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ALTERNATE FORECAST METHODS FOR
WATER AND LAND RESOURCES PLANNING IN MINNESOTA

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CONTENTS

ACKNOWLEDGEMENTS

This report is the fourth in the series on economic forecasts and forecast methods. The focus of this research is on development of a regional forecasting system for water and related land use planning in Minnesota. Funding for the research was provided by the Minnesota Energy Agency.

ABSTRACT

Alternate regional economic forecasting approaches were reviewed, including deomgraphic, geographic, gravity/potential, location quotient, economic base, input-output, shift-and-share, and econometric. The current status of regional forecasting systems in state government was reviewed, also.

SUMMARY AND CONCLUSIONS

Forecast methods for water and related land resources planning range from simple trend models to large complex input-output and econometric models of complete regional economic systems. Nine forecast methods were reviewed for this report. They were used in the preparation of four types of forecasts. The nine methods are demographic, geographic, gravity/potential, location quotient, economic base, input-output, shift-and-share, econometric and a combination of methods. The four types of forecasts include employment, income, population and composites of socio-economic indicators.

Three forecast methods -- location quotient, economic base and shift-and-share -- were identified as especially appropriate for state and substate planning. In this study, the three methods were viewed as elements of a single comprehensive modeling approach for water and land resources planning.

The combined modeling approach builds on the shift-and-share model given by the form,

$$emp_i^n = (1+r_i)^n \; emp_i,$$

or,

$$emp_i^n = (1+ A + B_i + C_i)^n \; emp_i,$$

where, for example, the forecast employment in the i-th industry, emp_i^n, is equal to the current employment, emp_i, times an employment multiplier $(1+r_i)$, with r_i being the rate of change in current year employment. The rate of change coefficient, in turn, is the sum of the three shift-and-share coefficients -- the national-growth coefficient, A, the industry-mix coefficient, B_i, and the regional-share coefficient, C_i. A special emphasis of this study was the regional-share coefficient and its decomposition into a number of economically significant relationships needed in forecasting regional growth and change.

The current status of regional economic forecasting systems in state government was reviewed, also. Altogether 77 published reports were examined for information on forecast methods in current forecast systems. The more widely used forecast systems were based on the input-output and econometric approaches.

ALTERNATIVE FORECAST METHODS FOR
WATER AND LAND RESOURCES PLANNING IN MINNESOTA [1/]

Wilbur R. Maki [2/]

Forecast methods for water and related land resources planning vary with forecast user and forecast provider. Most forecast users in water and related land resources planning depend on the 1972 OBERS projections for the U.S. Water Resources Council (196).[3/] The OBERS projections are derived from a regionalized U.S. forecasting model which yields a 33-industry breakdown of the total earnings of the employed work force in 1967 dollars.

Several geographical groupings -- the water resources subarea, the metropolitan-centered economic area, the Standard Metropolitan Statistical Area (SMSA), and the State -- are used in presenting the 1972 OBERS projections. While the individual county in the United States is the primary reporting unit for the data base in the forecasting system, the forecasts are compiled into multi-county groups, except for the single-county SMSA, for reporting purposes. Thus, use of the OBERS projections is limited to individual water resources subareas, economic areas or states unless a county database is available for regrouping counties into other multi-county planning units.

1/ This is the fourth in a series of reports on regional forecasting, the first being the Interim Report on Forecast Methods prepared for the Minnesota Energy Agency, October 1978. Two of the earlier reports were published in the Department of Agricultural and Applied Economics Staff Paper Series. These two reports are cited on page 6.

2/ The author gratefully acknowledges the interest and encouragement of E.C. Venegas, Manager, Forecasting Division, Minnesota Energy Agency.

3/ Literature cited is listed alphabetically on page 40.

Besides total earnings, the 1972 OBERS projections include total employment, total population and total personal income. An industry breakdown of total employment is not available. In a related study, the OBERS total earnings series was used in deriving a 25-industry breakdown of a total employed work force series for each statistical reporting unit. A modified shift-and-share method was used, also, in the preparation of county-level forecast series from the 1972 OBERS projections.[4/]

Study Objective

The study objective (for the phase of study reported here) is contained in the introductory statement, namely, review of the different forecast methods used in water and related land resources planning. The purpose of this revies is to provide a current status report on regional economic forecasting methodology.

This status report is intended to serve both the forecase user and the forecast provider. The literature review is summarized for the user by a topical listing of the type of forecasts. It is summarized for the provider by a topical listing of forecast methods. A total of 205 articles, books and other publications, which are listed under Literature Cited, have been reviewed for this report.

Study Approach

The approach used in the literature review is, first, to categorize the relevant reports under various topical headings and, then, to assess

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4/ Findings of the related study are reported in: Wilbur R. Maki, Regional Economic Forecasts for Water and Land Resources Planning in Minnesota, Staff Paper Series, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, MN, 1979.

the significance of each report in the building of a regional economic forecasting system. Four types of forecasts are identified, manely, employment, income, population, and composite forecast (of employment, income, population and other socio-economic indicators). Nine forecast methods -- demographic, geographic, gravity/potential, location quotient, economic base, input-output, shift-and-share, econometric and other -- are identified in the preparation of the four types of forecasts.

A total of 77 published reports were reviewed for information on current status of existing regional forecasting systems. The forecasting systems are identified by author and location, and by forecast method. In addition, a brief review of a regional economic impact forecasting and simulation system recently developed at the University of Minnesota is presented in the final chapter of this report.[5/]

5/ See: Wilbur R. Maki, Patrick D. Meagher, Leonard A. Laulainen, Jr., and Mason Chen, Users' Guide to Minnesota Regional Development Simulation Laboratory, Staff Paper Series P79-28, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, 1979.

TYPE OF FORECASTS

The 205 articles, books and other publications listed in this report are arranged topically by type of forecast and forecasting method. Four types of forecasts are identified -- employment, income, population and a composite forecast (of one or more of the three principal types of forecasts). Each type of forecast relates to a particular provider-user interest group. The composite forecast, which is related to the concerns of each provider-user interest group, is not necessarily the unanimously preferred type of forecast. The composite forecast typically is less accurate, but covers a wider range of economic activity than the special-purpose forecast. Examples of each type of forecast are cited in this report and the list of references is summarized under the four types of forecasts in Table 2.1.

Employment

The forecasting of industry employment is a widely used approach to the forecasting of spatial-economic growth and change. Two types of employment series are used -- one based on persons employed, the other based on jobs. Typically, the number of jobs reported exceeds the number of employed persons reported by 10 percent or more as a result of some employed persons having more than one job, e.g., newspaper delivery. Thus, the reported number of persons employed may exceed the reported jobs in some industries.

Employed persons are associated with households and, hence, are reported by place of residence. Jobs, on the other hand, are reported by place of work. For a single county, therefore, the number of employed persons may differ greatly from the number of jobs because of in-commuting and out-commuting.

able 2. 1. Listing of selected publications on employment, income, and population forecasts and forecasting methods.

Type of Forecast	Forecasts	Forecasting Methods
Employment	80, 168	2, 3, 6, 7, 9, 13, 15, 19, 21, 23, 33, 34, 35, 36, 37, 42, 43, 46, 52, 55, 56, 57, 58, 60, 63, 64, 72, 76, 80, 84, 85, 88, 90, 92, 98, 99, 101, 106, 111, 117, 121, 128, 129, 133, 135, 137, 138, 139, 140, 145, 168, 180, 184, 187, 190, 191, 192, 195, 197, 205
Income	3, 71, 102, 155, 156, 196	4, 9, 12, 16, 17, 18, 22, 26, 27, 29, 38, 39, 45, 47, 48, 49, 50, 51, 53, 54, 61, 62, 70, 71, 73, 74, 75, 78, 81, 82, 83, 86, 89, 93, 102, 104, 105, 108, 112, 114, 118, 119, 122, 123, 124, 130, 131, 132, 144, 153, 154, 155, 156, 160, 172, 176, 188, 189, 196, 201, 202, 203, 204
Population	165	5, 8, 10, 30, 40, 41, 59, 69, 77, 79, 84, 91, 94, 107, 109, 110, 113, 134, 136, 141, 142, 143, 146, 148, 150, 151, 152, 157, 161, 162, 163, 165, 166, 167, 172, 174, 175, 177, 178, 181, 182, 185, 189, 200
Composite	11, 14, 106, 193, 194, 198, 199	1, 11, 14, 20, 24, 25, 28, 31, 32, 44, 47, 65, 66, 67, 68 85, 86, 87, 96, 97, 101, 103, 115, 116, 125, 126, 127, 140, 143, 147, 149, 158, 159, 164, 169, 170, 171, 179, 183, 186, 193, 194, 198, 199

The number of industry groups for which employment changes are forecast differ between the two employment series. The U.S. Census of Population reports the number of persons employed in a minimum of 36 corresponding industry groups, including military, for the four Census years from 1940 to 1970.[6/] Jobs, on the other hand, are reported for a smaller number of industry groups at the county level because of disclosure rules, which apply to establishments rather than households.[7/]

Income

Income statistics are available on the same basis as employment statistics, i.e., by place of work (earnings) and place of residence (personal income). Local and regional income series are related to national income, most frequently, gross national product. Thus, the local or regional economy is linked to the national economy via the income variable and the more-or-less stable relationship between the income series.

For most regions, income per person is approaching the national average. Year-to-year fluctuations in income differ among regions, however, because of idfferences in industry mix. These differences account, in large part, for regional differences in total earnings.[8/]

6/ U.S. Department of Commerce, Bureau of Economic Analysis, Regional Employment by Industry, 1940-1970, U.S. Government Printing Office, Washington, D.C., 1975.

7/ Wilbur R. Maki, Gregory H. Michaels, Leonard A. Laulainen, Jr., and Mason Chen, Employment Trends and Projections for Minnesota and Its Substate Development Regions, Bulletin 531, Minnesota Agricultural Experiment Station, University of Minnesota, St. Paul, 1979.

8/ See, for example, Wilbur R. Maki, Income Trends and Projections for Minnesota and Substate Development Regions, Staff Paper Series P79-9, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, 1979.

Regional differences occur, also, in industry earnings per worker. These differences are related to intra-industry organization and structure, particularly with level of unionization. Differences in the level of capital utilization and size of establishment also occur, which account for differences in productivity per worker -- an additional source of income disparity between regions.

Population

Population, because of its importance in accounting for the level of labor force and employment in a region, is the third category of forecasts reviewed in this report. For the most part, population forecasts are based on the demographic identity, i,e., population change is equal to natural increases, plus or minus net migration. Of the two, migration presents most difficulty in forecasting.

Population forecasts typically are prepared by age and sex class to forecast total labor force and total employment. Labor force participation rates are derived for each age and sex class from historical population series. These rates show increases in female labor force participation for most age groups. At the same time, male labor force participation rates are declining, in those age groups 65 years and older. When coupled with a changing age distribution of population, the projected labor force participation rates thus yield forecasts of total labor forces.

Regional differences in total labor force occur because of differences in both labor force participation rates and the age distribution of the total population. A rapidly growing small area, for example, has a younger labor force, while a less rapidly growing large area has an older labor force.

Composite

Composite forecasts include inter-related income, employment and population series of forecasts. Regional differences in personal income and earnings account for regional differences in migration and, thus, population and employment change. Regional differences in the rates of population change, in turn, account for regional differences in unemployment and personal income levels and, in later years, higher or lower rates of migration and growth in total employment and income. Preparation of the composite forecast requires a more complete data base and forecasting method than in the preparation of the special-purpose forecasts.

The Minnesota regional development simulation laboratory, known locally by its acronym, SIMLAB, produces a wide range of forecasts, including employment, income and population. These forecasts are available for the State of Minnesota and several substate regions, including West Minnesota and Northeast Minnesota.[9/]

9/ The Minnesota reports, which are not listed in the literature review, include the following:

Patrick D. Meagher, Wilbur R. Maki and Leonard A. Laulainen, Jr., Economic Effects of Minnesota Peatland Development, Staff Paper Series P79-3, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, 1979.

Patrick D. Meagher and Wilbur R. Maki, Population Effects of Copper-Nickel Development in Northeast Minnesota, Staff Paper Series P79-13, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, 1979.

Wilbur R. Maki, Patrick D. Meagher and Leonard A. Laulainen, Jr., Economic Effects of Copper-Nickel Development in Northeast Minnesota, Staff Paper Series P79-26, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, 1979.

ALTERNATE FORECAST METHODS

Each of the special-purpose forecasts, whether income, employment or population, requires some sort of a mathematical model that is implemented by means of a data base and a computational procedure. Differences among these models are identified in the listing of the four types of forecasts by their forecasting method. A total of nine forecasting methods are presented in a regrouping of the 205 references (Table 3.1).

Three of the nine forecasting methods -- location quotient, economic base, and shift-and-share -- are used in building a composite approach to economic forecasting for water and land resources planning, which is presented in a companion publication. The three methods are presented in a separate chapter. In this chapter, the larger group of six forecast methods -- demographic, geographic, gravity/potential, input-output, econometric and other (a mix of forecast methods) -- is discussed. The six methods are generally more complex in concept and practice than the three discussed later.

Demographic

The demographic method is listed first because of its recurring use in the preparation of population forecasts.[10/] In recent years, this method has been linked with the input-output and econometric methods in the preparation of population and employment forecast series (see, A, 157, 169, 171, 181, 182, 183, 185).

10/ In the demographic approach, two types of analysis are involved -- period analysis and generation analysis. Period analysis is the study of population changes, e.g., age=specific death and birth rates, in a given period. Generation, or cohort, analysis involves the study of one cohort, e.g., females, 20 to 24 years of age, over time. This is a mainly temporal viewpoint of population change, which leads to migration models, for example, those based on Markovian processes (A, 79, 94, 113, 165, 166, and 174).

Table 3.1 Listing of selected publications on employment, income and population forecasting methods, by type of forecast.

Forecasting Method	Employment	Income	Population	Composite
1. Demographic			8, 59, 79, 94, 107, 109, 110, 113, 141 142, 148, 152, 162, 165, 166, 174, 200,	
2. Geographic			41, 76, 150, 151	
3. Gravity/ Potential		8, 144, 153	30, 134, 172	
4. Location Quotient	2, 15, 21, 37, 63, 88, 90, 98, 101, 106, 117, 129, 135, 140, 145, 190, 191, 192, 197	18, 70, 74, 118, 122, 188		
5. Economic Base	3, 19	26, 27, 53, 104, 105, 139, 176, 189, 204		
6. Input-Output	46, 111, 133	9, 12, 16, 17, 29, 38, 39, 46, 48, 50, 61, 62, 75, 78, 82, 83, 89, 93, 108, 112, 124, 130, 131, 132, 154, 160, 201, 202	181, 182	28, 65, 80, 126, 169, 170, 171, 180, 183, 193, 194
7. Shift-and-Share	6, 7, 23, 33, 42, 51, 55, 56, 58 64, 80, 84, 92, 137, 138, 180, 184, 187, 195, 205	45, 49, 54, 81, 114, 139, 173, 196		24, 25, 31
8. Econometric	9, 13, 35, 52, 64, 85, 99, 121	4, 102, 119, 155, 156	157, 185	1, 11, 14, 20, 32, 66, 67, 68, 96, 97, 100, 103, 115, 116, 120, 147, 149, 158, 159, 164, 179, 198, 199
9. Other	34, 36, 43, 57, 60, 72 128	22, 71, 73, 123	5, 10, 40, 69, 77, 91, 136, 142, 146, 161, 163, 175, 177, 178	44, 47, 64, 87, 109, 125, 127

The fundamental demographic identity is given by the form,

$$\Delta P_{t+1} = P_t + NI_t + MIG_t \ , \qquad (3.1)$$

where, P_i = total population, beginning of t-th year

P_{t+1} = total population, end of t-th year

NI_t = natural increase during t-th year

MIG_i = net migration during t-th year

This identity is used as an overall framework for the preparation of the demographic accounts. These accounts vary in detail and complexity depending upon the amount of disaggregation of age classes, by sex, and the inclusiveness of the social and economic factors contributing to changes in the levels of national increase and migration. Special studies dealing with births, deaths and migration are related to the building of the demographic accounts.

Geographic

In the geographic approach to socio-economic forecasting, the effects of income, employment and population changes on (1) the spatial distribution of population and (2) the flows and movements between regions are studied.[11/] The study of socio-economic changes in the populations of different regions during a given time period, which geographers call spatial-differentiation analysis, makes use of demographic approaches (e.g., reference to a standard population profile for area-to-area comparisons). The study of flows and movements of income, employment and population from one region to another during a given time period, i.e., spatial-

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11/ Synthesis of demographic and geographic approaches in the study of population and related economic changes is proposed by Courgean (41). Distance variables are introduced in the spatial-differentiation and spatial interaction analyses, along with other variables, to account for migration patterns in a multi-region population system (A, 77, 110).

interaction analysis, makes use of non-demographic approaches in the context of a more general systems analysis. The spatial-interaction analysis is used in the study of geographic traffic patterns, especially commodity and information flows.

The geographic approach also builds on a system of social and economic accounts (A, 181, 182, 183, 184). Rees and Wilson developed a set of accounts and models to forecast 16 different kinds of demographic flows for a two region system in England. Results for both aggregate and age/sex disaggregated population are presented in these studies (A, 150, 151, 152, 204).

Gravity/Potential

Gravity and potential models are widely used in socio-economic forecasting, especially in migration, transportation and lcoation studies (A, 20, 86, 87, 134, 144, 153). Model construction is based on a probailistic point of view. The probability of migration from one region to another region, for example, is dependent on the population of the two regions and the intervening distance. Using the concept of gravitational force from physics, a corresponding concept of demographic force has been developed to explain the probabilistic relationship between migration, population and distance.[12/] The related concept of demographic potential is analogous, finally, to the concept of gravitational potential (A, 30, 36).

12/ Measurement of the two key variables in gravity and potential models, namely, mass (i.e., population) and distance presents numerous difficulties. Mass is better represented by variables other than population(e.g., employment or income) in some studies while the distance relationships is not necessarily linear nor confined simply to physical values (i.e., miles or kilometers). By introducing additional explaatory variables and multiple regression analysis the usefulness of this class of models in population studies has been extended.

Input-Output

The input-output method is the best known approach in the estimation of regional multipliers. In this approach, a high-degree of industry disaggregation and interindustry interdependence is acknowledged in the model design and implementation. Both direct and indirect estimation techniques are used in the preparation of industry data. Also, most input-output studies focus on income flows among sectors in the region and between the region and the rest of world (see, Table 3.1).

In the input-output approach, the gross output of each industry in the region is estimated, first, using either direct or indirect, or both, measurement techniques. Industry output and industry outlays are equal by definition. The next step is the determination of all industry outlays for the purchases of intermediate and primary inputs, including purchases from sources outside the region. In some cases, only sales data are used to estimate interindustry transactions. This is the "rows only" approach. More typically, the purchases of industry inputs from various producing sectors are determined, also. Survey data are required to obtain reliable estimates of either purchases or disbursements of local industry, especially from, and to, export markets.

Input-output multipliers are contained in the so-called Leontief inverse.[13/] The table of multipliers is represented by the inverse of

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13/ The input-output multipliers partition the total effect into direct and indirect effects (the indirect effects being the total multiplier less the direct effects derived by use of the technical coefficients matrix). In the alternative set of multipliers, the indirect effects (due to household expenditures of income payments from the interacting industires) are included. This formulation of the input-output multiplier is analogous to the Tiebout-type economic base multiplier. Further expansion of the interacting sectors to include the local business investment and local government sectors would make the new Leontief inverse comparable with the Tiebout-type long-run multiplier. In this case, only the external (i.e., federal) government and export sectors are viewed as exogeneous to the local economy.

User preference for one or the other of the two types of model input-output coefficients in the equation,

$$X_{jt} = [I-A]^{-1} Z_{jt}, \qquad (3.2)$$

where X = total industry output

Z = total final demand

$[I-A]^{-1}$ = inverse of table of input-output coefficients, subtracted from identity matrix, I.

This equation requires a matric of industry multipliers and a vector of final demands for its implementation.

In a more complete formulation of the input-output model, a table of interindustry transactions is specified of the form,

$$X_i = X_{i1} + . . . + X_{ij} + . . . + X_{in} + Z_i, \text{ or} \qquad (3.3)$$

$$X_i = a_{i1}X_1 = . . . + a_{ij}X_j + . . . a_{in}X_n + Z_i \quad . \qquad (3.4)$$

In matrix and vector form,

$$X = [A] X + Z, \quad Z = [I - A] X \quad \text{and } X = [I - A]^{-1} Z. \qquad (3.5)$$

In the short-run, all final demands are exogeneous. Hence, only the interindustry transactions on current account are included in the derivation of the demand multipliers. In an alternative version, households are included among the interacting sectors, i.e., households are viewed as being endogeneous.

Income and employment coefficients are derived for each industry for converting the industry output forecasts to corresponding income and

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13/ (continued)

depends on the degree of local industry proliferation and interdependence and the time and money available for the study. Underdeveloped (or small) areas lack the necessary degree of local interindustry linkage to make a full-blown input-output study worthwhile. Yet, only the input-output approaches provides sufficient industry detail to make possible futuristic studies of the impacts of changing industry composition on a region's economy.

employment forecasts. The income data are acquired directly from the primary input rows of the interindustry transactions table. The employment data are acquired from the same sources as the payroll data used in the preparation of the value added payments to primary inputs, in this case, labor. Income and employment multipliers, instead of output multipliers, are thus available from the input-output study.[14/]

The recent literature on input-output analysis is extensive and voluminous and, hence, difficult to summarize in this report. The input-output approach is used in both small-area and large-area, i.e., state and multistate, studies. When based on survey data, it usually involves a costly and time-consuming effort of a large research team. Much of the related literature deals with procedures for reducing these costs.[15/]

Use of input-output tables in forecasting regional economic growth and change is a topic of widespread concern in the technical literature (A, 38, 39, 50, 65, 73, 85, 126, 132, 133). The input-output approach

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14/ Alternative procedures for construction of input-output tables are discussed by Barnard, Czamanski, Davis, Doekson,Little,Emerson, Garnick, Greytek, Grubb, Hansen and Tiebout, Hewings, Isard, Jensen and McGaurr, Level, McMenamun, Morrison, Riefler, Riefler and Tiebout, Toepke, Williamson and others (A, 12, 44, 45, 48, 51, 61, 74, 75, 78, 82, 87, 93, 124, 130, 131, 154, 160). Use of secondary data to reduce model construction costs is frequently proposed. The prioritizing of data preparation efforts based on analyses of the effects of data estimation errors is proposed. Specification errors and forecast errors due to unspecified parameter change also affect the reliability of input-output forecasts (A, 28). Computer simulation is used in demonstrating the importance of each of the three sources of forecast error and, thus, in establishing priorities in model construction within given set of cost constraints.

15/ Another area of input-output research is the use of cost-reducing procedures in the preparation of input-output multipliers (A,29,37,38, 39,46,62,83,89,99,105,108,170). Implicit in this approach is a singular concern with the input-output multiplier as an appropriate statistic for economic impact measurement and analysis. The exchanging of input-output multipliers is one proposal for extending the use of available input-output studies to analogous or comparable areas. The exchange of technical coefficients is appropriate, also, in combining direct and indirect methods of preparing a table of input-output coefficients which is then inverted and compiled to obtain the input-output multipliers.

is combined with other approaches (i.e., economic base, shift-and-share and econometric) in the development of dynamic models for economic and demographic impact analysis and forecasting (A, 46, 51, 126, 127, 132, 133). Development of the hybrid computer models is an essential step in extending input-output methodology beyond impact analysis to multi-variable economic forecasting. Progress in reducing time and money costs in the forecasting uses of input-output methodology will eventually make the input-output based computer models more widely accepted in multi-state, state and even sub-state planning and analyses.

Econometric

The econometric approach, like the input-output approach, involves the preparation of an extensive data base and the use of sophisticated statistical procedures. It differs from the input-output approach in the number of statistical tests which are available for evaluating the individual forecasts. The econometric model is based on time series data while the input-output model is based on cross-sectional data. One is dynamic. The other is static. In this report, the use of econometric models in employment, income and population forecasting is examined.

Two types of econometric models are cited in this report -- the special-purpose regional model and the model of an entire regional economy. Special-purpose models are built to forecast a particular economic series, while the comprehensive model relates directly to key national variables (i.e., gross national product) which "drive" the key sectors (i.e., economic base) of the region.

Special-purpose forecasting models of employment income and population have been prepared by Babcock, Barnes, Chang, Iacobelli, Mattila and More, and O'Hare (A, 9, 13, 32, 85, 119, 121, 136). The employment forecast models start with the procedure recommended by the U.S. Bureau of Labor Statistics (BLS) to forecast local employment by industrial group. The formulation proposed by Barnes is a combination of two of the three BLS-recommended equations.16/

In the Barnes model, a two-stage procedure is proposed. The first-stage, say sub-state region level, total employment is divided into two groups -- key industries and services industries. Employment growth in key industries is tied to growth in national employment while in service industries employment growth is tied to key industry growth in the region. Thus,

$$EK_{tj} = a_{oj} + a_{1j}\sum_{j} EK_{jt} \quad (3.6)$$

$$ES_{jt} = b_{oj} + b_{1j}\sum_{j} EK_{jt} \quad (3.7)$$

$$ET_{jt} = EK_{jt} + ES_{jt} \quad (3.8)$$

16/ Three regression models are cited by Barnes, namely, (see, A,13),

$$E_{ijt} = a_{oij} + A_{1ij}T,$$

$$E_{ijt} = b_{oij} + b_{1ij}\sum_{j} E_{ijt}$$

$$E_{ijt} = c_{oij} + c_{1ij}Z_{kjt} ,$$

where, E_{ir} = total employment in i-th industry, j-th region;
T = t-th time period,
Z_{kjt} = k-th explanatory variable (e.g., local populations, and/or income), j-th area

Thus, the first equation is a simple linear trend extrapolation while the second equation links local employment to corresponding national employment and the third equation is more appropriate for residentiary, rather than export-producing, industries.

where EK_j = total key industries employment, j-th region

ES_j = total service industries employment, j-th region

ET_j = total industry employment, j-th region

In the second stage, say county-level, industry employment in represented by a similar but more detailed series of equations. Thus,

$$EK_{jkt} = a_{oijk} + a_{1ijk} \sum_j E_{igt} a_{2ij} ET_{jt}, \quad (3.9)$$

$$ES_{ijkt} = b_{oijk} + b_{1ijk} \sum_{i=m+1}^{n} EK_{ijkt}, \quad (3.10)$$

$$ET_{jkt} = \sum_{i=1}^{m} EK_{ijkt} + \sum_{i=m+1}^{n} ES_{ijkt}. \quad (3.11)$$

Implicit in this procedure is an underlying economic base model in which the key industries are identified as export-producing. The service industries are related to the export-producing sector in the regression model (equations 3.7 and 3.10).

$$ET_{jkt} = \sum_{i=m+1}^{n} b_{otjk} + \sum_{i=m+1}^{n} 1+b_{ijk} \sum_{i=1}^{n} EK_{ijkt}, \text{ or} \quad (3.12)$$

$$ET_{jkt} = k_{ojk} + (1+k_{1jk}) \sum_{i=1}^{m} EK_{ijkt}$$

where, k_{ojk} = constant term and

k_{ijk} = regression coefficient

Mattila and Moor developed a multi-equation simulation model for each planning region of Michigan for predicting construction industry employment by occupation (A,121). The Barnes-type model was used to forecast total key industry and service industry employment. Total export-producing industry and specified service industry employment become explanatory variables in forecasting construction employment

The comprehensive economy-wide models generally follow the Klein-Glickman specifications for building regional econometric models (see, ref.

97 and 67). Two types of economy-wide models are illustrated in the selected references, namely, the single-region (A, 14, 99, 102, 103, 116, 120, 147, 159, 164) and the multi-region (A, 1, 111, 66, 96) models. All economy-wide models are linked to national economic variables in a manner similar to the linkages between the key industries in the Barnes and Mattila and Moor models. Close correspondence between regional and national economic structures provides for a high degree of reliability in forecasting regional variables, particularly earnings and income, given the national economic forecasts.

Other

Other forecasting approaches deal mostly with the preparation of data and procedures for population estimation and forecasting (A, 5, 40, 41, 69, 77, 91, 136, 142, 146, 161, 163, 175, 177, 178). Employment forecasting models represent the next largest category of cited references (A, 36, 43, 57, 60, 128). One study of importance in implementing small area input-output and econometric deals with the allocation of industry value added from the national to the county level (A, 73).

Because of the inter-dependence of employment, income and population changes, the article by Cordey-Hayes is especially appropriate as a concluding citation (40). Each of the preceding eight approaches fail, in some degree, to account for interactive effects. Input-output and econometric models are demand-based approaches to population forecasting while demographic models are supply-based approaches to employment forecasting. Migration models, on the other hand, fail to fully incorporate both demand and supply variables and relationships in forecasting changes in population and labor force. Cordey-Hayes gives a personal perspective on the construction of models to fully account for the role of population migration as an equilibrating mechanism between labor demand and labor supply. He proposes development of "a family of models that approach national settlement systems from differing conceptual viewpoints and at varying levels of approximation. The simplest of these should be able to give quick qualitative insights during the early stages of policy analysis, whilst more sophisticated techniques would be required in the detailed elaboration and evaluation of alternative strategies" (A, 40, p. 811).

COMPOSITE FORECAST APPROACH

Alternative forecast methods are presented, first, as antecedents of a composite forecast approach. Three closely related methods are identified -- location quotient, economic base, and shift-and-share. Each method has a counterpart in the logical framework for the extended shift-and-share method presented later in this report as a composite forecast model.

Location Quotient

The location quotient is a measure of the geographic localization of industry. It is the ratio of industry's share of total industry activity in a region to that industry's share of total industry activity in the reference economy, e.g., U.S. or State. The location quotient for a region, is expressed by the form,

$$lq_i = \frac{emp_i/empr}{EMP_i/EMPN} \qquad (4.1)$$

where, lq_i = location quotient for i-th industry in Region

EMP_i = employment in i-th industry in Nation

EMPN = employment in all industries in Nation

emp_i = employment in i-th industry in Region

empr = employment in all industry in Region

This equation can be rewritten as,

$$lq_i = \frac{emp_i/EMP_i}{empr/EMPN} \qquad (4.2)$$

If an industry location quotient for a region is greater than one, it is assumed that some of the industry employment is engaged in producing output for sale to non-resident buyers. To derive the export-producing employment, $empx_i$, the location quotient is used in the form,

$$empx_i = \left(\frac{emp_i}{empr} - \frac{EMP_i}{EMPN}\right) empr \qquad (4.3)$$

or alternatively,

$$empx_i = \left(\frac{emp_i}{EMP_i} - \frac{empr}{EMPN}\right) empr. \qquad (4.4)$$

The export-producing employment thus represents that portion of total industry employment which is in excess of the industry employment in the region when the industry's share of total employment in the region is the same as the corresponding industry share in the Nation. Numerous assumptions about productivity, earnings, income and expenditures are implied in the use of the location quotient is an indirect measure of export-producing activity (A, 90, 101).

Even if the region were exactly like the nation, except for differences in industry composition and employment, several major difficulties occur in the use of the location quotient formulation in income and employment forecasting. Foremost among these difficulties is the disaggregation problem: the finer the industry detail, the larger the location quotient and the larger the estimate of total excess employment.[17/]

A large amount of industry aggregation masks differences in intra-industry structure and related commodity transportation patterns. Much

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17/ The minimum requirements approach, developed by Ullman, provides a procedure for eliminating extreme values of location quotients in the estimation of the economic base of a region or community (A, 145, 192). Greytak found that while the minimum requirements provides some improvement in the accuracy of economic base estimation, it is too small to warrant even a qualified endorsement of the indirect measurement techniques (A, 74). Thus, the location quotient and related approaches provide only a rough approximation of a region's economic base.

cross-hauling occurs between regions because of regional differences in industry specialization. The location quotient approach ignores this cross-hauling and, hence, it tends to under-estimate industry levels of export-producing employment and output.

Isserman has suggested certain modifications of the location quotient approach to improve its predictive accuracy (A, 90). By shifting from a two-digit to a four-digit level of industry classification, predicted excess employment is increased markedly for most areas. This modification counters the assumption of "no cross hauling" implicit in the use of the excess employment equation.[18/]

A second modification suggested by Isserman is the inclusion of all exogeneous industry employment, e.g., federal, in the export-producing category. Again, the modification imporves the predictive accuracy of the excess employment queation for most areas (when compared with the range of input-output multipliers for the same areas). The location quotient multipliers nonetheless will continue to over-estimate total employment because of product mix problems and the existence of cross-hauling, even at the four-digit level.

Other modifications to the use of the location quotient approach in regional impact measurement include the use of (1) regional proxies for

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18/ The four assumptions in the use of location quotients are: (1) that for the ratio emp_i/EMP_i to represent the region's share of the nation's production, productivity per employee in the i-th industry is the same in the region and the nation; (2) that for the ratio emp_i/EMP_i to represent the region's share of the nation's consumption, there must be identical consumption per employee of the products of the i-th industry in the region and the nation; (3) that for the difference between the region's share of production and consumption to indicate export the region must consume only local production of the products it exports, i.e., no cross-hauling; (4) that, finally, there are no net exports for the i-th industry in the nation.

production, (2) net exports for nation to reduce regional employment levels, and (3) regional consumption data. The ratio of value added to employment can be computed for each region, using periodically reported data from the U.S. Bureau of the Census to adjust for regional differences in labor productivity in a given industry. Foreign consumption of regional production can be accounted for by use of the ratio of total nation production minus net exports to total national production in the total employment-share ratio, emp_i/EMP_i. Finally, the identical consumption assumption can be handled by using the regional to national ratio of income per employee, or per capita. The adjustment data are available by state and, for selected years, by county. Esistence of time series would make possible still another modification suggested by Pfister -- the use of regression analysis -- to estimate the relation of total employment to export-producing employment (A, 140).[19/]

Economic Base

The economic base of a region is defined as its export-producing activity in both the location quotient and the economic base approaches to regional employment and income forecasting. In the economic base approach, however, direct methods are used to estimate a region's export-producing activities.

19/ Conopask has suggested data-pooling as still another variant of the location quotient approach in deriving employment multipliers for small areas (A, 37). The Conopask formulation (like the earlier Bender model, see, ref. 15) introduces several explanatory variables to account for county-to-county differences in industry mix and adjacent county influence on the employment multiplier. Estimation of the regression coefficients from pooled (county-level) data also introduces problems in efficient estimation. The structure of the disturbance term for pooled data is more complex than for time-series or cross-section data alone. The co-variance approach and the recently developed error components technique are used to deal with these estimation problems.

The community economic base study is a survey technique for determining the levels of income and employment created by the region's industries and related economic activity (A, 138). The survey method may be supplemented, in varying degree, by indirect methods of measuring community income, employment, and, also, expenditures.

Much of the literature pertaining to the location quotient approach to small-area multiplier estimation applied, also, to the economic base approach. In this report, the two approaches are presented separately simply to identify the primarily survey-based studies used in estimating employment and income multipliers.[20/]

Findings of economic base studies are reported in terms of income flows within the region and between teh region and the rest of world (A, 2, 9, 27, 53, 104, 139, 184, 191). The income multipliers derived

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20/ The exporting-producing-residentiary dichotomy of a community was first recognized by M. Arcrousseau in his paper, "The Distribution of Population: A Constructive Problem", published in 1921 in the Geographical Review. In this paper, the primary and secondary functions of towns were identified. Subsequently, the New York Regional Planning Committee, under the direction of Frederick L. Olmstead, reported on "primary" and "auxillary" activities of the city in its Regional Survey of New York and Environs, published in 1927. More than a decade later, in April 1939, the research staff of Fortune magazine reported on its analysis of the economic functions of a rural community in Iowa under the title, "Oskaloosa vs. teh United States". In the same year, Homer Hoyt outlined six steps for measuring basic activity in the book, Principles of Urban Real Estate (which he coauthored with Arthur M. Weimer). The concept was expanded in 1942 by Harold McCarthy(see, "A Functional Analysis of Population Distribution," Geographical Review, 32: 287-288, 1942) to the occupational distribution of export-producing and residential activities. Robert E. Dickinson directed additional attention to the economic base concept in his book, City Region and Regionalism, published in 1947. Then in 1962, the Committee for Economic Development published The Community Economic Base Study by Charles M. Tiebout. This publication remains the standard reference on economic base studies. It provides a step-by-step procedure for the implementation and use of community economic surveys and related indirect measurement techniques for estimating community income and employment multipliers.

from these studies follow a Keynesian formulation of the form,

$$\Delta Y - M(\Delta Y), \tag{4.5}$$

where, ΔY = change in total income

ΔX - change in so-called basic income

M = income multiplier.

Data for deriving the income multiplier is obtained from the economic abse survey. Two coefficients are estimated -- the proportion, p_i, of total income spent, for the i-th item and the local income created, c_i, per $1 total sales of the i-th item. Thsu, the multiplier is represented as a function of the two sets of relationships in the form,

$$M = \frac{1}{1 - \sum_i p_i \cdot c_i} \tag{4.6}$$

Both coefficients are derived for each sector in the region's economy.[21/]

Shift-and-Share

Shift-and-share analysis deals with relative changes in a regional economy over time. The regional changes are compared with corresponding changes in the national economy. Unlike the location quotient, economic base and input-output approaches, shift-and-share analysis pertains to the dynamic properties of regional economy, represented, in part, by changing patterns of industry earnings and employment.

21/ Tiebout recognized a difference between the short-run multiplier, M_S, and the long-run multiplier, M_L (A, 190). In the short-run multiplier, only personal consumption expenditures and local government current expenditures are viewed as being endogenous. All other expenditures are basic, or income generating. In the long-run, however, all local investment is viewed as exogenous and, thus, basic. In the long-run formulation, the coefficients p_i and c_i are derived for each one of the endogenous sectors.

Ashby and Dunn are two of the early proponents of regional shift-and-share analysis (A, 6, 33). In the Ashby formulation, change in industry employment or earnings is due to three sources -- a national-growth effect, an industry-mix effect and a regional-share effect. In the Dunn formulation, the national-growth and industry-mix effects are combined into a proportionality effect while the regional-share effects is called the differential effect. The Ashby formulation is used in this report, as follows:

$$emp'_i = (1 + A + B_i + C_{ij})emp_i \qquad (4.7)$$

where, emp_i = total employment in i-th industry in the Region

A = national growth coefficient (i.e., $\frac{EMPN'}{EMPN} - 1$)

B_i = industry-mix coefficient for i-th industry (i.e., $\frac{emp'_i}{EMP_i} - \frac{EMPN'}{EMPN}$)

C_{ij} = regional-share coefficient for i-th industry, j-th county (i.e., $\frac{emp'_i}{emp_i} - \frac{EMP'_i}{EMP_i}$)

The national-growth and industry mix coefficients are derived from national forecasts while the regional-share coefficients must be forecast from each region. Few difficulties occur in the use of the national forecast inasmuch as they are readily available for a large number of industries and over extended time periods. The regional-share coefficients, on the other hand, are difficult to forecast because of their extreme variability.[22/]

22/ Much of the criticism of shift-and-share analysis centers on the difficulty of forecasting the regional share, or differential, effect (A, 3, 23, 24, 25, 81, 92, 137, 189). The technique itself has been used in the analysis of regional growth patterns since the early 1940's (see, ref. A, 42, 58, 139). It has reached its greatest popularity, however, in the last decade, partly as a result of its adoption by the former Office of Business Economics -- now the Bureau of Economic Analysis -- in the U.S. Department of Commerce (A, 6, 71, 195, 196). These studies have provided much data for supporting the contention that the regional-share effect is highly volatile and, hence, a source of large forecast errors.

Widespread use of the shift-and-share technique persists in spite of criticism. First, the technique is straightforward and readily comprehendable. It is an accounting relationship -- an identity. The two sides of the equation balance by definition. Expansion of the equation is done simply by partitioning one side of the equation into the three "effects". The difficulties of forecasting are not reduced but rather sorted into two categories -- "external" and "local". The external forecast, which covers the national-growth effect adn the industry-mix effect, is prepared outside the region. The local forecast is prepared in the region from internal (to region) data sources.

The task of forecasting the regional-share, i.e., local, effect is greatly facilitated by the existence of an extended time series for deriving the regional-share coefficient (see, equation 4.7). Inspection of a time series of regional-share coefficients reveal varying patterns of year-to-year fluctuations, ranging from oscillations of short duration to gradually increasing or decreating values which eventually may yield oscillation of long duration. However, lack of sufficiently long time series to ascertain the periodicity of the fluctuations limit the usefulness of the statistical approach in shift-and-share analysis.

Alternatively, the regional-share coefficient may be treated as a policy variable which approaches specified limits over a forecast period. A correlation of the postulated time path of the coefficient with the one derived directly from an historical series still remains. This task can be redefined in a way that overcomes the former difficulties in dealing with a highly variable regional-share coefficient.

An example of problem redefinition is presented in a paper by Exteban-Marguillas (A, 74). A follow-up by Herzog and Olson presents some empirical results based on the problem redefinition (A, 81). In the problem redefinition, the purpose is to eliminate the influence of the industry-mix effect on the regional-share effect. The instability of the regional-share effect is in part due to its lack of independence from the industry-mix effect (as demonstrated, for example, by the employment changes in a dominantly agricultural area which, because of the declining agricultural employment, also experiences declining employment in its residentiary industries). The concept of homothetic employment is proposed to deal with this difficulty.

Homothetic employment, $hemp_i$, is defined as the employment that would be found in the i-th industry in the Region if the distribution of industry employment were the same in the Region as the Nation. This is represented by the form,

$$hemp_i' = \left(\frac{EMP_i}{EMPN}\right) emp_i = \left(\frac{empr}{EMPN}\right) EMP_i \tag{4.8}$$

Differential employment, $demp_i$, is defined as total employment minus homothetic employment. The differential employment component of total employment may be positive or negative, as indicated earlier in the discussion of the location quotient method.

When used in the shift-and-share equation (see, p. 26), the employment variable is partitioned into the two components and then multiplied by the regional-share effect, C_i. The incidence of industry-mix on the regional-share effect is eliminated by use of the homothetic employment component. Because this procedure operates on the regional-share effect rather than the regional-share coefficient, however, it does not deal with the problem of coefficient variability cited earlier.[23/]

The shift-and-share model can be reformulated with industry location quotients as appropriate weights for the homothetic and differential components of the regional-share effect (A, 54, p. 254). The new employment multipliers are given in the form,

$$hemp_i = \frac{emp_i}{\bar{lq}_i} \tag{4.9}$$

$$demp_i = emp_i \left(1 - \frac{1}{\hat{lq}_i}\right) \tag{4.10}$$

23/ The follow-up paper by Herzog and Olson suggests that the use of the homothetic employment concept introduces added difficulties in interpretation of the results of shift-and-share analyses. Use of end-of-period rather than start-of-period i-th industry employment results in a vastly different pattern of allocation effects. Use of annual rather than 10-year intervals in the historical series is, of course, an obvious advantage in dealing with this difficulty. However, the proglem of unexplained variability in the regional-share coefficient still remains.

Another variant of the shift-and-share model is puported to improve its predictive capabilities by introducing a polynomial projection of the ratio of regional to national employment in a re-arrangement of the shift-share equation presented earlier (105). This new formulation introduces still another proglem, namely, incongruity between the polynomial and shift-share projections of the region-to-nation share component. Empirical tests of the alternative formulation nonetheless shoe measurable improvement in the regional forecast, especially for the export-producing industries.

Difficulties in forecasting the regional-share effect also account for the use of a totally different approach to forecasting regional growth, namely, covariance analysis (A, 52, 64). Emmerson,Ramanathan and Ramm argue that the covariance approach is "vastly superior" to shift-and-share analysis on statistical grounds. Numerous statistical tests can be devised with the covariance approach (which are illustrated for the San Diego SMSA). The real issue is not the number of statistical tests which can be performed but the usefulness of the forecast series for policy and management. Each of the components of the shift-and-share model provide for some sort of policy (or control) interpretation. The covariance approach is devoid of such possibilities.

In a critique of the Emmerson-Ramanthan-Ramm paper, an improved forecast procedure is proposed which has "a uniformily smaller mean square error" (A,64,p.263). The superiority of this procedure is demonstrated by again forecasting industry employment for the San Diego SMSA. The findings show nearly identical forecasts to the year 2000 for the two series. Again, neither formulation was tested for its usefulness in providing information for policy-making and management (and, thus, improving the quality of public and private decision making).

Using this form of the shift-and-share method, the rate of growth for the i-th industry is equal to the weighted sum of the four coefficients (i.e., national growth, industry mix, homothetic regional share and differential regional share). The weights are the reciprocals of the base-year industry location quotients for the region.

REGIONAL FORECASTING SYSTEMS

Regional forecasting systems are available in a majority of the states and provinces of the United States and Canada. The development and maintenance of these systems occurs generally within academic institutions. Several of the systems were developed in state agencies. Most of the users of operational systems are in state government.

Forecasting System Classification

Forecasting systems are grouped into two general classes -- special-purpose and comprehensive. The special-purpose forecasting systems typcially provide a single series of forecasts, for example, population, by age and sex, or employment, by industry and/or occupation. They make use of the demographic, geographic, gravity/potential, location quotient, economic base, and shift-and-share approaches cited earlier. Minnesota population projections, for example, are based on the demographic approach (B, 46).

The comprehensive forecasting system typically require a variety of statistical series as data input for the mathematical model which is used to convert the input data into a forecast series. Most state and regional forecasting models identified in a recent survey of state and regional forecasting systems are comprehensive in method and scope (see, Table 5.1 and B Section of Literature Cited).

Recently (since 1970) published reports on state and regional forecasting systems are listed under three forecasting approaches -- input-output, econometric, and other (i.e., a combination of input-output, econometric and demographic approaches (Table 5.2). Very few published reports on special-purpose forecasting systems were identified by the survey cited earlier. The survey was not directed to planning consultants,

Table 5.1. Survey of development and use status of state economic forecasting systems: Periodicals and documents reports, 1977.

State	Authors	Location	Forecasting System
Arizona	Carol A. Taylor	University of Arizona, Tuscon	Pima-County Short-term Forecasting Model, (1977)
Arkansas	Joe Jones Data Resource, Inc.	University of Arkansas, Little Rock	Arkansas Econometric Model (prelim.)
Florida	R. Blaine Roberts Henry Yisulcind	University of Florida, Gainesville	The Florida Outlook
Georgia	College of Business Administration	University of Georgia, Athens	Georgia Business
Indiana	College of Business Administration	Indiana University, Bloomington	Indiana Business Review
	William Styring	Indiana State Budget Agency, Indianapolis	Report, Revenue Fore casting, Technical Committee (1977)
	Rod Harrington James Kessler William Styring	Indiana State Budget Agency, Indianapolis	Local Government Finance Projections, (1977)
Iowa	Jerald R. Barnard Warrent T. Dent	University of Iowa, Iowa City	Iowa Revenue Fore-casting model (prelim)
Louisiana	Jim Richardson Loren Scott Fred Wrighton	Louisiana Legislative Fiscal Office,Baton Rouge	Louisiana Revenue Forecasting Model (1977)
Michigan	Fred Andres	Michigan State Energy Office, Lansing	Michigan Input-Outpu Model (prelim.)
Minnesota	Fred Post	Minnesota Department of Finance, St. Paul	Minnesota Revenue Forecasting Model (prelim.)
Montana	Bruce Finnie Jerry Fleming	Montana Department of Community Affairs	Overview of the Montana Futures Process (1976)
Vermont	Data Resources, Inc.	Vermont State Planning Agency, Montpelier	Vermont Revenue Fore casting Model (prelim.)
Wisconsin	Data Resourced, Inc.	Wisconsin Department of Revenue, Madison	Wisconsin Econometri Model (prelim.)

Table 5.2. Listing of selected references, periodicals and documents on state and regional forecasting models, by forecasting method, 1970-1978. 1/

	State	Input-Output	Econometric	Other 2/
1.	Arizona			T
2.	Arkansas		T	
3.	California	59		
4.	Florida	7,16	24	T
5.	Georgia	64	55	T
6.	Hawaii			31
7.	Illinois			33
8.	Indiana		41,T	T
9.	Iowa	4	3,T	
10.	Kansas		15	
11.	Kentucky		57	
12.	Louisiana		T	
13.	Maryland	56		
14.	Massachusetts		8	
15.	Michigan	T	12,60	
16.	Minnesota	18,28,29,37,65,71,72	T	38,39,46,47
17.	Mississippi	75,76		
18.	Missouri	25	43,61	
19.	Montana			T
20.	Nebraska	32		6,58
21.	North Dakota	10,63		35
22.	Ohio			74
23.	Oklahoma	13,14,66		
24.	Oregon	11,17		
25.	Pennsylvania	30	21	
26.	South Carolina	34,48		
27.	Texas	1,19,20,22,23,26,49, 51,52,53,67,68	54	50
28.	Utah			27,70,73
29.	Vermont		T	
30.	Washington	5		
31.	Wisconsin	2	62,T	
32.	West Virginia	45		
33.	Wyoming			
34.	Alberta			40
35.	Manitoba	36,69		
36.	Ontario			17

1/ References cited on state and regional forecasting models are listed numerically; periodicals and documents cited in table 3.1 are identified by symbol "T".

2/ Demographic method

for example, who make use of the location quotient and shift-and-share methods in the preparation of planning reports. Hence, the survey findings are biased toward the comprehensive systems.

In the comprehensive forecasting system, the econometric models that are operational at the state level are used primarily for revenue and expenditure forecasting. The input-output models are used to evaluate models which were developed initially to deal with overall economic response to policy changes may incorporate elements of an input-output model.

The main operational differences between the two types of core models result from differing abilities to deal with time and a wide variety of economic issues and problems. The econometric models deal readily with discrete time intervals of short duration while input-output models are not time sensitive. In tax revenue and expenditure management, the need is for forecasts that are time specific, e.g., quarterly or yearly, or which make the econometric-type model the predominant choice. For large-scale growth and development questions, the many-faceted input-output systems have proved more flexible, especially in dealing with resource problems phrased in non-monetary terms. Thus, a combined input-output/ econometric approach evolves in the development of the comprehensive forecasting system.

An input-output based forecast system was used recently in the study of copper-nickel development impacts in Minnesota (B, 39). This system evolved from a core input-output table which was supplemented later by a series of demand forecasts (Table 5.3). A 95-sector input-output table was reduced to a 55-sector table in the core input-output module. A demand forecasting module was linked to the input-output table and other operational modules -- a total of nine core and auxilary modules.

Table 5.3. Sequence of Module Development in a Regional Economic Impact Forecasting System.

Development Stage	Module Component No. Title
A.	Building input-output model
	1. Production
	a. Gross output (realized)
	b. Gross output (demand limit)
	c. Gross output (output-increasing capacity limit)
	d. Gross output (pollution abatement capacity limit)
	e. Gross output (employment limit)
B.	Building demand forecasting modules
	2. Export Market
	a. U.S. Industry gross output
	b. Regional market share
	c. Change in regional market share
	3. Investment
	a. Replacement investment, output increasing
	b. Expansion investment, output increasing
	c. Expansion investment, pollution abatement
	d. Output-increasing capital
	e. Pollution abatement capital
	4. Demand
	a. Personal consumption expenditures
	b. Gross private capital formation
	c. Net inventory change
	d. Federal government
	e. State and local government
C.	Building auxiliary modules
	5. Income
	a. Employee compensation, by industry
	b. Indirect taxes, by industry
	c. Capital depreciation, output-increasing
	d. Capital depreciation, pollution abatement
	e. Business income (retained earnings, dividends and direct taxes)
	f. Regional imports
	6. Employment
	a. Employment, by industry and occupation
	7. Labor Force
	a. Total population, by age and sex
	b. Unemployed labor force, by occupation
	c. In-commuting employment, by occupation
	e. Resident employment, by occupation
	8. Population
	a. Total population, by age and sex
	b. Total births, by sex
	c. Total deaths, by age and sex
	d. Total in-migration, by age and sex
	9. Households
	a. Total households, by income class
	b. Total personal income, by income class
	c. Total personal income tax, by income class
	d. Total personal taxes, by income class
	e. Total personal savings, by income class
D.	Building interactive computer control program

These nine modules are listed with the key operational variables used in each module. It is these modules that provide the primary economic impact forecast series for use in development planning within state agencies.

Forecast Information Users

Most agencies have some forecasting needs that are short-term and time-specific while others operate in a long-term perspective. Those agencies that have the short-term horizon are almost totally concerned with decisions affecting ongoing programs while those that deal with policy development have a non-specific time horizon. While these are not mutually exclusive conditions, one system could not meet all forecasting needs of all departments or agencies. Nor does the level of agency activity mean that an economic impact analysis and forecasting is or is not justified. The listing of the modules in Table 5.3 is presented, therefore, more as a guide to potential interaction between forecasting system and information user in certain functional areas of state government than as complete specification of module components and variables.

A focus on information use draws attention to the need for a forecasting system which relates data to decisions. Data lack value as information without an intervening capability for analysis and interpretation. An information system includes the three related entities -- the data system, the forecasting system, and the information user.

The forecasting system, like the data system, starts with concept building. Most forecast data systems are based on statistical series built from business reports. The initial concept for these data systems originated from, or is related to, legislation, not economic theory. In the forecasting system, its development relates to both the data system -- imperfect as it is -- and the information user. A forecasting model -- statistical and/or mathematical -- is built to operationalize the forecast concept. The model then is fitted and tested as a forecasting tool. Only after these steps are completed is the system operational in the sense that it provides reliable forecast output for the information user.

A modular system design provides for systematic reduction of a highly complex regional economy into a computable model which is, then, tested and fitted to various data -- time-series, cross-sectional (including survey), and engineering. Additional modules readily interface existing modules in the total system concept. System utilization is facilitated by the modular construction and the user-activated computer programs.

Only a few state forecasting systems make use of modular construction. In the Minnesota regional forecasting system, a total of nine core modules have been completed for several state and substate (Minnesota) regions. Under construction are the household and the fiscal modules. An energy system module is being prepared, also, along with a water industry module. Among the nine core modules, more than 100 different sets of variables are used.

Currently, the data base for each module is developed for 1970. Nearly complete data series exist for selected years, including 1972 and 1976. When the 1972 U.S. input-output tables are available, the entire data base will be updated from the 1970 base to a new 1972 base.

The modular approach to forecast system development facilitates the use of a regional forecasting system in special purpose studies, e.g., copper-nickel and peat land development in northern Minnesota and irrigated agricultural development in west Minnesota. In each study, a two-region input-output program (based on an expanded 1970 U.S. input-output table) is used in the preparation of a 95 to 112 sector regional input-output model. The detailed sector breakdown is aggregated to a smaller number of sectors in the regional impact forecasting system -- 35 to 65 sectors -- the maximum currently feasible.

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