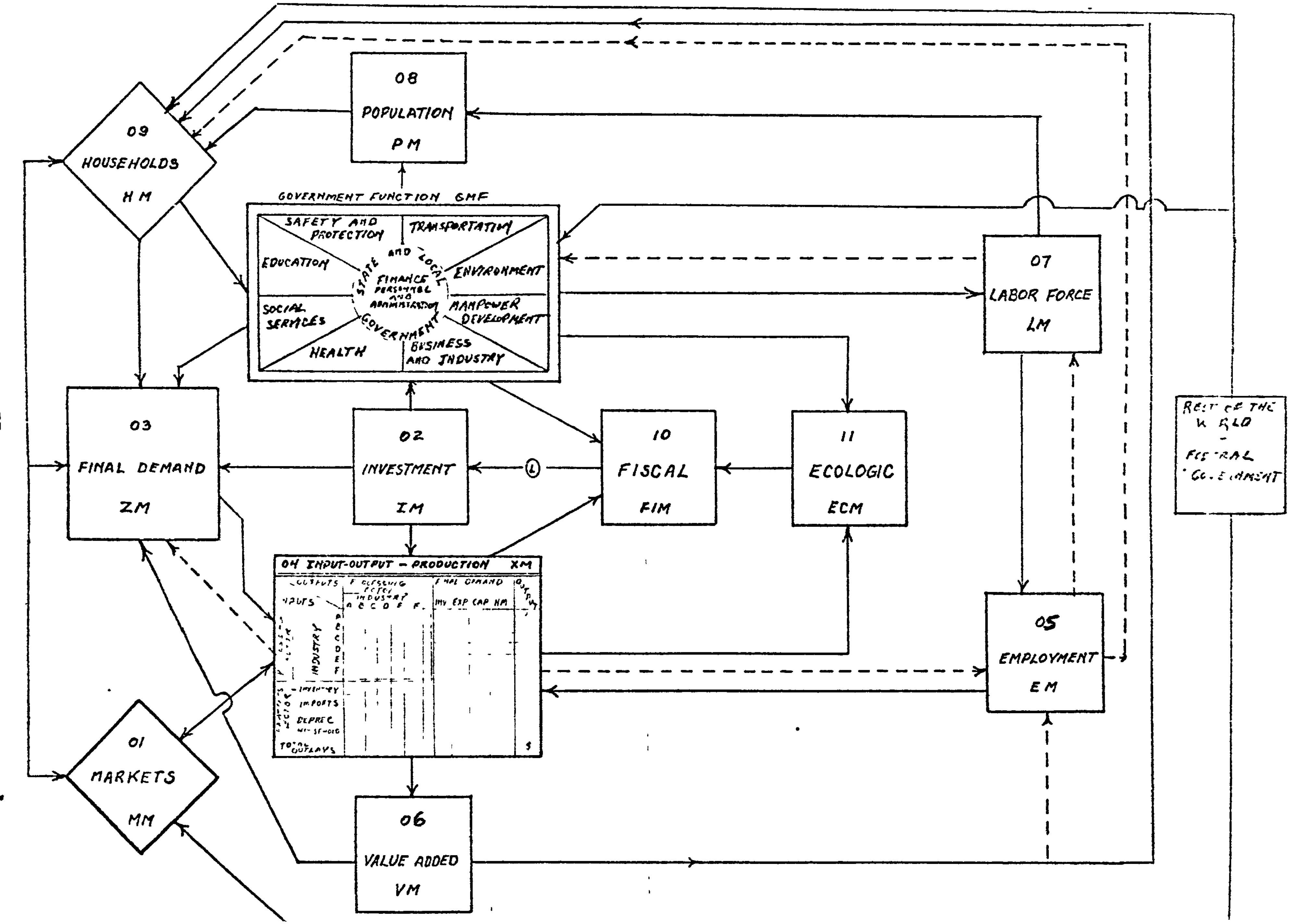

Table 1 Selected variables in SIMLAB core modules

Module and Variable No	Symbol	Name of Variable
Market (rest-of-nation)		
11	USGO	Industry gross output
12	EXPORT	Regional industry export
Investment (region)		
21	RINVOI	Replacement investment output increasing
22	EINVOI	Expansion investment, output increasing
23	EINVPA	Expansion investment, pollution abatement
24	OICAP	Output-increasing capital
25	PACAP	Pollution abatement capital
Demand (region)		
31	BINCH	Business inventory change
32	GPCFO	Gross private capital formation
33	PCECU	Personal consumption expenditure, current expenditure
34	PCECA	Personal consumption expenditure, capital expenditure
35	LGECU	Local government expenditure, current expenditure
36	LGECA	Local governement expenditure, capital expenditure
37	SGECU	State government expenditure, current expenditure
38	SGECA	State government expenditure, capital expenditure
39	FGETO	Federal government expenditure, total expenditure
Production (region)		
41	FD	Final demand
42	X	Gross output (realized)
43	XD	Gross output (demand limit)
44	XO	Gross output (output-increasing capacity limit)
45	XP	Gross output (pollution abatement capacity limit)
46	XE	Gross output (employment limit)
Employment (region)		
51	EMPLOY	Employment, by industry and occupation
Value added (region)		
61	EMPCOM	Employee compensation, by industry
62	INDTAX	Indirect taxes, by industry
63	CADEOI	Capital depreciation, output-increasing
64	CADEPA	Capital depreciation, pollution abatement
65	BUSINC	Business income (retained earnings, dividends and direct taxes)
66	IMPORT	Regional imports
Labor force (region)		
71	TOTLBF	Total labor force, by occupation
72	UNEMLF	Unemployed labor force, by occupation
73	INCOEM	In-commuting employment, by occupation
74	OUTCEM	Out-commuting employment, by occupation
75	RESIEM	Resident employment, by occupation
Population (region)		
81	POPUL	Total population, by age and sex
82	BIRTH	Total births, by sex
83	DEATH	Total deaths, by age and sex
84	INMIG	Total in-migration, by age and sex
85	OUMIG	Total out-migration, by age and sex
Households (region)		
91	HOUSEH	Total households, by income class
92	PERINC	Total personal income, by income class
93	PERTAX	Total personal income tax, by income class
94	SINTAX	Total personal taxes, by income class
95	PERSAV	Total personal savings, by income class

Table 2 Selected coefficients and parameters in SIMLAB core modules

Module and Relationship

No	Symbol	Name of Coefficient or Parameter
Market (rest-of-nation)		
11	GROWTHR	Annual percentage change in U S industry gross output
12	REGMKS	Regional industry market share rates
13	REGMKSR	Annual percentage change in regional industry market share
14	PCHOWN	Annual percentage change in own-price, by industry output
15	PCHCRS	Annual percentage change in cross-price, by industry output
Investment (region)		
21	CAPOUT	Output-increasing capital-output ratio
22	CAPPOL	Pollution-abatement capital output ratio
23	REPDEP	Output-increasing replacement investment-depreciation ratio
24	POLDEP	Pollution abatement replacement investment-depreciation ratio
25	BINOUT	Business inventory-output ratio
26	INVLIM	Total (output-incr and pol abat) investment limit coefficient
Demand (region)		
31	BINCHC	Business inventory-output change coefficient
32	PCHCOR	Annual percentage change in total capital-output ratio
33	PERINE	Personal income elasticity coefficient
34	OWNPRE	Own-price elasticity coefficient
35	CRSPRE	Cross-price elasticity coefficient
36	SLGIEC	State and local government income elasticity coefficient
37	PCHFGE	Annual percentage change in fed gov exp coefficients
Production (region)		
41	INPOUT	Input-output (technical) coefficient matrix
42.	CAPOUC	Capital-output coefficient (output-increasing) matrix
43.	CAPOUP	Capital-output coefficient (pollution abatement) matrix
44	LEMATR	Leontief (inverse) matrix
Employment (region)		
51	OUTPWK	Output per worker ratio, by industry
52	PCHOPW	Annual percentage change in output per worker
53	OCCUPM	Industry-occupation matrix
54	PCHOCC	Annual percentage change in industry-occupation profile
55	EARPWK	Earnings per worker by occupation
56	PCHEAR	Annual percentage change in per worker earnings, by occupation
Value added (region)		
61	EMCOMR	Employee compensation rate, by industry
62	PCHECR	Annual percentage change in employee compensation rate
63	INTAXR	Indirect tax rate, by industry
64	PCHITR	Annual percentage change in indirect tax rate
65	DEPROI	Capital depreciation rate, output-increasing, by industry
66	DEPRPA	Capital depreciation rate, pollution abatement, by industry
67	PCHCDR	Annual percentage change in capital depreciation rate
68	BUSINR	Business income residual, by industry
69	REGIMP	Regional import rate, by industry
Labor force (region)		
71	LFPAR	Labor force participate rate, by age and sex
72	PCHLF	Annual percentage change in labor force participation rate
73	OAGEM	Occupation-age matrix
74	PCHOA	Annual percentage change in occupation-age profile
75	COMPC	Commuting propensity coefficient
76	MIGPC	Migration propensity coefficient
77	UNEMPR	Regional unemployment rate
Population (region)		
81	MIGRAF	Migration factor, by occupation
82	FERTLR	Fertility rate, by age
83	DEATHR	Death rate, by age and sex
84	TFERTR	Total fertility rate
Household (region)		
91	TLBFDIN	Total labor force distribution, by income class and occupation
92	TINHIN	Total income distribution, by labor force status and income class
93	TLFHIN	Labor force per household, by occupation status and income class
94	TCUHIN	Consumer units per household, by occupation status and income class
95	TPINDIN	Total personal income distribution, by income class and occupation
96	PCHLBF	Annual percentage change in total labor force distribution
97	PCHINC	Annual percentage change in total personal income distribution
98	PITAXR	Total personal income tax rate, by income class
99	INTAXR	Total indirect tax rate (on pers cons exp)

Table 3 Selected Equations in SIMLAB core modules

Module and Variable

No	Symbol	Explanatory Variables and Related Coefficients
Market (rest-of-nation)		
11	USGO (t+1)	(1 + GROWTHR) * USGO (t)
12	REGMKS (t+1)	(1 + RZGMKSR) * REGMKS (t)
13	EXPORT (t+1)	REGMKS (t+1) x USGO (t+1)
Investment if BUSINC ≥ INVLIM (region)		
21	RINNOI (t+1)	DERROI (t)
22	EINVOI (t+1)	(XD (t) - XO (t)) * CAPOUT
23	RINVPA (t+1)	CADEPA (t)
24	EINVPA (t+1)	(XD (t) - XP (t))/CAPPOL
25	OICAP (t+1)	OICAP (t) + RINVOI (t+1) + EINVOI (t+1) - CADEOI (t+1)
26	PACAP (t+1)	PACAP (t) + RINVPA (t+1) + EINVPA (t+1) - CADEPA (t+1)
Demand (region)		
31	BINCH (t+1)	BINCHC * (X (t) - X (t-1))
32	GPCFO (t+1)	RINVOI (t+1) + EINVOI (t+1) + RINVPA (t+1) + EINVPA (t+1)
33	PCECU (t+1)	(1 + PERINE * PCHIPC + OWNPRE * PCHOWN + CRSPRE * PCHCRS) * PCECU(t)
34	PCECA (t+1)	(1 + PERINE * PCHIPC + OWNPRE * PCHOWN + CRSPRE * PCHCRS) * PCECA(t)
35	LGECU (t+1)	(1 + SLGIEC * PCHIPC) * LGECU (t)
36	LGECA (t+1)	(1 + SLGIEC * PCHIPC) * LGECA (t)
37	SGECU (t+1)	(1 + SLGIEC * PCHIPC) * SGECU (t)
38	SGECA (t+1)	(1 + SLGIEC * PCHIPC) * SGECU (t)
29	FGETO (t+1)	(1 + PCHFGE) * FGETO (t)
Production (region)		
41	FD (t+1)	(BINCH (t+1) + GPCFO (t+1) + PCECU (t+1) + PCECA (t+1) + PCECU (t+1) + LGECA (t+1) + SGECU (t+1) + SGECA (t+1) + FGETO (t+1)
42	X (t+1)	MIN (XD (t+1), XO (t+1), XP (t+1), XE (t+1))
43	XD (t+1)	LLMATR (t) * FD (t+1)
44	XO (t+1)	OICAP (t+1)/CAPOUT
45	XP (t+1)	PACAP (t+1)/CAPPOL
46	XE (t+1)	EMPLOY (t+1) * OUTPWK (t+1)
Employment (region)		
51	EMPLOY (t+1)	X (t+1)/OUTPWK (t+1)
52	OUTPWK (t+1)	(1 + OUTPWR) * OUTPWK (t)
53	EARPWK (t+1)	(1 + PCHEAR) * EARPWK (t)
Value added (region)		
61	EMPCOM (t+1)	EARPWK (t+1) * (OCCUPM (t+1) * EMPLOY (t+1))
62	INCOMR (t+1)	EMPCOM (t+1)/EMPLOY (t+1)
63	INDTAX (t+1)	INTAXR (t+1) * OUTPUT (t+1)
64	INTAXR (t+1)	(1 + PCHITR) * INTAXR (t)
65	CADEOI (t+1)	DEPROI (t+1) * OICAP (t+1)
66	CADEPA (t+1)	DEPRPA (t+1) * PACAP (t+1)
67a	DEPROI (t+1)	(1 + PCHCDR) * DEPROI (t)
67b	DEPRPA (t+1)	(1 + PCHCDR) * DEPRPA (t)
68	IMPORT (t+1)	REGIMP (t+1) * OUTPUT (t+1)
69	BUSINC (t+1)	X (t+1) - EMPCOM (t+1) - INDTAX (t+1) - CADEOI (t+1) - CADETA (t+1) - IMPORT (t+1)
Labor force (region)		
71	TOTLBF (t+1)	LFRAR (t+1) * POPUL (t+1)
72	LFPAR (t+1)	(1 + PCHLF) * LFPAR (t)
73	UNEMLF (t+1)	OAGEM (t+1) * TOTLBF (t+1) - OCCUPM (t+1) * EMPLOY (t+1)
74	INCOFM (t+1)	COMPC * OCCUPM (t+1) * (EMPLOY (t+1) - REISEM (t+1))
75	OUTCOEM (t+1)	COMPC * OCCUPM (t+1) * (REISEM (t+1) - EMPLOY (t+1))
76	RESIEM (t+1)	OCCUPM (t+1) * EMPLOY (t+1) - OAGEM (t+1) * (INCOEM (t+1) + OUTCOEM (t+1))
Population (region)		
81	POPULT (t+1)	POPUL (t) + BIRTH (t+1) - DEATH (t+1) + INMIG (t+1) - OUMIG (t+1)
82	BIRTH (t+1)	BIRTHR * FERTILR (t+1) * POPUL (FEMALE)
83	DEATH (t+1)	DEATHR * POPUL (t) (t)
84	INMIG (t+1)	MIN (003 * EMPLOY (t+1), EMPLOYD (t) - EMPLOYS (t))
85	OUMIG (t+1)	MIN (003 * EMPLOY (t+1), EMPLOYS (t) - EMPLOYD (t))
Household (region)		
91	HOUSEH (t+1)	TOTLBF (t+1) * TLBFDIN * PCHLBF/TLFHIN
92	PERINC (t+1)	TOTLBF (t+1) * TINHIN * PCHINC
93	PERTAX (t+1)	PERINC (t+1) * PERTXR
94	SINTAX (t+1)	(PCECU (t+1) + PCECA (t+1)) INTAXR
95	PERSAV (t+1)	PERINC (t+1) - PERTAX (t+1) - SINTAX (t+1) - PCECA (t+1)-PCECU (t+1)

Table 4. Demand, employment and income multipliers, by specified industry groups, Minnesota, 1972.

Industry group	Multipliers (direct and indirect effects) Demand (dollar)	Employment (number)	Income (dollar)
Agriculture			
1. Livestock	2.253	4.990	6.234
2. Crops	1.553	1.226	3.823
3. Other Agric.	1.553	1.330	1.315
Mining			
4. Iron, Ferro	1.432	1.683	1.752
5. Non-ferrous	1.362	1.390	1.348
6. Other, quarry.	1.370	1.250	1.220
7. Construction	1.523	2.049	1.555
Manufacturing			
8. Food & kindred	2.299	5.042	2.678
9. Lumber, Furn	1.591	1.720	1.655
10. Pulp & paper	1.844	2.181	2.040
11. Print. & publ.	1.759	1.550	1.536
12. Chemical, etc.	1.635	2.305	1.129
13. Petrol. refin.	1.367	3.663	2.331
14. Stone, clay, gl.	1.480	1.574	1.642
15. Primary metal	1.384	1.417	1.337
16. Fabric. metal	1.420	1.479	1.432
17. Machinery	1.582	1.733	1.647
18. Electrical	1.559	1.637	1.526
19. Other mfg.	1.630	1.561	1.451
Transportation; Commun.			
20. Railroad	1.431	1.250	1.208
21. Trucking	1.300	1.141	1.221
22. Other trans	1.434	1.503	1.320
23. Communication	1.189	1.206	1.137
Utilities			
24. Electric	1.498	2.701	1.938
25. Gas	1.675	2.099	1.842
26. Other	2.140	7.329	2.784
Trade; Finance			
27. Wholesale	1.311	1.192	1.232
28. Retail	1.253	1.074	1.220
29. Fin., ins., real est.	1.360	1.864	1.612
Services			
30. Hotels, pers.	1.425	1.242	1.410
31. Business serv	1.605	1.321	1.789
32. Medical, educ.	1.340	1.164	1.173
33. Other serv.	1.251	1.185	1.215
34. Fed. Govt. Ent.	1.416	1.348	1.147
35. State-Loc. ent.	1.550	1.159	1.603

Source: "A 1972 Structural Model of the Minnesota Economy Towards a Policy-Oriented Tool", E.C. Venegas, W.R. Maki, and J.E. Carter, Minnesota Energy Agency, Research Division, April 1975.

Table 5. Output per worker, annual change in output per worker, annual change in national market, regional share, and annual change in regional share, Head-of-the-Lake Region, 1970-1980.

Industry group	Output per worker 1970 (dol.)	Output per worker 1972 (dol.)	Output per worker 1974 (dol.)	Output per worker 1980 (dol.)	Annual change in output per worker (units)	Annual change in national market[1/] (units)	Reg. share of national market[1/] (units)	Annual change in reg. shar (units)
1 LIVESTOCK	22122.	24483.	27095.	36727.	.052	.02116	0	0
2 CROPS	16388.	18171.	20148.	27467.	.053	.00534	0	0
3 OTHER AGRI	29078.	30134.	31229.	34757.	.018	-.04039	.03547	-.00791
4 IRON, FERR	48532.	52492.	56776.	71839.	.040	.03724	5.91390	.07275
5 NON-FERROU	18826.	19973.	21193.	25301.	.030	-.14474	0	0
6 OTHER QUAR	18338.	18818.	19310.	20966.	.013	.04341	0	0
7 CONSTRUCTI	36329.	38317.	40414.	47420.	.027	.00949	.00018	.00052
8 FOOD AND K	78125.	83044.	88272.	106017.	.031	.02741	.00106	.01075
9 LUMBER, FU	33031.	35315.	37758.	46145.	.034	.03895	.00280	.01330
10 PULP AND P	33843.	36113.	38536.	46824.	.033	.03363	.03645	.02460
11 PRINT AND	17785.	19089.	20488.	25331.	.036	.05033	0	0
12 CHEMICAL,	20882.	22979.	25286.	33692.	.049	.07260	0	0
13 PETROL. RE	323732.	189265.	211857.	297137.	.058	.05062	.00048	.01666
14 STONE. CLA	18129.	18935.	19778.	22536.	.022	.04689	0	0
15 PRIMARY ME	31834.	34299.	36956.	46224.	.038	.10069	.01468	.02884
16 FABRIC, ME	22090.	23254.	24479.	28554.	.026	.06113	0	0
17 MACHINERY	27790.	30231.	32897.	42338.	.043	.06648	0	0
18 ELECTRICAL	51176.	55992.	61262.	80239.	.046	.06112	0	0
19 OTHER MANU	21437.	23320.	25369.	32659.	.043	.03911	0	0
20 RAILROAD	14213.	15432.	16755.	21447.	.042	.03873	.00732	.01623
21 TRUCKING	5783.	6005.	6235.	6981.	.019	.03182	0	0
22 OTHER TRAN	60442.	64747.	69359.	85259.	.035	.06799	.00185	.01940
23 COMMUNICAT	22375.	24810.	27509.	37501.	.053	.09074	0	0
24 ELECTRIC U	79891.	86576.	93821.	119400.	.041	.07122	.00315	.01711
25 GAS UTILIT	83475.	87188.	91067.	103768.	.022	.04107	0	0
26 OTHER UTIL	111388.	113852.	116371.	124265.	.011	.02846	.00055	-.03211
27 WHOLESALE	10255.	11371.	12608.	17188.	.053	.0556	0	0
28 RETAIL	5222.	5562.	5923.	7155.	.032	.04455	0	0
29 F.I.R.E.	40604.	42410.	44297.	50475.	.022	.04768	0	0
30 HOTELS, PE	9809.	10346.	10912.	12804.	.027	.02470	0	0
31 BUSINESS S	9489.	9911.	10352.	11796.	.022	.04555	0	0
32 MEDICAL,	8332.	8857.	9414.	11307.	.031	.05048	0	0
33 OTHER SERV	26853.	1674.	1738.	1946.	.019	.02004	0	0
34 FED. GOVT.	3329.	3573.	3835.	4741.	.036	.05038	.00032	.03065
35 STATE-LOCA	6711.	7203.	7731.	9558.	.036	.03423	0	0

1/ National market share is U.S. final demand, which is changed in later simulation runs to U.S. gross output.

Table 6. Baseline and growth projections of selected economic indicators, Head-of-the-Lake Region, 1970 - 1980.

Year	Population: Births	Population: Deaths	Population: Migration	Population: Total	Personal Consumption Expenditure[1]	Personal Income Per Capita[1]	Labor Force	Employment	Unemploy: Total	Unemploy: Rate
	(no.)	(no.)	(no.)	(no.)	($100)	($)	(100)	(100)	(no.)	(pct.)
Baseline Projection II:										
1970	5699	5100	X	3747	7222	3290	1306	1210	9173	7.02
1971	5015	4173	-130	3754	7615	3422	1392	1275	12491	8.97
PCT.	-12.00	-18.18		.19	5.44	4.01	6.58	5.37		
1972	5255	6218	-17	3744	7918	3561	1394	1280	10236	7.77
PCT.	4.79	49.01		-.27	3.98	4.06	.14	.39		
1973	5510	6048	-139	3737	8245	3707	1396	1286	10827	7.75
PCT.	4.85	-2.73		-.19	4.13	4.10	.14	.47		
1974	5770	5922	-139	3734	8594	3857	1400	1292	10886	7.77
PCT.	4.72	-2.08		-.08	4.23	4.05	.29	.47		
1975	6047	5803	-140	3735	8965	4011	1404	1300	10861	7.73
PCT.	4.80	-2.01		.03	4.32	3.99	.29	.62		
1976	6302	5718	-140	3739	9356	4169	1410	1308	10949	7.77
PCT.	4.22	-1.46		.11	4.36	3.94	.43	.62		
1977	6546	5615	-69	3747	9769	4330	1415	1317	10836	7.66
PCT.	[illegible]	-1.80		.21	4.41	3.86	.35	.69		
1978	6733	5534	606	3767	10223	4490	1424	1328	10665	7.49
PCT.	2.86	-1.44		.53	4.65	3.70	.64	.84		
1979	6923	5457	981	3793	10697	4647	1433	1339	10506	7.33
PCT.	2.82	-1.39		.69	4.64	3.50	.63	.83		
1980	7096	5358	1344	3827	11193	4802	1443	1350	10360	7.18
PCT.	2.50	-1.81		.90	4.64	3.34	.70	.82		
Growth Projection II:										
1972	5253	6205	-16	3734	7912	3645	1392	1290	9673	6.95
PCT.	4.75	18.96		-.27	4.17	6.33	.14	1.26		
1973	5508	6035	-139	3727	8399	3820	1395	1308	9573	6.86
PCT.	4.85	-2.74		-.19	6.16	4.80	.22	1.40		
1974	5768	5910	2046	3751	8881	3967	1409	1324	9565	6.79
PCT.	4.72	-2.07		.64	5.74	3.85	1.00	1.22		
1975	6107	5820	2222	3781	9314	4288	1425	1367	6865	4.82
PCT.	5.88	-1.52		.80	4.88	8.09	1.14	3.25		
1976	6437	5767	2636	3819	10004	4491	1444	1401	5363	3.71
PCT.	5.40	-.91		1.01	7.41	4.73	1.33	2.49		
1977	6777	5702	4026	3879	10666	4667	1469	1431	4905	3.34
PCT.	5.28	-1.13		1.57	6.62	3.92	1.73	2.14		
1978	7098	5676	5153	3957	11325	4823	1502	1459	5362	3.57
PCT.	4.74	-.46		2.01	6.18	3.34	2.25	1.96		
1979	7438	5662	4638	4031	11943	4977	1532	1483	5966	3.89
PCT.	4.79	-.25		1.87	5.46	3.19	2.00	1.64		
1980	7743	5617	3814	4099	12555	5142	1557	1505	6266	4.02
PCT.	4.10	-.79		1.69	5.12	3.32	1.63	1.48		

[1] In constant 1970 dollars.

Table 7. Projected increases in gross output, capital expenditures and employment in selected industries, Head-of-the-Lake Region, 1975-1980. 1/

Sector No.	Title	Gross Output	Capital Expenditures 2/	Employment
		(thou. dol.)	(thou. dol.)	(no.)
1.	Livestock	13343	14669	-129
2.	Crops	6962	8702	-67
3.	Other agriculture	2028	1602	-5
4.	Mining: ferrous	351476	527179	2635
5.	Non-ferrous	972	1652	24
6.	Quarrying	1198	1411	45
7.	Construction	125770	35379	1902
	Manufacturing:			
8.	Food and kindred	76649	33894	158
9.	Lumber, furn.	25019	10398	153
10.	Pulp, paper	43173	33697	1
11.	Printing, publ.	12968	8300	252
12.	Chemical	1817	1520	4
13.	Petro. refining	21300	17040	-13
14.	Stone, clay, glass	4027	2879	129
15.	Primary metal	49490	31139	495
16.	Fabr. metal	8784	3848	177
17.	Machinery, exc. elect.	9042	4180	25
18.	Electrical machinery	4375	1316	-10
19.	Other manufacturing	16696	5698	22
	Regulated industries:			
20.	Railroad	17356	56407	-67
21.	Trucking	2205	771	202
22.	Other transportation	40504	56199	197
23.	Communications	12579	28293	6
24.	Electric utilities	34267	181615	66
25.	Gas utilities	6071	14873	37
26.	Other utilities	2717	4510	18
	Trade and service:			
27.	Wholesale	29020	31899	50
28.	Retail	57113	62778	3819
29.	Finance, ins., real estate	94697	18200	1270
30.	Hotels, personal	26077	36507	1378
31.	Business, repair	8843	4244	488
32.	Medical, educ.	57274	100229	2935
33.	Other services	6838	14650	1242
34.	Federal gov't. enter.	5762	3/	443
35.	State-local enter.	6117	3/	208
	TOTALS	1182529	1355878	18090

1/ Based on Growth Projection II

2/ Based on Battelle Memorial Institute Research Report, "on Ex Ante Capital Matrix for the United States, 1970-75", March 31, 1971.

3/ Data not available

APPENDIX: INTRODUCTION TO SIMLAB

To further illustrate the study findings, the Minnesota Regional Resource Development Simulation Laboratory (SIMLAB) is introduced briefly as a demonstration model for regional economic impact forecasting. Computer simulations presented in this report are derived from SIMLAB. Hence, the brief introduction serves the purpose of providing background for both the findings in this report and the current study program on regional energy and environmental impact analysis.

Objectives, Assumptions and Design

SIMLAB provides a computer-interactive procedure for modifying a series of baseline projections and assumptions about a regional economic system. SIMLAB I (which is used for this report) is the first stage in the development of a regional analysis tool for planners, for determining the relative importances of factors affecting regional economic and demographic growth.

SIMLAB permits the user to alter historical economic and demographic data by changing nine parameters that are basic to the growth of a given area, thus allowing the user to analyze their impacts on population, labor force requirements, migration, commuting and economic growth.

General objectives of SIMLAB are to:

1. Explore ways in which population, employment, labor force, income and regional economic activity generally can be better understood within a development planning framework.

2. Study the regional implications of changes in the population of an area as a result of births, deaths, and migration.

3. Analyze the effects of employment (and unemployment) changes on migration and commuting for a region.

4. Understand the development planning implications of alternative assumptions that are made about economic development of a region.

5. Explore the influence of external forces (e.g., national growth and industry mix) on regional economic and demographic variables (e.g., export demand and migration).

Relationships typically are specified in linear form in SIMLAB. Present year estimates are based on past year estimates. If trends from the previous year indicate out-migration, growth in personal consumption expenditures or out-commuting, the present year calculations will reflect these trends. These trends, however, are subject to constraints imposed on certain variables, or parameters for a specified period

Data processing in SIMLAB is serial or recursive. Equations are not simultaneous, but are calculated through a step-process method. The model is deterministic, and its dynamics derive from the recursive equations system.

Base parameters are estimated from cross-sectional data. Economic data, though collected on a cross-sectional basis, are related to estimates based on time-series data.

Structure of SIMLAB does not alter during the simulation period. New sectors or constraints are not created or destroyed, and the functional relationships change proportionately

Parameters (in SIMLAB) can be altered by user are:

1. Migration factor: Total number of persons that would migrate to or from an area per worker

2. U.S. growth rate: Annual rate of change in U S. final demand for output at a national level.

3. Regional market share: The percentage of exports for each producing sector in relation to U.S. final demand.

4. Rate of change in regional market share: Annual rate of change in area market share by I-O sectors, reflecting demand for exports.

5. Personal consumption expenditure (PCE): Industry distribution of consumer purchases from local producing sectors.

6. Labor force participation rate: The rate of participation by male and female in the labor force by cohorts

7. Fertility factor: The number of children born per female.

8. Death rate: Rate of death of male and female members of the population by age specific.

9. Range of unemployment rate: Percentage range with an upper and lower bound for migration.

Operational Use of SIMLAB

Use of the demonstration SIMLAB program requires preparation of the following limited list of input data:

1. Population: male, female by age cohort.
2. Birthrate, by age, and total fertility rate.
3. Death rate, by age and sex.
4. Migration probability, by sex and age.
5. Based year commuting pattern.
6. Labor force participation rate.
7. Output per worker.
8. Rate of change in output per worker.
9. Regional market share.
10. Rate of change in regional market share.
11. U.S. Growth rate (final demand).
12. Rate of change in U.D. growth rate.
13. Output/employment elasticities, by input-output sector, for personal consumption expenditures.

After deriving initial data, the user then reads it into SIMLAB. A user manual is available which provides the format sequence in which data is typed into the program (fig. 2).

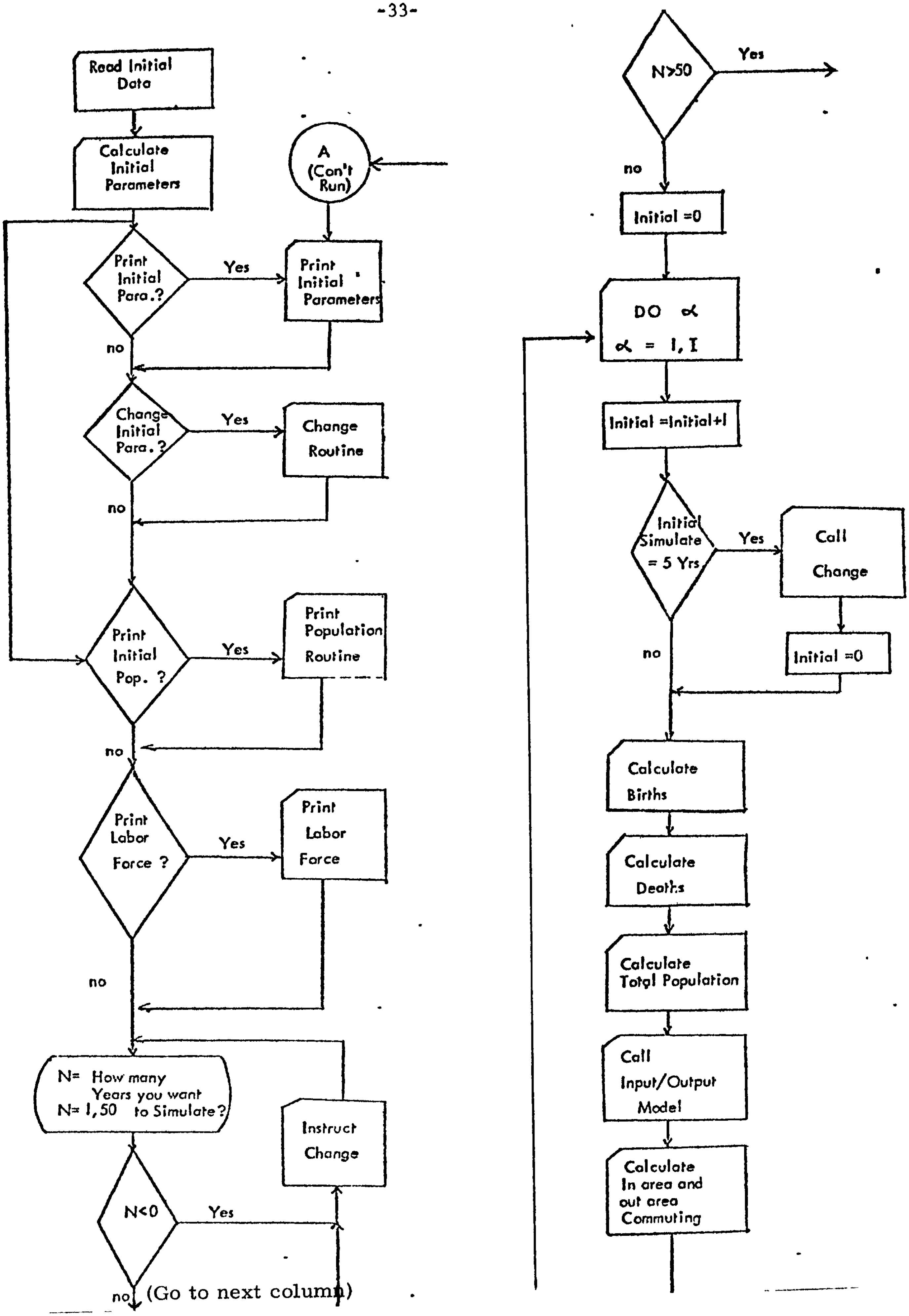

Fig. 2. Partial program flow chart for SIMLAB