TECHNICAL REPORT NUMBER 5

A REGIONAL ECONOMIC SIMULATION MODEL

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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TECHNICAL REPORT

NUMBER 5

THE REGIONAL ECONOMIC SIMULATION MODEL THEORY AND APPLICATION

Prepared by the

Southeastern Wisconsin Regional Planning Commission

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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STATEMENT OF THE EXECUTIVE DIRECTOR

Early in 1963 the Southeastern Wisconsin Regional Planning Commission began work on a series of major regional planning studies directed at the preparation of certain key elements of an advisory plan for the physical development of the Region. The findings and recommendations of these studies will be presented in Planning Reports to be published by the Commission upon the completion of each of these studies or major phases thereof. These Planning Reports are intended to constitute the official findings and recommendations of the Commission. Much valuable information is being collected in the course of these planning studies, however, that may be helpful in assisting various public and private bodies within the Region in reaching decisions concerning community development. Consequently, the Commission has decided to present such information on a work progress basis through the media of interim Technical Reports such as this.

This document constitutes a progress report on Commission research efforts over the last three years directed toward the development of a mathematical model of the economy of the Southeastern Wisconsin Region. Although this model was developed primarily for application in the regional land use-transportation study, it has potential usefulness in other regional studies requiring forecasts of future regional economic activity levels.

The Regional Economic Simulation Model is a dynamic model of the input-output type and represents the first known attempt to apply a dynamic inter-industry model to a small region. Although its requirements for data are quite demanding, it provides the regional planner with forecasts in greater detail than more aggregative models.

Respectfully submitted,

K. W. Bauer
Executive Director

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PREFACE

The Regional Economic Simulation Model was developed and applied as part of the Regional Land Use-Transportation Study of the Southeastern Wisconsin Regional Planning Commission. The function of the model is to provide a series of regional employment and population forecasts required as inputs to the land use-transportation planning sequence. The model also allows for the dynamic analysis of inter-industry relationships for the regional economy. Difference equations are used to simulate inter-industry relationships over time. This introduction of the dynamic dimension of time differentiates this model from most input-output models developed in the past, which have been static in nature.

Primary data obtained from small samples of firms in various industries were used in preparing parameter estimates for the model. These primary data were supplemented by state corporate tax and employment records and other secondary sources, such as the U. S. Department of Commerce input-output tables.

Historical simulation tests were conducted over the 1946-1960 period. Comparisons of model outputs with historical data indicated an error of 2.99 percent in the overall employment level forecast by the model for 1960 from 1946 initial conditions, when that level was compared with actual 1960 employment levels. Errors in major industry component forecasts ranged from 0.8 percent in manufacturing to 19.6 percent in private services and education. Future employment levels were forecast for the 1970-1990 period using the simulation model. These forecasts were somewhat higher than those developed using non-model techniques developed and applied by the Commission.

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Chapter I
INTRODUCTION

THE FUNCTION OF THE REGIONAL ECONOMIC SIMULATION MODEL

The preparation of regional land use and supporting facility plans requires the preparation of forecasts of future population and employment levels within the Region. These forecasts are necessary for the determination of both the demands which the plans must seek to meet and the financial feasibility of plan implementation.

The function of the Regional Economic Simulation Model is to provide a series of conditional forecasts of future regional population and employment levels that are sensitive to alternative public and private development policies, such as investment in certain industries and changes in the state and local governmental tax levels. These forecasts are then translated into needs for land that must be satisfied by the land use plan. Since transportation and other utility and facility systems are then designed to serve the future land use pattern proposed in the land use plan, socio-economic forecasts play a crucial role in the overall regional planning process.

The specific forecasting needs of the regional land use-transportation study are based on the lead time requirements of various activities in the regional development process. To implement a plan, certain commitments, such as land reservation or acquisition, must be made in advance; and facilities must be designed to satisfy expected utilization during their life cycle. The forecasts required for plan preparation must be of sufficient accuracy to allow these commitments to be made with confidence. In general, the forecasting accuracy requirements become less stringent for longer period forecasts; but specific forecasting accuracy requirements must be determined based on the technical and political nature of the planning function involved. A sensitivity analysis of the effects of forecasts on the land use plan in a separate mathematical model, to be explained later in the report, permits the determination of quite specific forecasting accuracy requirements.

Most urban transportation studies in the past have developed the required forecasts of population and employment primarily by extrapolation of past trends in population growth and in the development of individual industrial groups. Although such forecasts can provide an adequate measure of future demand for land and transportation facilities, trend extrapolation has certain inherent shortcomings:

1. It ignores the structural interrelationships existing within the regional economy. Industries, such as retail trade and medical services, are so heavily dependent on the income generated by basic manufacturing industries that forecasts prepared individually for such industries may be a poor measure of future growth in these industries.

2. It assumes that current trends will continue independent of public and private decisions made in a conscious attempt to modify these trends. Such a forecast procedure is, therefore, insensitive to any changes in public or private development policies, including the land use-transportation plan itself. Since many observers feel that the most important effects of a pessimistic economic forecast are the changes in public and private policies that are made to reverse its pessimistic conclusions, continuation of current trends may be a poor measure of future population and employment levels.

3. It ignores the basic information-feedback nature of public and private decision-making. Such decisions are based on continuous evaluation by governmental officials and businessmen of the current situation and perceived trends. The economic time history resulting from such a process is characterized by dynamic changes in direction not readily forecast by trend extrapolation methods.

It is hoped that the Regional Economic Simulation Model will alleviate to some degree the shortcomings of the simpler trend extrapolation forecast methods. Since the model is still in an experimental stage of development, "conventional" forecasts have been developed by the Commission to provide both a basis of comparison and a "backup" if the model does not fulfill expectations.

A second but extremely important use of the model, not possible with traditional time series extrapolation forecasts, is the determination of the effects of the land use-transportation plan on the regional economy. The "feedback effect" of the plan will be determined by varying in the model the transportation cost inputs, as they are affected by the plan.

An additional use of the model, not now part of the program of the Southeastern Wisconsin Regional Planning Commission, but of great potential importance for the Region, is in promotion of industrial development. The model should be extremely useful in evaluating the effects of local governmental decisions on the regional economy and the relative importance of individual industries in this economy.

Readers of this report will undoubtedly possess a wide variety of professional backgrounds. Some may not be familiar with the basic concept of a mathematical model and its application to planning. Prior to reading the remaining portions of this report, such readers are referred to Appendix I of this report, which provides the basic definition and primary classification of mathematical models.

LAND USE-TRANSPORTATION PLANNING PROCESS

A system block diagram illustrating the functional relationships in the regional land use-transportation planning process is shown in Figure 1. Although this diagram specifically represents the planning sequence related to the formulation of a regional land use-transportation plan, it is typical of other facility planning sequences.

The second function in the planning sequence, after completion of the necessary inventories, is that of employment and population forecasting. The execution of this function using the Regional Economic Simulation Model provides the primary subject of this report. The need for, and required characteristics of, such forecasts are better understood in the light of the succeeding functions in the process. For this reason the remaining planning functions will be briefly described to provide the necessary background for the ensuing description and discussion of the model.

In the third function, aggregate land use demand requirements are determined by applying a conversion coefficient, usually designated as a design standard, to each forecast employment and population category. Such a multiplication and summation results in a detailed classified set of aggregate demands for residential, industrial, commercial, and other land uses. These aggregate demands provide one of the primary inputs to the fourth function in the planning sequence—plan design.

Plan design lies at the heart of the planning process. Obvious as it may seem, it is necessary to continually emphasize that the end point of the planning process is a plan. The most sophisticated data collection, processing, and analyses activities are of little value if they do not result in better plans and in their efficient execution.

The land use plan design function consists essentially of the allocation of a scarce resource, land, between competing and often conflicting land use activities. This allocation must be accomplished so as to satisfy the aggregate needs for each major land use category and comply with all of the design standards derived from the regional development objectives at a reasonable cost.

The Land Use Plan Design Model[1] assists the land use planner in the design of a land use plan. Given a set of land use demands; design standards; land characteristics, natural and man-made; and land development costs, the model synthesizes a land use plan that satisfies the land use demands and complies with the design standards at a minimal combination of public and private costs. It is important to emphasize that the plan is the minimal cost plan complying with the design standards. It will be a pure minimal cost plan

[1] *See SEWRPC Technical Report No. 3, "A Mathematical Approach to Urban Design," 1966.*

only if no design standards are specified. The rationale implies that there is no need to have a more expensive plan provided all of the design standards are satisfied.

The plan selected in the design stage of the planning process must be implemented in the real world under conditions often adverse to its realization. Private decisions of land developers, builders, and households often run contrary to the development of the land pattern prescribed in the plan. This problem of plan implementation is the focus of the fifth stage of the planning process illustrated in Figure 1—land use plan test.

If plan design is visualized as the development of the anatomy of the system, then plan implementation represents the physiology. Plan design emphasizes the structure of the system. Plan implementation considers the dynamics of changing land patterns over time. Flow is the key concept in dynamics; and a second land use model, the Land Use Simulation Model,[2] simulates the flows related to the emerging land pattern.

Land development in the Land Use Simulation Model is portrayed as a series of interacting flows like the physiology of a complex chemical processing plant. A continual stream of decisions made by land developers, builders, and households results in a changing land pattern and a continuous movement of households and business firms to new geographical locations.

Land use development is simulated in the Land Use Simulation Model by detailed representation of the decision processes of households and business firms influential in land development. Public land use control policies and public works programs are exogenous inputs to the model. In practice, a number of experimental simulation runs must be performed with different land use control policies and public works programs until a set of policies and programs are determined that result in the implementation of the target land use plan. The feedback on the diagram between land use development and land use plan design accounts for the changes that will probably need to be made in the plan design to make it realizable. The output of the fifth stage of the process illustrated in Figure 1 is a land use plan capable of practical implementation.

The remaining stages of the planning sequence depicted in Figure 1 relate to the development of a transportation plan. The primary inputs to a transportation system are the trips generated as a function of land use. For this reason, the land use plan is shown in the diagram as an input to transportation plan design. It will be noted that no models are indicated in the transportation plan design function. None exist to the knowledge of the Commission staff at this time. Trip distribution and traffic assignment models are, however, used to test the intuitively designed transportation plan. As a result of the simulation model application, the transportation plan network is revised until a satisfactory system is developed. A sizeable literature presently exists in the field of transportation planning and associated simulation models.

In the system diagram, certain feedback relationships are designated by dotted lines. These feedbacks relate to the effect of a later stage of the planning process on an earlier stage. The most obvious is the accessibility effect of the transportation network on land use development. This effect is explicitly formulated in the Land Use Simulation Model by an accessibility factor that influences the flow of relocating households to each geographic area.

The other feedback, relating to the economic effects of the transportation plan, is more difficult to explicitly formulate. Decreased travel times may reduce both the inter- and intra-regional costs of transporting goods, and adequate industrial sites may encourage new firms to locate in the Region; but these effects, particularly the second one, on economic activity within the Region are more difficult to measure and formulate.

SIMULATION MODEL CHARACTERISTICS

Both the Regional Economic Simulation Model, the subject of this report, and the Land Use Simulation Model are dynamic process models which generate a synthetic history of the system variables over a period

[2] *Ibid.*

of time (see Appendix I). Starting from a given set of initial conditions, the difference equations used in the model permit the calculation of the change in the system variables during the first time interval. The new state of the system then becomes the new base for the change computations of the second time period. If A is the initial residential land area and a function dR expresses the change in residential land use in a given time period, then

$$R_t = R_{t-1} + (dT)(dR)$$

where

$$R_o = A$$

and $dR = f(x_1, x_2 --- x_n)$

R_t - Residential land area

dT - Recursive time interval

dR - Rate of change of residential land use

$x_1, x_2 --- x_n$ - Other model variables influencing the rate of change of residential land use

In general, the difference equations are sequential rather than simultaneous, although an exception to this general rule exists in the land use simulation model.

Both the regional economic and land use simulation models are made up of a large number of equations of the type illustrated above. Four classes of problems exist in the development of simulation models of this kind: 1) the formulation of the basic functional relationships involved in the model, 2) the development of a computer program of the model, 3) the estimation of the parameters for the model relationships, and 4) the validation of the model.

The rationale for the solution of each of these problems in the Regional Economic Simulation Model will be explained and related to the current state of model development.

ACCURACY REQUIREMENTS OF EMPLOYMENT AND POPULATION FORECASTS

Each function in the planning process, as illustrated in Figure 1, requires output specifications. The primary specifications of the socio-economic forecasting function relate to accuracy as a function of horizon time. Some estimate of the reliability of the forecast for each five-year time increment into the future must be determined if the forecasts are to be useful in plan design and implementation.

The vital question, of course, is just how accurate must the forecasts be to be useful. To stress the need for forecasts in planning is only to state the obvious. A more difficult problem is to determine the effects of varying degrees of accuracy on the land use and supporting transportation or other facility system plans. The answer to this problem must be framed within the context of the important characteristics of spatial plans and the planning process.

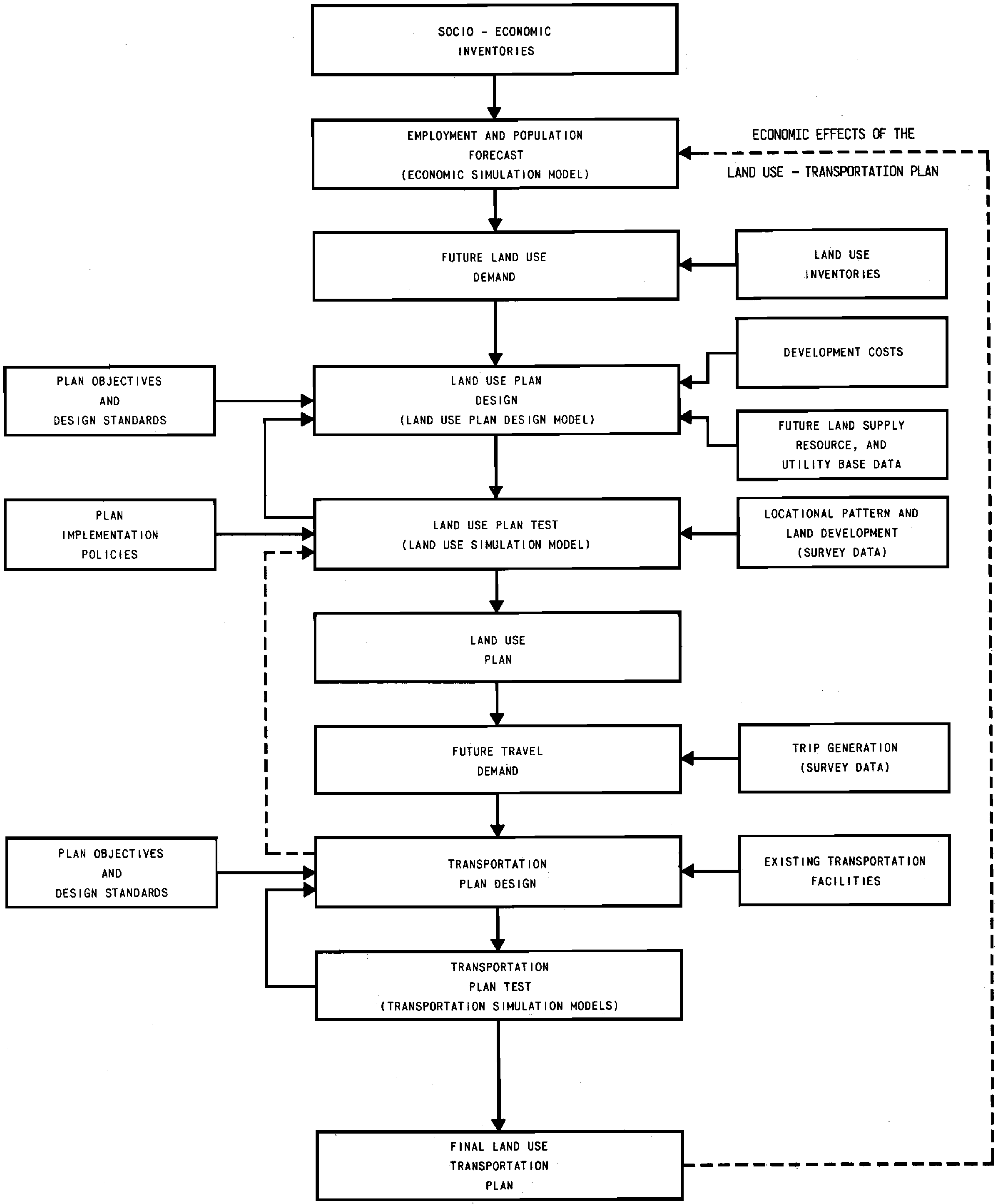
A distinction must be made between incremental changes and structural changes in the plan. Minor variations in the land use pattern or traffic flow will cause little concern, but excessive errors in forecasts may dictate a fundamental structural change in the regional land use pattern or transportation network.

The continuous nature of the planning process must be recognized. Forecasts are not made for once and evermore. New information is used with the passage of time to update forecasts, plans, and plan implementation policies and programs to adapt to changing regional needs. The crucial element is the lead time required to properly implement the planning program.

Fortunately, it is possible using the Land Use Plan Design Model to determine the effects of forecast errors on the land use plan. A sensitivity analysis of the land use plan, accomplished with parametric linear programming techniques, will reveal the critical range of forecast error beyond which the basic structure of the plan would be modified. Such an analysis can provide detailed accuracy specifications for

Figure I

LAND USE-TRANSPORTATION STUDY
PLANNING SYSTEM DIAGRAM



each of the population and employment categories. Through such an approach, it is possible to objectively determine forecast requirements and avoid the two subjective and extreme schools of thought on forecasts for regional planning. One extreme view holds that successful planning is impossible unless extremely accurate forecasts are somehow made. Advocates of this viewpoint rarely provide suggestions for the techniques which might be used to achieve the necessary advances in the state of the art. Aside from its technical naivete, such a view automatically raises doubts about the utility of planning since the extreme difficulties in forecasting the future are only too well known.

Analysis also provides little support for the opposite extreme view that forecast accuracy is of little importance since it only affects the timing of plan implementation and not the structure of the plan design itself. This view implies that the impact of all forecast errors is incremental and not structural. Although a sensitivity analysis of proposed land use plans will not be available until later in 1966, preliminary analysis indicates that accuracy requirements will lean toward the second or "loose" view of forecast accuracy needs, although not to the extreme advocated above. In other words, forecast errors within a reasonable range of accuracy, 10 to 20 percent, will not produce significant structural change in the plans.

The feedback or continuous planning effect on accuracy is more difficult to analyze. In general, it serves to further alleviate accuracy requirements since it is not necessary to forecast beyond the time horizon affected by current plan implementation decisions. It is not necessary to have an accurate forecast of 1990 land requirements if they do not affect decisions being made in 1964.

Extensive analyses of forecast requirements for mathematical production planning models in manufacturing industries indicate that forecasts beyond a few months have little effect on an optimal production plan.[3] Such analyses have not been performed in land use and transportation planning. The general practice has been to base transportation planning forecast periods on a facility life of 20 years. If an additional five years is required for planning, land acquisition, design, and construction, then a 25-year time horizon is indicated. The degree of flexibility for change in the initial five-year period is not clear; but even if a conservative approach allowing for no flexibility is taken, the tolerances allowed prior to structural effects on the plan design indicate that forecast accuracy requirements may be attained with current forecasting methodology.

[3] *Charles C. Holt et al, Planning Production Inventories and Work Force, Prentice-Hall, Englewood Cliffs, N.J., 1960.*

Chapter II
MODEL ORGANIZATION AND RELATIONSHIPS

BASIC ORGANIZATION

The Regional Economic Simulation Model is a flow model. It can be physically visualized as analogous to a large chemical processing plant with a myriad of pipes interconnecting processing facilities. Rather than chemical liquids, the model flows represent materials, finished products and services, and money in the regional economy. In the model these flows interconnect various industries, each of which receives certain flow inputs—labor, materials, and capital equipment—and produces certain outputs—finished goods or services.

A diagram of the model is shown in Figure 2. This diagram illustrates the basic nature of the model flow pattern, although for the sake of simplicity not all of the flows are shown. The three primary exogenous or "outside" variables are government, consumer, and foreign purchases. These variables must be forecast as outside inputs to the model. They are illustrated in the upper right-hand corner of the diagram.

These consumer, government, and foreign purchases flow to the industry (or business) sector of the national and regional economies. This flow subdivides between industries based on an input-output structure. The input-output structure designates the sales and purchasing pattern between industries. For example, a major purchase of electric utilities is coal. This purchase would be represented in the input-output structure by a percentage of electric utility purchases ordered from the mining industry.

The other input-output interconnections are accounted for in a similar fashion. The upper part of the model diagram represents the national economy. The lower part depicts the regional economy. Government, foreign, consumer, and business purchase orders flow into the regional economy. A more detailed input-output structure interconnects the industries, governments, and households in the regional economy. The regional economy differs from the national economy in that it is a "closed"[4] economy. The national economy is "open" in that government, consumer, and foreign purchases are determined outside the model. The regional economy is closed in that households (consumers) and government both consume goods and services and produce goods and services in the regional economy. Government is paid for these services through taxes; and households, by wages, salaries, and dividends.

Inside each of the industries, "bookkeeping" computations are made to account for the short-term flows of materials, goods, and money. Employment of hourly and salaried personnel depends on the level of industry sales and personnel productivity.

The key decision that modifies the flow pattern of the model over time is the investment decision. Investment in plant and equipment results in new levels of output and employment in an industry. In the model investment takes place in response to anticipated sales and profit and the current capacity to produce. Investment in the public sector occurs in response to needs for public facilities and services as limited by funds available from taxes and debt.

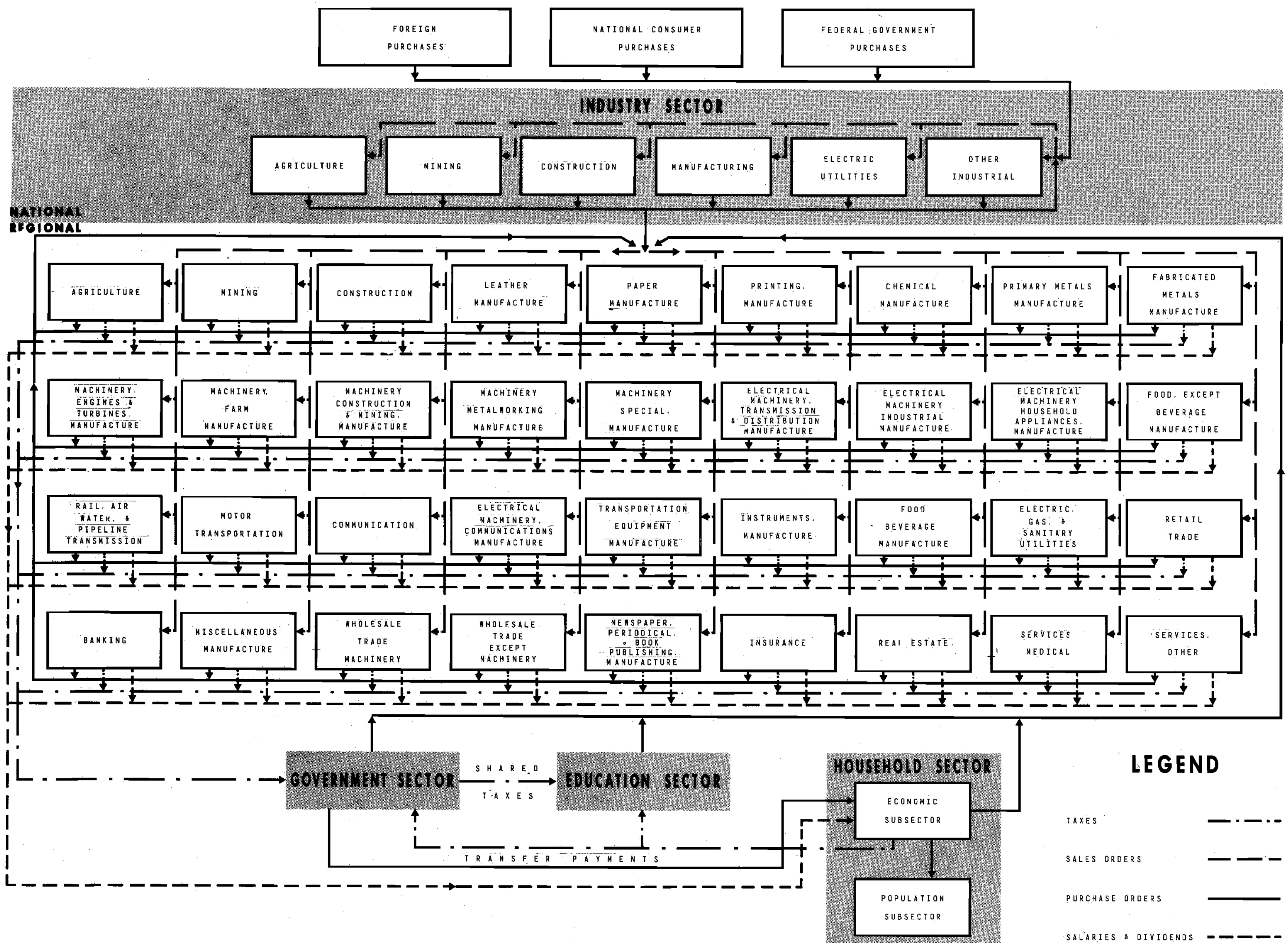
The investment decision is the primary dynamic element in the model. The effects of changes in public (tax or investment changes) and private investment policies will be reflected through the investment decisions.

In summary, the model is a dynamic input-output feedback simulation model. It is behavioral and descriptive in its approach in that it attempts to simulate the way industrial investment decisions are actually made in the Region and not how they should be made. The model is organized into a number of sectors that are interconnected by an input-output matrix. The model is recursive in its operation and sequentially generates a synthetic economic time history of the Region.

[4] *It is technically only partially closed since imports-exports flow in and out of the Region.*

Figure 2

REGIONAL ECONOMIC SIMULATION MODEL



MODEL CHARACTERISTICS

The Regional Economic Simulation Model will be recognized as one of a class of inter-industry or input-output models pioneered by Professor Leontief of Harvard University in the 1930's.[5] Although the original empirical investigations of Leontief and most of the subsequent applications of input-output models have been at the national economy level, a number of urban and regional economic base studies in recent years have used a static input-output structure to analyze a local economy and in a few instances to project industrial output and employment as a function of a forecasted final demand. Although the Regional Economic Simulation Model uses the Leontief input-output structure, it differs from previous urban economic models in a number of significant ways:

1. The model is dynamic and recursive in that it generates a synthetic time history of a changing regional economy rather than a single set of outputs for a given final demand.

2. The regional sector of the model is "closed" by generating household consumption of goods and services as a function of income received from the other regional sectors. In the static open input-output model, household consumption (final demand) is determined outside the model.

3. The classic input-output model of current purchases is supplemented by a companion input-output matrix of purchases for investment. This addition was considered to be crucial in a capital-goods producing region like southeastern Wisconsin.

4. A partial representation of the national economy is included in the form of the primary industrial customers of the Region. This inclusion of an abbreviated national input-output matrix seemed preferable to the alternative of forecasting the national current and capital purchases by individual industry groups.

It is not contended that any of the above model characteristics are new to the field of inter-industry economics. All, except possibly 4. above, have been discussed in the literature.[6] In fact, one economist, Chakravarty, produced a research publication[7] that has been invaluable in the evaluation of the model. Although Chakravarty apparently has not applied his model to an actual nation or region, his theoretical construct is exceptionally well developed and explained. The basic characteristics of the Regional Economic Simulation Model, such as the emphasis on investment, the household consumption function, the investment input-output matrix, and the dynamic recursive operation, were all developed at length by Chakravarty in his publication. Despite the earlier independent nature of the two research efforts, Chakravarty's model will be constantly referred to in the description to follow because of the elegance of his formulation.

While it is important to recognize the characteristics of the Regional Economic Simulation Model, particularly where they represent a change from more conventional economic base studies, it is also crucial to understand that the model represents an extension rather than a negation of previous work. An input-output structure is after all only an elaboration of the fundamental concept of inter-sectoral economic flows implicit in the concept of an economic base of a community. And while the dynamic nature of the model is new, the local multiplier is also really dynamic in the steady-state sense that it represents the end point of a dynamic response to a change in equilibrium. Even the recursive dynamic nature of the model has been anticipated by Tiebout[8] in his excellent summary of economic base study practices.

MODEL RELATIONSHIPS

From the earlier general description, it is apparent that the most fundamental aspect of the model relates to the flows between the respective sectors. This set of flow relationships is mathematically expressed as

[5] *W. Leontief, The Structure of the American Economy, 1919-1939, Oxford University Press, New York, Second Edition, 1951.*

[6] *H. B. Chenery and P. G. Clark, Inter-Industry Economics, Wiley, New York, N.Y., 1959.*

[7] *S. Chakravarty, The Logic of Investment Planning, North-Holland Publishing Company, Amsterdam, 1959.*

[8] *Charles M. Tiebout, The Community Economic Base Study, Committee for Economic Development, New York, N.Y., 1962, p. 57.*

a series of balance equations which relate the output of each sector to the inputs of the other sectors. For each of the industrial sectors:

$$S_k = \sum_i (F_{ki})(P_i) + \sum_i (FC)_{ki}(C_i)$$

where

S_k - Sales (gross output) of industry sector k

P_i - Current purchases of industry sector i

C_i - Capital investment purchases of industry sector i

F_{ki} - Input-output coefficients (share of industry k of current purchases of industry i)

FC_{ki} - Investment coefficients (share of industry k of capital investment purchases of industry i)

The above relationship is general enough in form to encompass both the regional and national sectors. The primary difference between regional and national sectors is that the purchases of the latter partially determine the sales of the former, but the reverse is not true. In other words, regional purchases do not "close back" on the national sectors. Although the generality of the equations expresses the sales-purchase-investment relationship between all industries, it is apparent that the coefficients relating many industries will be zero because there is no transaction activity between many sectors.

One balance equation is required for each industry in the model. Since there are 30 industries at the regional level and 6 at the national level, there are 36 balance equations in the model. The number of input-output and investment coefficients is much larger since these parameters increase by the square of the number of industries. Since the regional household and government sectors are sources of current and investment purchases, there are 32 sectors at the regional level and 1,024 input-output coefficients and the same number of investment coefficients. In addition, each of the regional sectors will have an input-output and investment relationship with each of the nine national sectors (industrial, national household, national government, and foreign) to increase the number of input-output and investment coefficients by 288, for a grand total of 1,312 in each set. Again, it should be emphasized that many of these parameters will be zero.

These balance equations are equivalent to equation set (1) in Chakravarty's Model E. The only differences arise from his consideration of export sales as exogenous variables—he provides no external input-output or investment matrix—and his classification of household consumption as a separate set of variables, although he determines the output of this sector in the same manner as the industrial sectors. In fact, Chakravarty's Model E is equivalent, except in detail, to the primary structure of the Regional Economic Simulation Model.

The balance equations for the household sector are similar in structure to the industrial sectors and differ only in that wages, salaries, dividends, and interest payments from the other sectors serve as the "sales" of the household sector.

$$TWS = \sum_i R_w W_i + \sum_i R_s (SA)_i + \sum_i R_d (DIV)_i + \sum_i R_{in} (INT)_i + \sum_i R_{tp} (TP)_i$$

where

TWS - Total wages, salaries, dividends, interest, and transfer payments paid to the regional household sector

W_i - Wages paid in industry sector i

$(SA)_i$ - Salaries paid in industry sector i

$(DIV)_i$ - Dividends paid in industry sector i

$(INT)_i$ - Interest paid in industry sector i

$(TP)_i$ - Transfer payments paid by regional and national governments

R_w - Regional share of regional wages

R_s - Regional share of regional salaries

R_d - Regional share of regional and national dividends

R_{in} - Regional share of regional and national interest payments

R_{tp} - Regional share of regional and national transfer payments

The government balance equations are also similar in structure except that taxes and debt receipts provide the sales of the sector.

$$TT = \sum_i R_t T_i + \sum_i (DR)_i$$

where

TT - Total governmental tax and debt receipts

T_i - Tax payments, sector i

$(DR)_i$ - Debt payments, sector i

R_t - Regional share of regional tax payments

The income or, in financial terminology, cash flow of each industrial sector is the difference between the revenue received, as determined in the balance equations described above, and the payments for the outputs of the other sectors. These outputs would include raw materials, component parts, supplies, and services from the industrial sectors; wage, salary, dividend, and interest payments to the household sector; and tax payments to the government sector. These payments are determined in the model from the following equations:

$$P_k = (RFG)_k S_k \quad \text{(current purchase payments)}$$
$$W_k = (PRAW)_k S_k \quad \text{(wage payments)}$$
$$(SA)_k = (PRAS)_k S_k \quad \text{(salary payments)}$$
$$T_k = (TR)_k (S_k - P_k - W_k - (SA)_k) \quad \text{(tax payments)}$$

where

RFG_k - Ratio of current purchase to sales, sector b.

$PRAW_k$ - Productivity-wage ratio, sector b.

$PRAS_k$ - Productivity-salary ratio, sector b.

TR_k - Tax ratio, sector b.

The number of hourly and salaried personnel are also determined from the sales output of the industry:

$$EH = (PRH)(S_k)$$
$$ES = (PRS)(S_k)$$

EH - Employment, hourly

ES - Employment, salaried

PRH - Productivity, hourly

PRS - Productivity, salaried

Industrial investment in plant and equipment are discussed separately later in this report.

The household sector resembles the industrial sector except that only current purchases and tax payments are included. Domestic servants and their associated wages are ignored, since they do not form a large group within the Region. Investment in housing will be considered later in the following section.

$$P_k = (RFG)_k (TWS)_k$$
$$T_k = (TR)_k (TWS)_k$$

Symbology for the above equation is as previously defined.

In the regional government sector, tax and debt receipts replace industrial sales and household income in the above equations:

$$P_k = (RFG)_k (TT)_k$$
$$(SA)_k = (PRAS)_k (TT)_k$$
$$(ES)_k = (PRS)_k (TT)_k$$

All government personnel are considered as salaried employees.

At this point, all of the economic flows except those related to investment by industries, households, and government have been accounted for. Since investment is the dynamic force in model operation, it will be discussed separately in the following section.

INVESTMENT RELATIONSHIPS

The investment relationship in the model takes on special meaning for a number of reasons. First of all, investment, as previously indicated, provides the dynamic element in model operations. Without investment the synthetic history generated by the model would depend completely on the exogenous variables of government, consumer, and foreign spending and the input-output and internal parameters previously estimated. The investment relationship, however, adds a third determinant of model output.

A second cause of importance results from the industrial nature of southeastern Wisconsin as a region. Since the primary industrial output of the Region consists of capital goods, the investment decision is the primary determinant of most of the sales of the Region. Industrial investment decisions will be discussed first, followed by households and government.

The formulation of an industrial investment decision relationship in the model is a difficult task since there is no well-accepted theory of industrial investment behavior. A number of studies have identified pertinent variables and tested a number of experimental relationships. The following variables have been identified: 1) sales in relation to plant capacity, 2) income (or cash flow), and 3) costs of raising outside capital.

In Chakravarty's model, investment formulations involving both of the first two variables above are described. In the first, Model D, investment is a function of change of income with a time lag. While in the second, Model E, it is a lagged function of the change in output. Both types of relationships will be tested in the Regional Economic Simulation Model, together with a third version in which investment will be primarily a function of output change but with an income constraint. The equations for each of these three investment relationships are shown below:

INVESTMENT RELATIONSHIP A (income dependent)

$$C_k = (CINV)_k (S_k - P_k - W_k - (SA)_k - T_k)$$

CINV - Capital - income ratio

INVESTMENT RELATIONSHIP B (output change dependent)

RLP with variable k

$$C_k = (COUT)_k (S_{k(t)} - S_{k(t-1)})/(TC)_k$$

COUT - Capital - output ratio

TC_k - Capital gestation time lag

INVESTMENT RELATIONSHIP C (output change and income constraint dependent)

$$C_k = (COUT)_k (S_{k(t)} - S_{k(t-1)})/(TC)_k$$

if $C_k \leq (CINV)_k (S_k - P_k - W_k - (SA)_k - T$

otherwise $C_k = (CINV)_k (S_k - P_k - W_k - (SA)_k - T_k)$

Although conceptually simple, the above relationships represent the primary investment variables of output and income that must be considered in an investment decision. Considerations of plant capacity are implicitly incorporated through the capital-output ratio parameter. The external cost of capital was not considered because of the complexity it would add to the model with little promise of additional accuracy in a region in which most expansion is internally financed.

The household sector investment decision was formulated only as a function of gross income.

$$C_k = (CINV)_k (TWS)_k$$

Government investment is regarded as a programmed exogenous variable since one of the primary purposes of the model is to determine the effects of public works investment spending on the regional economy. Historical simulations of the model will be provided with actual governmental investment spending for the period being simulated. Future simulations make use of programmed capital budgets for the time horizon years.

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Chapter III
ESTIMATION OF MODEL PARAMETERS

PARAMETERS AND DATA SOURCES

All mathematical models consist of variables, relationships, and parameters. The variables and their associated relationships have been described previously in this report. Even with a representative set of variables and relationships, successful model operation is still dependent on the accurate estimation of the relevant model parameters. One of the greatest obstacles to the effective application of economic models to planning has been the lack of data necessary for parameter estimation. In spite of the seemingly endless publication of economic statistics in newspapers and other periodicals, the amount of publicly available data pertinent to the estimation of model parameters is extremely small. The difficulties in using available economic data are compounded by the varied assumptions and definitions used by numerous data collection agencies. All of these difficulties indicated the need for an original economic data collection program to provide the data necessary to make the Regional Economic Simulation Model operable. The use of secondary data sources was considered desirable only when the variable definitions and analytical assumptions were consistent with those used in the model construct. The quantity and quality of the data to be collected, however, is critically dependent on the approach taken to parameter estimation.

Two general approaches to the estimation of the parameters of the Regional Economic Simulation Model are possible. The first approach, common to most econometric models, is that of regression analysis utilizing either primary or secondary historical variable data. Varying levels of statistical sophistication are possible in regression analysis, ranging from an independent simple linear regression for each relationship in the model to a simultaneous maximum-likelihood estimation. Some of the most important recent advances in econometric research have been in the area of advanced simultaneous regression techniques.

A second approach to parameter estimation is through sampling. The behavior of a small number of firms and households may be considered typical of the larger groups of which they are a part. Parameters may be estimated from microscopic analyses of the sample and a subsequent expansion of the results to the entire class of firms or households.

The sampling approach was selected as the primary approach for the Regional Economic Simulation Model for the following reasons:

1. A validity test of the model was considered desirable using the 1946-1963 history of the output variables. If these historical data were used to determine the model parameters, they could not be used as an independent test of model validity.

2. The behavioral approach used to ascertain investment decision rules through firm interviews was more conducive to sampling.

3. The complex nature of the model and the existence of many inequal relationships made a regression analysis approach of the simultaneous kind exceedingly difficult, if not impossible.

The last reason would seem to make the first two extraneous, but sampling was actually more consistent with the concepts involved in the model.

DATA COLLECTION

A complete detailed description of the sources and procedures used in the Regional Economic Simulation Model data collection program is beyond the scope of this report. A separate detailed report of the data collection program has been prepared under separate cover.[9] This report details each of the data sources

[9] *Data Collection Program for the Regional Economic Simulation Model*, Southeastern Wisconsin Regional Planning Commission, Waukesha, Wisconsin, November 1964. Because of the confidential nature of the data contained in this report, collected through private interviews with corporate managers, this report has not been published as have other Commission findings; and loan copies are available only upon special request and after approval by the Commission.

and the relevant procedures. It is, therefore, necessary only to describe herein the basic data sources and some of the problems encountered in processing and analyzing the required data.

Both primary and secondary data sources were used, with the principal sources being: 1) survey of selected firms in each regional industry group, 2) state corporate tax records, 3) state industrial employment and payroll records, and 4) household survey data of the land use-transportation study.

The second source, state corporate tax records, proved to be most valuable, providing important data used for parametric estimations. The third source, in the form of industrial employment data, was also critical in that it provided data at the industry level which provided a basis for sample expansion. The other three sources provided data only for sampled firms and households. Although it would have been theoretically possible to obtain the total universe of corporate tax records, the sheer volume of the data involved made sampling an economic necessity.

External input-output parameters at the regional level were estimated from the purchasing records of sampled firms. Because of the uneven quality of these records, which ranged from detailed commodity classifications to estimates by purchasing personnel, a confirmation of the estimated parameters was sought from a regression analysis of regional sales-purchasing data. The sampled data constituted, however, the primary data source. National input-output parameters were based on the recently computed Department of Commerce table compiled for the year 1958.

The most difficult data to obtain related to that needed for input-output parameter estimation. Although it would have been ideal to provide a control check on the data by obtaining firm data on both input (purchases) and output (sales) composition, such an approach was most difficult to implement. Firms were quite reluctant to provide data on sales composition but were usually willing to provide a detailed classification of purchases. For this reason, the primary check on the input-output parameters was provided by comparisons with the 1958 national input-output matrix.

DATA PROCESSING

Some of the parameters were estimated with only a minimal amount of data processing. This was the case for most of the input-output parameters. Although the data necessary to estimate these parameters was obtainable only by special surveys of sampled firms, the raw form of the data was such that little manipulation was required to provide final model input parameters. Since the input-output parameters were collected as sales output composition ratios and purchasing input composition ratios for the sampled firms, these same ratios could be used to represent the industry of interest. Indeed, most of the data processing related to input-output parameters was the result of accuracy checks of the parameters using the 1958 national matrix and other sources of input-output data.

The direct measurement approach used for the input-output parameter estimation was not applicable to the remaining parameters relating to internal operations and to the investment decision. Considerable data manipulation was necessary to calculate the purchasing, productivity, and personnel ratios and the parameters relating to the investment decision.

All of the economic data collected from corporate tax records, the Wisconsin Industrial Commission, and the industrial surveys, with the exception of the purchase and sales composition (input-output) data, which required special handling, was recorded and key punched with a standard data input format. This format provided the following information from each data source document:

1. Standard industrial classification code of industry.

2. Company or county code.

3. Variable or parameter name.

4. Value of variable or parameter.

5. Variable or parameter indicator.
   (Each record contained only one and not the other.)

6. Units of variable or parameter.

7. Not available indicator.
   (To indicate the absence of a variable or parameter value in an annual series.)

8. Source of data.

9. Date of data.

Source data, which was originally transcribed on numbered data sheets prior to transfer to punched cards, include the following data items:

1. Total personnel in each industry in each county by year.

2. Hourly personnel in each industry in each county by month and year.

3. Total personnel for each sampled firm by month and year.

4. Hourly personnel for each sampled firm by month and year.

5. Sales and costs for each sampled firm by year.

6. Current purchases for each sampled firm by year.

7. Plant and equipment value for each sampled firm by year.

8. Profit for each sampled firm by year.

9. Depreciation for each sampled firm by year.

10. Payroll for each sampled firm by year.

11. Capital purchases for each sampled firm by year.

The basic data reduction problem was to transform the above historical variables into estimates of the internal (non-input-output) parameters of the model. In essence, this reduction involved the expansion of the data from the sampled firms to represent the appropriate industry. This expansion was based on employment since this was the only common variable obtainable at both the firm and industry level. An expansion factor was calculated for each sampled firm in each industry by determining the ratio of firm employment to industry employment. This expansion factor was then used to expand other firm variables to the industry level.

Detailed descriptions and equations of each of the data reduction programs are included in Appendix III. The summary of the data reduction sequence that follows is intended to provide an overview of the procedure. The programs are ordered in computation sequence.

Program 1 Regional Industry Employment Summation

A. Inputs

   1. Monthly county total personnel by industry.

   2. Monthly county hourly personnel by industry.

B. Operation

1. The program summarizes monthly county employment by industry to obtain annual average regional employment by industry.

C. Output

1. Annual average regional total personnel by industry.

2. Annual average regional hourly personnel by industry.

Program 2 Company Expansion Factors

A. Inputs

1. Annual average regional total personnel by industry.

2. Monthly company total personnel.

3. Monthly company hourly personnel.

B. Operation

1. The program accumulates monthly company total personnel data to obtain annual average personnel and divides this average by the total personnel in the industry to calculate the expansion factor for each firm. It also accumulates monthly company hourly personnel to determine an annual average.

C. Outputs

1. Company expansion factor.

2. Annual average company total personnel.

3. Annual average company hourly personnel.

Program 3 Regional Industry Sales

A. Inputs

1. Company expansion factor.

2. Company national sales.[10]

3. Company national manufacturing costs.

4. Company Wisconsin manufacturing costs.

B. Operation

1. Company regional sales are calculated by reducing national sales by the ratio of Wisconsin manufacturing costs (really regional manufacturing costs since all firms used had all of their Wisconsin plants in the Region) to national manufacturing costs. Regional industry sales are then determined using the company expansion factors.

[10] *All variable data is annual unless otherwise specified.*

C. Outputs

1. Regional industry sales.

2. Regional company sales.

Program 4 Raw Material Fraction

A. Inputs

1. Company national sales.

2. Company total raw material purchase.

3. Company total purchase discounts.

4. Company expansion factor.

B. Operation

1. Company purchases are discounted and expanded to provide industry purchases. The raw material purchase ratio (fraction) of sales is also calculated.

C. Outputs

1. Industry raw material purchases.

2. Company raw material fraction.

3. Industry raw material fraction.

Program 5 Plant and Equipment

A. Inputs

1. Company national plant and equipment.

2. Company national tangible (total) property.

3. Company Wisconsin tangible property.

4. Company expansion factor.

B. Operation

1. The regional plant and equipment is determined from the ratio of property in Wisconsin to total national property in each firm. Plant and equipment for each industry is then provided using the company expansion factors.

C. Outputs

1. Company regional plant and equipment.

2. Industry regional plant and equipment.

Program 6 Hourly Personnel, Average Monthly Wage

A. Inputs

1. Company hourly payroll.

2. Company hourly personnel.

B. Operation

1. The company and industry average monthly wage is computed.

C. Output

1. Company average monthly wage.

2. Industry average monthly wage.

Program 7 Average Monthly Salary

A. Inputs

1. Company total personnel.

2. Company hourly personnel.

3. Company taxable and nontaxable payroll.

B. Operation

1. Salaried personnel are determined from the difference between total and hourly personnel. Total payroll is the sum of taxable and nontaxable payroll. Salaried payroll is indirectly determined from total and hourly payroll data. Knowing both salaried personnel and monthly salaries, the average salary may then be determined.

C. Outputs

1. Company salaried personnel.

2. Company average monthly salary.

3. Industry average monthly salary.

Program 8 Capital Expenditures

A. Inputs

1. Company Wisconsin capital purchases.

2. Company national capital purchases.

3. Company plant and equipment.

4. Company depreciation.

B. Operation

1. If capital expenditures data was available for the firms, it was used directly. If it was not available, capital expenditures were computed indirectly from the plant and equipment depreciation.

C. Outputs

1. Company capital expenditures.

2. Industry capital expenditures.

Program 9 Industry Hourly and Salaried Personnel

A. Inputs

1. Industry total personnel.

2. Industry hourly personnel.

3. Company hourly personnel.

4. Company salaried personnel.

5. Company expansion factor.

B. Operation

1. This program provides an annual summation of hourly and salaried personnel for those industries in which employment data at the county level was not available for summation in Program 1.

C. Outputs

1. Industry hourly personnel.

2. Industry salaried personnel.

Program 10 Industry Summary

A. Inputs

1. Outputs of previous programs.

B. Operation

1. This program provides a printed output of the key variables and parameters by year from each of the previous programs.

C. Outputs

1. Annual key variables.

2. Annual key parameters.

The combination of the input-output parameters; the outputs of the above data reduction programs; and a future forecast of federal government, national consumer, and net foreign purchases provided all of the required inputs for the Regional Economic Simulation Model runs which will be discussed in the next section of this report. A summary of the key variables and parameters is presented in Tables 1 and 2.

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Chapter IV
MODEL TESTS AND FORECAST RESULTS

INTRODUCTION

The two objectives of the model runs were:

1. To test the model by comparing simulated and historical variable outputs from 1946-1962.
2. To provide population and employment forecasts for the years 1970, 1980, and 1990 for regional plan preparation.

Originally, it was intended that extensive sensitivity analyses of the model would be performed to determine the effects of changes in parameters, such as productivity, capital investment rate, and regional market share on future employment in the Region. Time and cost limitations and the requirements of other activities in land use model application limited sensitivity analysis to investigations of the effects of changes in the future increase in productivity. Productivity proved to be a most sensitive parameter affecting model operation. It is planned to perform more extensive sensitivity analyses as part of the continuing regional planning program.

The model program used for both the historical and forecast model runs is listed in Appendix II. The program is in Fortran II-D language for the IBM 1620. The program listing includes definitions of symbols used and is extensively commented so that a person familiar with Fortran can easily understand the model program operation.

In addition to the model program, three classes of data, discussed in the previous chapter, were necessary for the historical and forecast runs. These included:

1. The exogenous variables of consumer purchases, federal government purchases, and gross exports for the years 1946-1960 and a forecast of these same variables for 1970, 1980, and 1990.
2. The input-output parameters, national and regional, relating the sales and purchases of all of the industries in the model.
3. The internal resource parameters in each industry relating material purchases, capital spending, employment, and wages in each industry to the output of that industry.

The exogenous variables used in the model runs are tabulated in Table 1. The variables with the exception of gross exports were available on an annual basis from 1946-1960. Gross export data were available only at five-year intervals. Intermediate-year values were obtained by linear interpolation. Forecasts of each exogenous variable were made for 1970, 1980, and 1990. Intermediate future years were also obtained by linear interpolation. Gross national product was not used directly as a model input but is listed as a general measure of national output that includes all of the other exogenous variables.

The input-output parameters are tabulated in Table 2. The upper part of the table illustrates the aggregated national matrix used to convert the exogenous variables into business spending (current purchases and capital goods) at the national level. As previously discussed, this national matrix singles out regional customers, such as construction and electric utilities. This approach obviated the need for an exogenous forecast of each of these national industries. The lower and much larger part of the matrix depicts the regional inter-industry relationships.

The third set of input data, the internal parameters within each industry, are presented in Appendix IV. These parameters denote the labor, material, and capital equipment resources needed to provide the output of each industry, including government (local and state) and households.

Although historical and forecast runs of the model will be discussed separately in the sections to follow, it is important to note that in actual model operation the two periods (historical and future) were run as a single simulation. The model was initialized in 1946 and then run until 1990. The model was not reinitialized in 1960 or 1962, the two years for which detailed historical data were available. These milestone years, particularly 1960, were used rather to evaluate the historical performance of the model as discussed in the following section.

This approach to model operation provides a simulation model which may be defined as a free running model not recalibrated on a period-to-period basis, in contrast to a single-period model which is calibrated on a period-to-period basis.

HISTORICAL SIMULATION

A comparison of the model-generated employment variables and the actual employment by major industries in 1960 is shown in Table 3. A detailed comparison within primary manufacturing categories is shown in Table 4.

The overall accuracy of the model in simulating historic economic activity proved to be quite good. Total employment was in error by only 2.9 percent and manufacturing employment by only 0.8 percent. Individual industries, however, deviated to a much greater degree. When compared with actual employment figures in the major industries, finance, insurance, and real estate simulated employment was in error by 19.1 percent and private services employment by 19.6 percent. In the manufacturing industries, paper and wood products manufacturing simulated employment was in error by 45.3 percent. Historical results, however, established sufficient confidence to justify application of the model to forecasting. Employment rather than the output (sales) of each industry was used for the model performance comparisons because of the higher reliability of available data.

It is important to note that the historical accuracy of the model is not necessarily indicative of the future forecasting performance of the model. Since the actual exogenous variables were used in the historic simu-

Table 1

EXOGENOUS VARIABLES-HISTORICAL AND FORECAST
REGIONAL ECONOMIC SIMULATION MODEL

(In Billions of Dollars, 1960)

Year	Gross National Product	Consumer Purchases	Federal Government Purchases	Gross Exports
1946	322.3	211.5	55.9	11.3
1947	321.8	215.1	47.2	12.3
1948	334.1	219.3	52.7	13.3
1949	333.8	224.7	58.6	14.3
1950	362.6	238.4	56.8	15.3
1951	391.4	240.6	79.4	16.3
1952	406.5	246.9	96.9	17.3
1953	423.6	258.7	104.1	18.3
1954	416.8	262.1	93.7	19.3
1955	449.3	281.5	91.4	20.3
1956	459.0	290.9	90.6	21.6
1957	468.0	298.6	94.5	22.9
1958	460.1	301.2	98.9	24.1
1959	490.7	319.0	99.9	25.4
1960	504.4	328.9	100.1	26.7
1970	746.0	462.0	160.0	38.0
1980	1,060.0	662.0	242.0	58.4
1990	1,510.0	944.0	365.0	91.2

Source: SEWRPC.

Table 2

INPUT-OUTPUT MATRIX FOR REGIONAL ECONOMIC SIMULATION MODEL

	Selling Industries / Purchasing Industries	NATIONAL									REGIONAL											
		Foreign Purchases (export spending)	Consumer Purchases	Government Purchases	Agriculture	Mining	Construction	Manufacturing	Electric Utilities	Other Industries	Agriculture	Mining	Construction	Food	Leather, Apparel, Textiles	Paper, Lumber, Furniture	Newspaper, Periodical, & Book Publishing & Printing	Chemicals	Primary Metals	Fabricated Metals	Machinery, Engines & Turbines	Machinery, Farm
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		DIRECT REQUIREMENTS PER DOLLAR OF GROSS OUTPUT																				
NATIONAL	4 Agriculture	0.0789	0.0168	0.0217	.54212			.06247		.00769												
	5 Mining	0.0206	0.0010	0.0040	.00230	.16991	.02060	.01936	.17553	.00101												
	6 Construction	0.0001	0.2	0.0830																		
	7 Manufacturing	0.5041	0.3558	0.3047	.14072	.13140	.67479	.64938	.05313	.20600												
	8 Electric Utilities	0.0015	0.0278	0.0065	.00574	.03568	.00392	.01493	.34650	.05233												
	9 Other Industries	0.2020	0.5865	0.2153	.30910	.48238	.30066	.25383	.42481	.73294												
REGIONAL	10 Agriculture	.00019	.00004	.00005	.00132			.00015		.00001	.54212			.43968	.04681	.05455		.00119	.00027			.00274
	11 Mining					0.00001		0.00023	0.00003	0.00018		0.00727	0.00122		0.00003	0.01024	0.00031	0.05695	0.06233	0.00073		0.00001
	12 Construction			.00083																		
	13 Food	.00063	.00208	.00005	.00069			.00035		.00018	.05252	.00002		.22443	.00084	.00659		.01335	.00065	.00001		.00013
	14 Leather, Apparel, Textiles	.00011	.00031	.00002	.00004			.00064		.00006	.00867	.00087	.00026	.00303	.65780	.02936	.00288	.05645	.00339	.00382	.00347	.00410
	15 Paper, Lumber, Furniture	.00009	.00006	.00001	.00005	.00006	.00041	.00050	.00001	.00013	.01007	.01226	.07897	.02794	.01922	.42768	.33944	.03639	.06011	.03152	.01874	.01618
	16 Newspaper, Periodical, & Book Publishing & Printing	.00007	.00015	.00003				.00031		.00073	.00027	.00039	.00018	.00253	.00245	.00906	.24923	.00405	.00279	.00295	.00448	.00102
	17 Chemicals	.00029	.00013	.00009	.00019	.00021	.00066	.00028	.00008	.00021	.06207	.06885	.21861	.01816	.07735	.08431	.03227	.43133	.07338	.03988	.03407	.09411
	18 Primary Metals	.00049	.00001	.00009		.00049	.00216	.00185	.00006	.00009	.00067	.04256	.18617	.01329	.00217	.03427	.00231	.02466	.36118	.56204	.43067	.35328
	19 Fabricated Metals	.00038	.00004	.00017	.00008	.00026	.00253	.00099	.00027	.00009	.00485	.01542	.15000	.03678	.00352	.03710	.00369	.02680	.03304	.13081	.07879	.09105
	20 Machinery, Engines & Turbines	.00127	.00005	.00063																		
	21 Machinery, Farm	.00073																				
	22 Machinery, Construction & Mining	.00216		.00025																		
	23 Machinery, Metalworking	.00031		.00007																		
	24 Machinery, Special	.00075	.00002	.00014				.00022		.00001	.00009	.00034	.00005	.00001	.00003	.00044	.00009	.00176	.00588	.00688	.09156	.03239
	25 Elec. Mach., Transmission Distribution & Industrial	.00075		.00021																		
	26 Electrical Machinery, Lighting & Medical	.00006	.00002	.00002		.00001	.00024	.00012		.00004	.00065	.00143	.02010	.00053	.00030	.00183	.00021	.00119	.00713	.00499	.05514	.01842
	27 Electrical Machinery, Household Appliances	.00012	.00015				.00017	.00004		.00003			.00938			.00036		.00029	.00035	.00703	.00012	.00786
	28 Electrical Machinery, Communications & Components	.00020	.00008	.00049		.00002	.00005	.00053		.00014		.00148	.00342		.00013	.00028	.00087	.00064	.00053	.00193	.00027	.00018
	29 Transportation Equipment	0.00190	0.00160	0.00030																		
	30 Instruments	.00012	.00002	.00013				.00002		.00004		.00005			.00022	.00020	.00759	.00088	.00016	.00042	.00018	.00015
	31 Miscellaneous Manufacturing	.00012	.00011	.00003			.00004	.00010	.00001	.00009	.00106	.00176	.00798	.00120	.01966	.00483	.01172	.00473	.00358	.00658	.00615	.00967
	32 Transportation	.00096	.00029	.00026	.00023	.00069	.00046	.00039	.00037	.00042	.02420	.07075	.04683	.05408	.02093	.05961	.02843	.04898	.07908	.03133	.03804	.03554
	33 Communication	.00002	.00010	.00002	.00004	.00001	.00002	.00006	.00003	.00033	.00525	.00186	.00283	.00327	.00418	.00511	.02434	.00517	.00591	.00554	.00777	.00546
	34 Electrical, Gas, & Sanitary Utilities	.00004	.00029	.00009	.00006	.00043	.00004	.00017	.00619	.00091	.00653	.04519	.00426	.00855	.01066	.02047	.02210	.02580	.05329	.01574	.01652	.01691
	35 Trade	.00054	.00194	.00011	.00041	.00053	.00198	.00063	.00022	.00061	.04552	.05815	.21667	.04955	.05559	.06947	.04550	.04698	.06394	.06446	.08257	.08811
	36 Banking & Insurance		.00028		.00013	.00017	.00005	.00008	.00007	.00065	.01937	.02476	.00774	.00710	.01028	.00943	.01858	.01217	.01580	.01383	.01807	.01550
	37 Real Estate	.00012	.00152	.00002	.00067	.00219	.00006	.00020	.00006	.00189	.06120	.19797	.00548	.00598	.01448	.01080	.06980	.01559	.01057	.01173	.01374	.01160
	38 Services, Except Medical	.00011	.00042	.00074	.00034	.00042	.00012	.00039	.00020	.00150	.05333	.06564	.01885	.04687	.03191	.03571	.13298	.07436	.03947	.04392	.08601	.08149
	39 Services, Medical		.00125	.00003	.00005	.00004	.00002	.00003	.00002	.00016	.00286	.00229	.00151	.00131	.00173	.00158	.00210	.00160	.00186	.00180	.00286	.00217
	40 Households																					
	41 Government																					

Table 2 (continued)

INPUT-OUTPUT MATRIX FOR REGIONAL ECONOMIC SIMULATION MODEL

	Selling Industries / Purchasing Industries	REGIONAL: Machinery, Construction & Mining	Machinery, Metalworking	Machinery, Special	Electrical Machinery, Transmission Distribution & Industrial	Electrical Machinery, Lighting & Medical	Electrical Machinery, Household Appliances	Electrical Machinery, Communications & Components	Transportation Equipment	Instruments	Miscellaneous Manufacturing	Transportation	Communication	Electrical, Gas, & Sanitary Utilities	Trade	Banking & Insurance	Real Estate	Services, Except Medical	Services, Medical	Households	Government
		22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
		DIRECT REQUIREMENTS PER DOLLAR OF GROSS OUTPUT																			
NATIONAL	4 Agriculture																				
	5 Mining																				
	6 Construction																				
	7 Manufacturing																				
	8 Electric Utilities																				
	9 Other Industries																				
REGIONAL	10 Agriculture									.00210	.00282	.00323			.00618		.20218	.00072	.00155	0.0168	0.0010
	11 Mining	0.06066	0.00007	0.00352	0.00183	0.00025			0.00372	0.00026	0.00037	0.01610	0.00167	0.02419	0.03824	0.01086	0.02512	0.00998	0.00091		
	12 Construction																				0.3803
	13 Food	.00007		.00024			.00001			.00562	.00142	.00862		.00004	.02136		.00561	.00123	.02702	0.0300	0.0013
	14 Leather, Apparel, Textiles	.00380	.00404	.00570	.00426	.00252	.00956	.00250	.01865	.02614	.03888	.00394	.00859	.00020	.00584	.00466	.00499	.03904	.01595	0.00056	0.00003
	15 Paper, Lumber, Furniture	.00827	.00559	.02180	.03409	.03251	.03750	.06079	.02489	.05787	.08342	.00591	.00197	.00197	.03980	.01094	.00444	.01984	.01721	0.0006	0.0002
	16 Newspaper, Periodical, & Book Publishing & Printing	.00130	.00026	.00319	.00307	.00055	.00127	.00223	.00194	.00112	.00733	.00650	.09181	.00051	.00949	.03420	.00511	.16414	.05136	0.0084	0.0043
	17 Chemicals	.06674	.03538	.04391	.06280	.11961	.09458	.04526	.07073	.08462	.10993	.16071	.01988	.02718	.04891	.01370	.04749	.06245	.11587	0.0431	0.0216
	18 Primary Metals	.43873	.36846	.33856	.36179	.30730	.25564	.12080	.26942	.15491	.15170	.00827	.01868	.00562	.01002		.00511	.00983	.00101	0.0012	0.0001
	19 Fabricated Metals	.11967	.16733	.10813	.06835	.07999	.20374	.06625	.14448	.07566	.05120	.00491	.00235	.01618	.00852		.00211	.00564	.00329	0.0024	0.0012
	20 Machinery, Engines & Turbines																			0.0004	0.0001
	21 Machinery, Farm																				0.0004
	22 Machinery, Construction & Mining																				0.0017
	23 Machinery, Metalworking																			0.0001	0.0001
	24 Machinery, Special	.02146	.01994	.05131	.00455	.00898	.00194	.00191	.02300	.01312	.09364	.00058			.00088		.00077	.00278	.00003	0.0012	0.0044
	25 Elec. Mach., Transmission Distribution & Industrial																			0.0001	0.0001
	26 Electrical Machinery, Lighting & Medical	.00937	.00223	.00799	.04959	.14980	.01608	.02122	.03086	.01224	.01684	.00691	.00364	.00029	.00272	.00016	.00055	.00517	.00184	0.0020	0.0010
	27 Electrical Machinery, Household Appliances	.00032	.00628	.01748	.00152	.00264	.02129	.00095	.00487	.00145	.00219				.00096		.00094	.01110		0.0083	
	28 Electrical Machinery, Communications & Components	.00214	.00049	.04164	.09792	.02244	.00059	.38519	.05594	.07083	.04455	.00368	.10504	.00039	.00295		.00222	.02286	.00173	0.0052	0.0015
	29 Transportation Equipment														0.03132					0.00160	0.00015
	30 Instruments	.00019	.00046	.00147	.00173	.00047	.00290	.00326	.00308	.04695	.00081			.00002	.00146		.00044	.01693	.01150	0.0028	0.0025
	31 Miscellaneous Manufacturing	.02534	.01165	.00626	.00784	.00806	.00342	.04231	.08241	.06425	.08348	.00786	.03881	.00236	.01356	.01380	.00422	.04582	.01902	0.0238	0.0078
	32 Transportation	.03902	.02659	.03183	.03151	.02722	.03144	.02258	.04206	.02911	.02799	.18756	.01389	.03807	.01598	.02042	.03488	.01496	.01910	0.0298	0.0099
	33 Communication	.00922	.02662	.01949	.01068	.00594	.00823	.00627	.00976	.00966	.01028	.02340	.07945	.00477	.04084	.03576	.02121	.07298	.03031	0.0135	0.0047
	34 Electrical, Gas, & Sanitary Utilities	.01849	.02287	.01875	.02475	.01571	.01654	.01438	.01943	.01273	.01211	.08119	.08241	.64808	.13129	.04535	.08398	.05869	.07104	0.0311	0.0138
	35 Trade	.10614	.09640	.11974	.08206	.10482	.08372	.08458	.07952	.10929	.09582	.08664	.04326	.02457	.06382	.02221	.09581	.08288	.06692	0.2122	0.0045
	36 Banking & Insurance	.02048	.02547	.01854	.01189	.00879	.00648	.00779	.01077	.01313	.01571	.06055	.04522	.01132	.06374	.46817	.18519	.03597	.04214	0.0407	0.0047
	37 Real Estate	.01839	.05713	.02657	.02023	.01734	.01044	.02211	.01291	.02585	.01911	.08829	.13848	.00571	.20364	.17887	.11370	.10288	.24809	0.1378	0.0058
	38 Services, Except Medical	.07712	.07981	.08755	.08829	.06442	.19127	.07782	.05454	.11488	.07368	.12847	.25506	.03173	.30258	.12861	.16208	.21205	.20692	0.0654	0.0179
	39 Services, Medical	.00271	.00306	.00261	.00260	.00202	.00198	.00201	.00280	.00236	.00213	.00270	.00733	.00168	.00384	.01219	.00338	.00169	.04717	0.0705	0.0077
	40 Households																				
	41 Government																				

Table 3

COMPARISON OF ACTUAL AND MODEL SIMULATION EMPLOYMENT BY MAJOR INDUSTRY GROUP FOR THE REGION

Employment Type	1960 Actual	1960 Model Simulation	Percent Error
Agriculture	12.9	13.3	3.1
Construction and Mining	29.5	33.2	12.6
Manufacturing	253.0	255.1	0.8
Trade	120.2	110.3	8.1
Transportation, Communications, and Utilities.	34.8	37.9	8.9
Finance, Insurance, Real Estate	23.0	18.6	19.1
Private Services and Education.	119.9	143.4	19.6
Government Services (Except Education). . . .	22.7	22.3	1.8
Total Employment	616.0	634.1	2.9

Source: SEWRPC.

Table 4

COMPARISON OF ACTUAL AND MODEL SIMULATION MANUFACTURING EMPLOYMENT BY INDUSTRY FOR THE SOUTHEASTERN WISCONSIN REGION

Industry Type	1960 Actual	1960 Model Simulation	Percent Error
Food and Related Products.	21.3	21.9	2.8
Textile, Apparel, Leather Products	14.2	16.2	14.1
Paper and Wood Products.	9.5	13.8	45.3
Printing and Publishing.	16.3	15.6	4.3
Chemicals.	4.0	4.9	22.5
Primary Metals	19.4	20.3	4.6
Fabricated Metals.	18.3	17.7	3.3
Machinery.	58.8	53.0	10.0
Electrical Equipment	40.9	39.2	4.2
Transportation Equipment	33.4	35.4	6.0
Instruments.	3.4	3.1	8.8
Miscellaneous Manufacturing.	13.5	14.0	3.7
Total	253.0	255.1	0.8

Source: SEWRPC.

lation, no error was contributed from this source. In the forecast simulation, these exogenous variables themselves must be forecast and would, therefore, introduce a source of error.

Errors in the historical run may be attributed to approximations in the input-output matrix and the internal resource parameters. These approximations will also be present, perhaps to a greater degree, in the forecast runs. In the forecast runs, the present input-output matrix was assumed to remain constant over time, an admittedly weak assumption but a necessary one which can be modified only as more input-output data becomes available in future years to indicate trends in these parameters. Most of the internal resource parameters were also assumed to remain constant over time in the forecast runs. An exception to this rule was productivity, which was assigned an annual rate of increase based on recent historical trends. Productivity trend forecasts are discussed more fully in the next section.

FORECAST SIMULATION

Model forecasts of future regional employment by major industry for the years 1970, 1980, and 1990 are shown in Table 5. Model forecasts of manufacturing employment for these same years are tabulated in Table 6.

Table 5

MODEL FORECAST OF EMPLOYMENT BY MAJOR INDUSTRY FOR THE REGION
(2 1/2 Percent Average Annual Productivity Growth)

Employment Type	Year				Percent Change
	1960	1970	1980	1990	1960 to 1990
Agriculture	12.9	10.6	9.1	7.9	-38.8
Construction and Mining	29.5	38.9	43.9	49.8	68.8
Manufacturing	253.0	288.2	327.5	370.2	46.3
Trade	120.2	127.4	143.8	162.1	34.8
Transportation, Communications, Utilities	34.8	43.8	49.5	55.9	60.6
Finance, Insurance, and Real Estate	23.0	21.5	24.3	29.4	27.8
Private Services and Education	119.9	166.9	188.6	213.2	77.8
Government Services (except education)	22.7	33.2	48.1	69.4	205.7
Total Employment	616.0	730.5	834.8	957.9	55.5

Source: SEWRPC.

Table 6

MODEL FORECAST OF MANUFACTURING EMPLOYMENT
BY INDUSTRY FOR THE REGION
(2 1/2 Percent Average Annual Productivity Growth)

Industry Type	Year				Percent Change
	1960	1970	1980	1990	1960 to 1990
Food & Related Products	21.3	24.8	27.9	31.3	46.9
Textile, Apparel, Leather Products	14.2	18.2	20.6	23.2	63.3
Paper and Wood Products	9.5	15.7	17.8	20.0	110.5
Printing and Publishing	16.3	17.9	20.2	22.8	39.8
Chemicals	4.0	5.7	6.5	7.3	82.5
Primary Metals	19.4	22.7	25.7	29.1	50.0
Fabricated Metal Products	18.3	20.0	22.7	25.8	40.9
Machinery	58.8	60.4	70.4	81.1	37.9
Electrical Equipment	40.9	44.3	50.9	57.8	41.3
Transportation Equipment	33.4	40.3	45.5	51.2	53.2
Instruments	3.4	3.6	4.1	4.7	38.2
Miscellaneous Manufacturing	13.5	14.6	15.2	15.9	17.7
Total	253.0	288.2	327.5	370.2	46.3

Source: SEWRPC.

Employment forecasts were the major output requirements of the model. These variables are used to estimate future population and the resulting land requirements. A number of other variables of interest, however, are generated in model operation. These variables, such as sales, purchases, value added, and capital expenditures, are summarized for the forecast years in Tables 7, 8, and 9.

Productivity parameters are a key factor in any forecasts of future employment since this set of parameters provides the conversion matrix necessary to translate output variables into employment variables. Regional productivity data for the years 1946-1960 were used to forecast trends in future regional productivity in each industry. The long-term (1946-1960) average annual growth in productivity was 2 percent

Table 7

MANUFACTURING INDUSTRIAL OUTPUT FORECAST FOR THE REGION 1970

(In Millions of Dollars)

Industry	SIC	Sales	Purchases	Value Added	Capital Expenditures
Food	20	1,400.0	1,050.0	350.0	26.1
Leather, Apparel, Textiles	22,23,31	255.2	191.4	63.8	3.9
Paper, Lumber, Furniture	24,25,26	386.3	231.7	154.6	14.1
Printing and Publishing	27	424.2	220.5	203.7	11.5
Chemicals	28	393.3	235.9	157.4	14.7
Primary Metals	33	474.2	260.8	213.4	19.2
Fabricated Metals	34	625.6	394.1	231.5	16.4
Machinery, Engines and Turbines	351	401.3	232.7	168.6	14.3
Machinery, Farm	352	204.3	130.7	73.6	4.4
Machinery, Construction and Mining	353	333.6	196.8	136.8	6.1
Machinery, Metalworking	354	123.5	60.5	63.0	3.7
Machinery, Special	355,356,357, 358,359	441.6	247.3	194.3	12.4
Electrical Machinery, Transmission Distribution and Industrial	361,362 364,369	494.9	247.5	247.4	10.3
Electrical Machinery, Appliances	363	70.2	47.0	23.2	1.2
Electrical Machinery, Components	365,366,367	361.2	180.6	180.6	15.0
Transportation Equipment	37	1,871.0	1,122.0	749.0	66.8
Instruments	38	100.9	33.9	67.0	3.1
Miscellaneous Manufacturing	19,21,30, 32,39	98.4	59.0	39.4	4.9
Total Manufacturing		8,459.7	5,142.4	3,317.3	248.1

Source: SEWRPC.

Table 8

MANUFACTURING INDUSTRIAL OUTPUT FORECAST FOR THE REGION 1980

(In Millions of Dollars)

Industry	SIC	Sales	Purchases	Value Added	Capital Expenditures
Food	20	2,014.0	1,510.0	504.0	37.4
Leather, Apparel, Textiles	22,23,31	368.7	276.5	92.2	5.6
Paper, Lumber, Furniture	24,25,26	558.9	335.3	223.6	20.3
Printing and Publishing	27	612.9	318.7	294.2	16.7
Chemicals	28	569.8	341.9	227.9	21.3
Primary Metals	33	689.0	379.0	310.0	27.9
Fabricated Metals	34	909.3	572.8	336.5	23.8
Machinery, Engines and Turbines	351	601.8	349.0	252.8	21.4
Machinery, Farm	352	304.1	194.6	109.5	6.5
Machinery, Construction and Mining	353	505.6	298.3	207.3	9.2
Machinery, Metalworking	354	182.9	89.6	93.3	5.5
Machinery, Special	355,356,357, 358,359	646.9	362.3	284.6	18.2
Electrical Machinery, Transmission Distribution and Industrial	361,362 364,369	727.4	363.7	363.7	15.1
Electrical Machinery, Appliances	363	101.3	67.9	33.4	1.7
Electrical Machinery, Components	365,366,367	527.4	263.7	263.7	57.0
Transportation Equipment	37	2,705.0	1,623.0	1,082.0	96.6
Instruments	38	146.9	49.3	97.6	4.5
Miscellaneous Manufacturing	19,21.30 32,39	142.3	85.4	56.9	7.1
Total Manufacturing		12,314.2	7,481.0	4,833.2	395.8

Source: SEWRPC.

Table 9

MANUFACTURING INDUSTRIAL OUTPUT FORECAST FOR THE REGION 1990

(In Millions of Dollars)

Industry	SIC	Sales	Purchases	Value Added	Capital Expenditures
Food	20	2,892.0	2,169.0	723.0	53.8
Leather, Apparel, Textiles	22,23,31	531.7	398.8	132.9	8.1
Paper, Lumber, Furniture	24,25,26	808.1	484.9	323.2	29.4
Printing and Publishing.	27	885.5	460.4	425.1	24.1
Chemicals.	28	824.7	494.8	329.9	30.8
Primary Metals	33	998.7	549.2	449.5	40.4
Fabricated Metals.	34	1,318.0	830.3	487.7	34.5
Machinery, Engines and Turbines. . .	351	892.3	517.5	374.8	31.8
Machinery, Farm.	352	446.7	285.9	160.8	9.6
Machinery, Construction and Mining .	353	752.1	443.7	308.4	13.8
Machinery, Metalworking.	354	268.6	131.6	137.0	8.1
Machinery, Special	355,356,357, 358,359	943.0	528.0	415.0	26.6
Electrical Machinery, Transmission Distribution and Industrial. . . .	361,362 364,369	1,063.0	531.8	531.2	22.1
Electrical Machinery, Appliances	363	146.0	97.9	48.1	2.5
Electrical Machinery, Components	365,366,367	767.7	383.8	383.9	82.9
Transportation Equipment	37	3,896.0	2,337.0	1,559.0	139.0
Instruments.	38	213.6	71.7	141.9	6.6
Miscellaneous Manufacturing.	19,21,39, 30,32	205.7	123.4	82.3	10.3
Total Manufacturing		17,853.4	10,839.7	7,013.7	574.4

Source: SEWRPC.

per annum. This trend has increased in recent years to 2 1/2 percent per annum. The more recent trend was finally used for the final forecasts although sensitivity runs were performed at 2 percent and 3 percent per annum. The higher trend of 2 1/2 percent per annum was used for the forecasts because it was considered to be more typical of future trends.

Since the model results are forecasts, only time will indicate their accuracy. It is of interest to observe, however, that a comparison of model forecasts with recent 1965 employment figures indicates that, in the short run at least, model performance is more than satisfactory. These results have occurred in spite of an earlier opinion that model forecast results might be "high." A discussion of the application of the model forecasts in the planning process in southeastern Wisconsin is contained in SEWRPC Planning Report No. 7, Volume 2, Forecasts and Alternative Plans, 1966.

Appendix I
MATHEMATICAL MODELS: DEFINITION AND CLASSIFICATION

The purpose of this appendix is to provide some qualitative insight into the nature of mathematical models. Models are representations of the real world that are used to explain or modify some aspect of it. Originally, models were confined to physical representations of structures. These physical models were related in scale to the objects represented. The basic purpose of these physical models was that of dimensional analysis. The dimensional relationships of a building or bridge could be analyzed using the model since there was a geometric similarity between the model and the real object.

At first, the dimensions of physical models were restricted to static characteristics, such as height, width, length, and weight. Later, the dynamic dimension of time was added; and aircraft and ship models were used which not only "looked like" their real world counterparts but "acted like" them over a period of time. The dynamic characteristics of ships and aircraft could be determined in model water basins and wind tunnels just as the static dimensional characteristics of bridges and buildings had been.

Architects and engineers using these physical models as aids in design understood their limitations. They realized that they were only approximations of the real object in question. Certain detailed characteristics of the object were not well represented in the model. The key question, however, related to the degree of accuracy of the approximation. If the representation was accurate enough for the relationship being studied, it was useful in description or design.

A mathematical model is like a physical model in that it is a representation of the real world. Instead of physical dimensions, however, the similarity is expressed in mathematical symbols. Physical dimensions of the modeled object are represented as algebraic variables in a mathematical relationship, such as an equality. A sample example would be the weight of a cube which would be represented by the third power of its side dimension multiplied by the density of the material involved. This mathematical model resembles the real object in the sense that it embodies the same relationships between weight, side dimension, and density as the real object.

A mathematical model becomes dynamic when time is included as one of the variables. A very simple model is one that expresses the velocity of a falling body accelerated by gravity as a function of time. A slightly more complex model relates the vertical motion of an oscillating weight on a spring. Dynamic models differ from static models in the interaction of other variables with the variable of time.

Because of the logical relationship between mathematics and language, a mathematical relationship is equivalent to a sentence in language. The cube and vehicular velocity models discussed above could be expressed in words, as well as mathematical symbols, as in fact was actually done in the previous paragraphs. A language, such as English, does not provide an ideal vehicle for models because of the multiple meanings of words and the difficulty in manipulating verbal statements. Mathematics allows for more precise definition of variables and facilitates the manipulation of complex relationships.

The language analogy does assist, however, in clarifying the function of a mathematical model as a statement of an outcome. The cubic weight model states that the outcome of a given side dimension and material density will be a given weight of the cube. The dynamic model of a falling body states the velocity "outcome" of a falling body after a given period of time.

Most models are statements of the value, outcome, or output of one dependent variable depending on the values of other independent variables. A special class of models, important in planning, are optimal-value or normative models which are capable of determining the values of the variables that result in an optimal outcome. The Land Use Plan Design Model is an example of such a model. This design model optimizes the cost variable by determining the land use plan that minimizes development costs while complying with land use demands and design standards.

The second land use model, the Land Use Simulation Model, is not an optimal-value model. It is only an outcome-producing model which includes the variable of time. Such models are generally designated as simulation models because they simulate the dynamic sequence of some process. Strictly speaking, simulation models would not need to include the variable of time; and in this sense all models, other than optimal-value models, are simulation models. A simulation model that includes the time variable is more strictly a dynamic simulation model.

It is important to realize that the concept of a model is not really new. As has been previously pointed out, physical models have always been used by architects and engineers. And if language is a model, all human beings are model-builders from their earliest years. Since a model, broadly speaking, is a representation of reality, then all thought is a model since it is a representation of reality.

It is also necessary, however, to understand what is new. Optimal-value models, while not strictly new since the calculus was used to determine maxima and minima, have reached a high state of development in the last two decades. Mathematical programming in all of its forms—linear, nonlinear and dynamic—has made the application of optimal-value models a practical reality. Prior to the development of the Simplex Algorithm by Dantzig after World War II, linear programming in most of its current applications was not practical. A model, such as the Land Use Plan Design Model, even with the largest and fastest digital computer, could have never been developed without the techniques of linear and dynamic programming.

Since the objective of science is to describe nature, optimal-value models have little use in this area (unless nature is believed, as in some economic theories, to act in an optimal manner). In the applied fields of business management, architectural and engineering design, and urban planning, however, optimal-value models are at the core of the task to be accomplished, which is to shape nature to the purposes of man.

Dynamic simulation models, in a generic sense, are less new than optimal-value models since any equation that includes the variable of time is, in a sense, a dynamic simulation model. What is new is the practical reality of large-scale simulation models. Prior to the advent of the digital computer, large-scale simulation models could be formulated but not economically solved. One solution of the model could consume many man-years of human effort. With an electronic digital computer, however, large-scale simulation models of the type represented by the Land Use Simulation Model may be computed in a reasonable time and, therefore, become practical tools for planning applications.

Appendix II
THE REGIONAL ECONOMIC MODEL

```
      DEFINE DISK (10,9000)
      DIMENSION DATA(267), CI(50), F(50), FC(50), DMTB(50), CITB(50)
      DIMENSION PUR(41), CPUR(41), WAGE(41), TAX(41), SAL(41)
      DIMENSION PRHV(50), PRSV(50)
                                COMMON DATA, I
            EQUIVALENCE
     $ (DATA( 1),P      ), (DATA( 8),RFG    ), (DATA(15),SIC    ),
     $ (DATA( 2),C      ), (DATA( 9),CINV   ), (DATA(16),FNCI   ),
     $ (DATA( 3),W      ), (DATA(10),PRAW   ), (DATA(17),S),
     $ (DATA( 4),SA     ), (DATA(11),PRAS   ), (DATA(18),CI(1))
      EQUIVALENCE
     $ (DATA( 5),T      ), (DATA(12),TR     ), (DATA(67),F(1)),
     $ (DATA( 6),EH     ), (DATA(13),FLAMDA), (DATA(117),FC(1)),
     $ (DATA( 7),ES     ), (DATA(14),SALS60), (DMTB( 1),CI( 1)),
     $ (CITB( 1),F(1)), (DATA(167),PRHV(1)), (DATA(217),PRSV(1))
      READ 103, END, DT, PERIOD, FNIND, TIME
      NIND=FNIND
      IDT=(END-TIME)/DT+1.0
      OUTIME=0.0
      INDWS=NIND+2
      DO 9999 IDD=1,IDT
      TIME=TIME+DT
      TOC=0.0
      TOEH=0.0
      TOES=0.0
      TOP=0.0
      TOSA=0.0
      TOS=0.0
      TOT=0.0
      TOW=0.0
      TOSN=0.0
      TOPN=0.0
      TOCN=0.0
      TOEHN=0.0
      TOESN=0.0
      TOWN=0.0
      TOSAN=0.0
      TOTN=0.0
      IF(SENSE SWITCH 2) 407, 408
  407 CONTINUE
      PUNCH 100, TIME
      PUNCH 104
  408 CONTINUE
      I=1
      IDK=1
   10 FETCH (IDK) DATA
      IF(INDWS-I)16,11,11
   11 IDK=I*40+1
      FIND (IDK)
      IF(SENSE SWITCH 2)13,20
   13 PUNCH 101, I, SIC, S, P, C, EH, ES, W, SA, T
   20 CONTINUE
  201 PUR(I)=P
  202 CPUR(I)=C
  203 WAGE(I)=W
  204 SAL(I)=SA
  205 TAX(I)=T
  200 IF((40-I)*(I-9))15,15,14
   14 TOS=TOS+S
  206 TOP=TOP+P
  207 TOC=TOC+C
  208 TOT=TOT+T
  209 TOW=TOW+W
  210 TOSA=TOSA+SA
  211 TOEH=TOEH+EH
```

```
  212 TOES=TOES+ES
   15 CONTINUE
      IF((9-I)*(I-4))8,7,7
    7 TOSN=TOSN+S
      TOPN=TOPN+P
      TOCN=TOCN+C
      TOTN=TOTN+T
      TOEHN=TOEHN+EH
      TOESN=TOESN+ES
      TOWN=TOWN+W
      TOSAN=TOSAN+SA
    8 CONTINUE
      I=I+1
      GOTO 10
   16 IF(TOEHN)161,161,162
  161 HPN=0.
      SPN=0.
      SP=0.
      HP=0.
      GO TO 163
  162 HPN=TOSN/TOEHN
      SPN=0
      HP=TOS/TOEH
      SP=0
  163 PRINT 105, TIME,TOSN,TOEHN,TOESN,HPN,SPN,TOS,TOEH,TOES,HP,SP
      IF(SENSE SWITCH 2) 18,181
   18 PUNCH 101, I, SIC, TOS, TOP,TOC, TOEH, TOES, TOW, TOSA, TOT
      PUNCH 101,I,SIC,TOSN,TOPN,TOCN,TOEHN,TOESN,TOWN,TOSAN,TOTN
  181 CONTINUE
      IF(SENSE SWITCH 3)406,405
  406 CALL LINK (LAMDA)
  405 CONTINUE
C                             THE INDUSTRY MODEL
C                 DEFINITIONS
C       C ------ CAPITAL INVESTMENT
C       CI ----- CUSTOMER INDUSTRY VECTOR
C       CINV --- CAPITAL INVESTMENT PER SALES DOLLAR
C       CITB     CAPITAL INVESTMENT TABLE
C       DATA --- VECTOR CONTAINING ALL INDUSTRY DATA
C       EH ----- EMPLOYMENT HOURLY
C       ES ----- EMPLOYMENT SALARIED
C       DMTB     PURCHASE DEMAND TABLE
C       F ------ SHARE OF CUSTOMER INDUSTRY RAW MATERIAL PURCHASE VECTOR
C       FC ----- SHARE OF CUSTOMER INDUSTRY CAPITAL EXPENDITURE VECTOR
C       FNCI --- NUMBER OF CUSTOMER INDUSTRIES FLOATING
C       IND ---- INDUSTRY IN PROCESS
C       NCI ---- NUMBER OF CUSTOMER INDUSTRIES FIXED
C       NIND --- NUMBER OF INDUSTRIES
C       P ------ RAW MATERIAL PURCHASE
C       PRAS --- SALARIED PRODUCTIVITY TIMES AVERAGE SALARY
C       PRAW --- HOURLY PRODUCTIVITY TIMES AVERAGE WAGE
C       PRH ---- PRODUCTIVITY HOURLY
C       PRS ---- PRODUCTIVITY SALARIED
C       RFG ---- FRACTION OF GOODS PURCHASED
C       S ------ SALES
C       SA ----- SALARIES
C       SIC ---- STANDARD INDUSTRIAL CLASSIFICATION
C       T ------ TAXES
C       TR ----- TAX RATE
C       W ------ WAGES
C     PROCESS EACH INDUSTRY
      DO 9 IND=1,NIND
      PUN1=0.0
      IF(SENSE SWITCH 1) 402,403
```

```
  402 TYPE 101, IND
      PAUSE
      IF(SENSE SWITCH 2) 404,403
  404 PUN1=1.
  403 CONTINUE
C     READ INDUSTRY DATA
      IDK=(IND-1)*40+1
      FETCH(IDK)DATA
C     INDUSTRIES 1, 2, AND 3 WILL REPRESENT FOREIGN PURCHASES, NATIONAL
C     CONSUMER PURCHASES AND FEDERAL GOVERNMENT PURCHASES
      IF(IND-3) 99,99,21
   21 CONTINUE
C     COMPUTE SALES
      NCI=FNCI
      S=0.0
      DO 2 I=1,INDWS
      IF(CI(I))2,2,6
C     FETCH CUSTOMER INDUSTRY RAW MATERIAL PURCHASES AND CAPITAL
C     INVESTMENTS
    6 PRTSAL=(PUR(I)*F(I)+CPUR(I)*FC(I))*FLAMDA
      IF(PUN1) 401,401,400
  400 PUNCH106,IND,I,PRTSAL,PUR(I),F(I),CPUR(I),FC(I)
  401 S=S+PRTSAL
    2 CONTINUE
C     COMPUTE RAW MATERIAL PURCHASE
      P=RFG*S
C     COMPUTE WAGES
      W=PRAW*S
C     COMPUTE SALARIES
      SA=PRAS*S
C     COMPUTE TAXES
      T=(S-P-W-SA)*TR
      IF(T)303,304,304
  303 T=0.0
  304 CONTINUE
C     COMPUTE CAPITAL INVESTMENT
      C=CINV* S
      IF(C)301,302,302
  301 C=0.0
  302 CONTINUE
C     ADJUST TAXES FOR ATATE AND LOCAL GOVERMENT ONLY
      T=T/10.
C     COMPUTE HOURLY PERSONNEL
      PRH=TABLIN(TIME+1.0,PRHV)
      EH=S/(PRH      *DT    )
C     COMPUTE SALARIED PERSONNEL
      ES=0
C     THIS INDUSTRY IS PROCESSED RETURN DATA VECTOR TO THE DISK
   90 CONTINUE
      IDK=(IND-1)*40+1
      RECORD(IDK)DATA
    9 CONTINUE
      GO TO 31
C     COMPUTE PURCHASES AND CAPITAL INVESTMENT FOR FOREIGN, NATIONAL
C     CONSUMER AND FEDERAL GOVERNMENT PURCHASES
   99 CONTINUE
      P=TABLIN(TIME,DMTB)
      P=P*DT
      GO TO 90
C
C                         THE HOUSEHOLD MODEL
C     D ------ DUMMY VARIABLE
C     TWS ---- TOTAL WAGES AND SALARIES
C     INDWS -- NUMBER OF INDUSTRIES THAT PAY WAGES AND SALARIES
      EQUIVALENCE (DATA(17),TWS)
C     FETCH HOUSEHOLD DATA
   31 CONTINUE
      IDK=(NIND+1-1)*40+1
      FETCH(IDK)DATA
C     COMPUTE TOTAL WAGES AND SALARIES
      TWS=0.0
      DO 3 I=10,INDWS
      TWS=TWS+WAGE(I)+SAL(I)
    3 CONTINUE
C     COMPUTE CONSUMER PURCHASES
      P=RFG*TWS
C     COMPUTE CONSUMER INVESTMENT
      C=CINV*TWS
C     COMPUTE HOUSEHOLD EMPLOYEE WAGES
      W=PRAW*TWS
C     COMPUTE HOUSEHOLD EMPLOYEE SALARIES
      SA=PRAS*TWS
C     COMPUTE TAXES
      T=TR*TWS
C     COMPUTE HOURLY PERSONNEL
      EH=0
C     COMPUTE SALARIED PERSONNEL
      ES=0
C     RETURN DATA VECTOR TO DISK
      IDK=NIND*40+1
      RECORD(IDK)DATA

C                    THE GOVERNMENT MODEL
C     TT ----- TOTAL TAXES
C     INDT --- THE NUMBER OF INDUSTRIES THAT PAY TAXES
      EQUIVALENCE (DATA(17),TT)
C     READ GOVERNMENT DATA
      IDK=(NIND+2-1)*40+1
      FETCH(IDK)DATA
C     COMPUTE TOTAL TAXES
      INDT=NIND+1
      TT=0.0
      DO 4 I=10,INDT
      TT=TT+TAX(I)
    4 CONTINUE
C     COMPUTE NON CAPITAL PURCHASES
      P=RFG*TT
C     COMPUTE CAPITAL INVESTMENT
      C=CINV*TT
C     COMPUTE SALARIES
      SA=PRAS*TT
C     COMPUTE SALARIED EMPLOYMENT
      ES=TT/(49000.*DT)
C     RETURN DATA TO DISK
      IDK= (NIND+1)*40+1
      RECORD(IDK)DATA

C     OUTPUT PROCEDURE
C     DT ----- TIME INCREMENT
C     END ---- LENGTH OF RUN
C     OUTIME - NEXT OUTPUT PERIOD
C     TIME --- TIME
C     TOC       TOTAL CAPITAL INVESTMENT
C     TOEH      TOTAL HOURLY EMPLOYMENT
C     TOES      TOTAL SALARIED EMPLOYMENT
C     TOP       TOTAL PURCHASES,
C     TOSA      TOTAL SALARIES
C     TOS       TOTAL SALES
C     TOT       TOTAL TAXES
C     TOW       TOTAL WAGES
 9999 CONTINUE
                          CALL EXIT
  106 FORMAT(1H9,2I3, 2F17.0, F10.5, F17.0, F10.5)
  105 FORMAT(/I3, 5F15.0/3X,5F15.0)
  104 FORMAT(4H IND, 12X, 3HSIC/ 5X,25HSALES   RAW MAT  CPT PUR,
     $ 50H  HOUR EMP   SAL EMP      WAGE     SALARY      TAX//)
  100 FORMAT(1H1, /// 25H REGIONAL ECONOMIC MODEL //     6H TIME ,F6.2)
  101 FORMAT(I4, 5X, F10.0/ 8E10.4)
  102 FORMAT(1H , F10.0, 4(2X,E10.4)/  4(2X,E10.4),I4)
  103 FORMAT(5F13.0)
      END
```

Appendix III
DATA REDUCTION PROGRAM EQUATIONS

Program 1 — Regional Industry Employment Summation

$$ARE_y = \sum_{c=1}^{7}\left[\sum_{m=1}^{12} ME_{c,m,y} \Big/ \sum_{m=1}^{12} MA_{c,m,y}\right]$$

ARE_y - Annual average regional employment
c - County
m - Month
$ME_{c,m}$ - Monthly employment for the industry
$MA_{c,m}$ - Month availability figure - this figure equals one if "$ME_{c,m}$" is available and equals zero if "$ME_{c,m}$" is not reported.

Annual county employment is the average of the monthly county employment reported. Annual regional employment is the sum of the seven annual county employment totals. The program was used to compute regional hourly personnel and regional total personnel.

Program 2 — Company Expansion Factors

$$CEF = \frac{\sum_{y=46}^{63}\left[\left(\sum_{m=1}^{12} CTP_{y,m} \Big/ \sum_{m=1}^{12} MA_{y,m}\right) \Big/ ARTP_y\right]}{(63-46)}$$

CEF - Company expansion factor
y - Year (from 1946 to 1963)
m - Month (1 to 12)
$CTP_{y,m}$ - Company total personnel for month "m" and year "y"
$MA_{y,m}$ - Month availability figure - this figure is one if $CTP_{y,m}$ is available and zero if it is unavailable

ARTP - Annual regional total personnel (this industry) for year "y". This variable was computed in Program 1.

$$\left(\sum_{m=1}^{12} CTP_{y,m} \Big/ \sum_{m=1}^{12} MA_{y,m}\right)$$ - Annual company (average over the reported months) total personnel

A company expansion factor was calculated for all companies having the required data. The total personnel figure explained above was saved along with the company expansion factor for use by succeeding programs.

That part of the program $\left(\sum_{m=1}^{12} CTP_{y,m} \Big/ \sum_{m=1}^{12} MA_{y,m}\right)$ which was used to compute company annual total personnel was pressed into service converting other monthly data annual averages. The use of such data will be explained with the pertinent programs.

Program 3 Regional Industry Sales

$$IRS_y = \sum_{c=1}^{NCR} CRS_{c,y} \Big/ \sum_{c=1}^{NCR} CEF_c$$

$$CRS_{y,c} = (CTS_{y,c})(AWCP_{y,c})$$

$$AWCP_{y,c} = AWC_{y,c} \Big/ ATC_{y,c}$$

IRS_y - Industry regional sales in year "y"

y - Year

c - Company

NCR - The number of companies reporting the required data

$AWC_{y,c}$ - Apportionment data - company "c" cost of manufacturing in Wisconsin (actually in the Region because only regional companies were used) in year "y"

$ACT_{y,c}$ - Total cost of manufacturing during year "y" for company "c"

$AWCP_{y,c}$ - Percent cost of manufacturing in the Region - company "c" year "y"

$CTS_{y,c}$ - Company "c" total sales year "y"

CEF_c - Company "c" expansion factor

Sometimes $AWCP_{y,c}$ was reported directly; sometimes the basic variables $AWC_{y,c}$ and $ATC_{y,c}$ were reported, and on occasion the input was mixed. Industry regional employment is the expanded sum of company regional employment.

Program 4 Raw Material Fraction and Purchases

$$IRMP_y = \sum_{c=1}^{NCR} (DRP_{c,y})(AWCP_{c,y}) \Big/ \sum_{c=1}^{NCR} CEF_c$$

$$RFG = \sum_{y=46}^{63} IRFG_y \Big/ \sum_{y=46}^{63} A_y$$

$$IRFG = \sum_{c=1}^{NCR} DRP_{c,y} \Big/ \sum_{c=1}^{NCR} CTS_{c,y}$$

$$CRFG_y = DRP_{c,y} \Big/ CTS_{c,y}$$

$$DRP_{c,y} = RP_{c,y} - RD_{c,y}$$

$IRMP_y$ - Industry regional raw material purchase in year "y"

RFG - Industry time average raw material fraction

$IRFG_y$ - Industry raw material fraction year "y"

$CRFG_y$ - Company raw material fraction year "y"

$DRP_{c,y}$ - Discounted raw material purchase company "c" year "y"

$RP_{c,y}$ - Company "c" total raw material purchase year "y"

$RD_{c,y}$ - Company "c" raw material purchase discount year "y"

$CTS_{c,y}$ - Company "c" total sales year "y"

A_y - $IRFG_y$ availability vector - one if $IRFG_y$ is available and zero if it is unavailable

$AWCP_{c,y}$ - Company "c" Wisconsin manufacturing cost percentage year "y"

NCR - Number of companies reporting required data

CEF_c - Company "c" expansion factor

Industry raw material purchases are the expanded sum of company regional raw material purchases. Industry raw material fraction is a weighted average of company raw material purchase. Average industry raw material fraction "RFG" is the time average of available industry raw material fractions.

Program 5 Plant and Equipment

$$RIPE_y = \sum_{c=1}^{NCR} RPEV_{c,y} \Big/ \sum_{c=1}^{NCR} CEF_c$$

$$RPEV_{c,y} = (PEV_{c,y})(AWPPC_{c,y})$$

$$AWPPC_{c,y} = AWP_{c,y} \Big/ ATP_{c,y}$$

$RIPE_y$ - Regional industry plant and equipment year "y"

CEF_c - Company "c" expansion factor

$RPEV_{c,y}$ - Company "c" regional plant and equipment year "y"

$AWPPC_{c,y}$ - Company "c" percent of total tangible property located in Wisconsin during year "y"

$PEV_{c,y}$ - Company "c" total plant and equipment in year "y"

$AWP_{c,y}$ - Company "c" apportionment data, tangible property in Wisconsin in year "y"

$ATP_{c,y}$ - Company "c" apportionment data, total tangible property in year "y"

Industry regional plant and equipment is the expanded sum of regional company plant and equipment. Regional company plant and equipment (in the case of a company owning property outside Wisconsin) is a reduction of total company plant and equipment everywhere. Apportionment data was used to accomplish this reduction.

Some companies reported AWPPC directly; some companies reported AWP and ATP from which AWPPC could be computed, and some companies switched back and forth from year to year.

Program 6 Hourly Personnel and Average Monthly Wage

$$HWCI_y = \sum_{c=1}^{NCR} HLPM_{c,y} \Big/ \sum_{c=1}^{NCR} HP_{c,y}$$

$$HWC_{c,y} = HLPM_{c,y} \Big/ HP_{c,y}$$

$$HLPM_{c,y} = \left[\sum_{m=1}^{12} HLP_{c,m,y} \Big/ \sum_{m=1}^{12} A_{c,m,y} \right] \left(\frac{52}{12}\right)$$

$HWCI_y$ - Industry average hourly personnel monthly wage in year "y"

$HWC_{c,y}$ - Company "c" average hourly personnel monthly wage in year "y"

$HLPM_{c,y}$ - Company "c" hourly personnel average monthly payroll in year "y"

$HP_{c,y}$ - Company "c" annual (average over the reported months) hourly personnel

$HLP_{c,m,y}$ - Company "c" hourly personnel payroll for one week in month "m" and year "y"

$A_{c,m,y}$ - $HLP_{c,m,y}$ availability figure - one if $HLP_{c,m,y}$ is available and zero if it is not

NCR - Number of companies reporting the required data

Industry average annual wage is the weighted average of company annual average wage. The company average wage was computed from company hourly payroll and hourly personnel. Company annual hourly personnel was converted from monthly reports by Program 2.

Program 7 Average Monthly Salary

$$\mathrm{SWCI}_y = \sum_{c=1}^{NCR} (\mathrm{TPA}_{y,c} - \mathrm{HLPM}_{y,c}) \Big/ \sum_{c=1}^{NCR} \mathrm{SP}_{c,y}$$

$$\mathrm{SWC}_{y,c} = (\mathrm{TPA}_{y,c} - \mathrm{HLPM}_{c,y}) \Big/ \mathrm{SP}_{c,y}$$

$$\mathrm{TPA}_{y,c} = \left[\sum_{q=1}^{4} \mathrm{TPAT}_{c,y,q} + \mathrm{TPAU}_{c,y,q} \right] \Big/ \sum_{q=1}^{4} A_{c,y,q}$$

$$\mathrm{SP}_{c,y} = \mathrm{TP}_{c,y} - \mathrm{HP}_{c,y}$$

SWCI_y - Industry average monthly salary for year "y"
$\mathrm{SWC}_{y,c}$ - Company "c" average monthly salary for year "y"
$\mathrm{TPA}_{y,c}$ - Average total monthly payroll company "c" year "y"
$\mathrm{SP}_{c,y}$ - Company "c" salaried personnel in year "y"
$\mathrm{HLPM}_{c,y}$ - Company "c" hourly personnel monthly payroll for year "y"
$\mathrm{TPAT}_{c,y,q}$ - Company "c" total taxable payroll for quarter "q" and year "y"
$\mathrm{TPAU}_{c,y,q}$ - Company "c" total untaxable payroll for quarter "q" and year "y"
$\mathrm{TP}_{c,y}$ - Company "c" annual (average of reported months) total personnel for year "y"
$\mathrm{HP}_{c,y}$ - Company "c" annual (average of reported months) hourly personnel for year "y"
NCR - Number of companies reporting the required data
$A_{c,y,q}$ - $\mathrm{TPAU}_{c,y,q} + \mathrm{TPAT}_{c,y,q}$ availability figure - one if both $\mathrm{TPAU}_{c,y,q}$ and $\mathrm{TPAT}_{c,y,q}$ are available and zero if they are not

Industry average monthly salary is the weighted average of company monthly salary. Company average monthly salary is computed from the difference between total payroll and hourly payroll and the difference between total personnel and hourly personnel.

$\mathrm{TP}_{c,y}$ and $\mathrm{HP}_{c,y}$ were computed in Program 2. $\mathrm{HLPM}_{c,y}$ is from Program 6.

Program 8 Capital Expenditures

$$\mathrm{RMSWI}_y = \sum_{c=1}^{NCR} \mathrm{RMSW}_{c,y} \Big/ \sum_{c=1}^{NCR} \mathrm{CEF}_c$$

$\mathrm{RMSW}_{c,y} = \mathrm{RMS}_{c,y}$ if AWCP indicates that the firm is located completely in Wisconsin

$\mathrm{RMSW}_{c,y} = \mathrm{PEV}_{c,y} - \mathrm{PEV}_{c,y-1} + \mathrm{DEU}_{c,y} - \mathrm{PAL}_{c,y} + \mathrm{PAL}_{c,y-1}$

If AWCP indicates that this is a Wisconsin firm and RMS is missing.

RMSWI_y - Regional industry capital expenditure in year "y"
$\mathrm{RMSW}_{c,y}$ - Company "c" apportionment data capital expenditure for year "y"
$\mathrm{RMS}_{c,y}$ - Company "c" total capital expenditures
$\mathrm{PEV}_{c,y}$ - Company "c" plant and equipment year "y"
$\mathrm{DET}_{c,y}$ - Company "c" straight line depreciation in year "y"
$\mathrm{PAL}_{c,y}$ - Company "c" accumulated depreciation in year "y"
$\mathrm{DEU}_{c,y}$ - Company "c" accelerated depreciation in year "y"
$\mathrm{CEF}_{c,y}$ - Company "c" expansion factor
$\mathrm{AWCP}_{c,y}$ - Company "c" percent cost of manufacturing in Wisconsin
NCR - Number of companies reporting the required data

Industry regional capital expenditures are the expanded sum of company regional capital expenditures. Company regional capital expenditures, RMSW , were set equal to total company capital expenditures, RMS , if it was a Wisconsin firm and RMS was reported. If RMS was not reported, RMSW was computed from plant and equipment, depreciation, and accumulated depreciation.

Program 9 Industry Hourly and Salaried Employment

$$HPI_y = \sum_{c=1}^{NCR} HP_{c,y} \Bigg/ \sum_{c=1}^{NCR} CEF_c$$

$$SPI_y = \sum_{c=1}^{NCR} SP_{c,y} \Bigg/ \sum_{c=1}^{NCR} CEF_c$$

HPI - Indestry hourly personnel year "y"

SPI - Industry salaried personnel year "y"

$HP_{c,y}$ - Company "c" hourly personnel year "y"

$SP_{c,y}$ - Company "c" salaried personnel year "y"

CEF_c - Company "c" expansion factor

NCR - Number of companies reporting the required data

This program was added as an afterthought to fill in missing years in the total regional industry hourly and salaried employment data which is entered through Program 1. The industry regional employment estimates are expanded sums of company regional employment variables

Program 10 Industry Summary

No equations are needed to explain this program since it is only a summary of the output variables described in previous programs.

Appendix IV
REGIONAL MULTIPLIER

The Regional Economic Simulation Model requires a detailed set of input-output parameters for system operation. The details of this input-output matrix must be consistent with the parameters in the model equations. Many economic analyses, however, do not require such detail; and for many, a useful measure is provided by the regional multiplier, which relates changes in total regional income to changes in export (or in the short run regional investment) income.

Total income increase = Export income increase x regional multiplier

$$y = (x)\ (r)$$

The multiplier, r, may be defined by two alternative formulations; one in terms of the outputs of the Region and the other in terms of the inputs. The output formulation relates local production of goods and services for export to that for local consumption.

Regional multiplier = r = 1/export income/total income
r = 1/ (1-non-export income/total income)
r = 1/export output/total output
r = 1/export employment/total employment

The alternative input formulation of the regional multiplier depends upon the propensity to spend locally on goods and services and the proportion of this spending that remains within the regional economy.

Regional multiplier = r = 1/ (1-propensity to spend locally x income created per dollar of local consumption sales)
= r = 1/1-ak)

where:

a - income created per dollar of local consumption sales
k - propensity to consume locally

Each of these formulations are, of course, different ways of stating the same relationship with the first emphasizing output (or sales) and the second, input (or purchases). Only the first of these relationships will be used to determine a multiplier here.

A regional multiplier determined from a summation of the outputs (based on employment in 1962 and the proportion of sales of each industry in the Region) is described in Table A1. From this calculation a regional multiplier of 2.44 is indicated.

Table A-1

REGIONAL MULTIPLIER = (r)

Industry	SIC	Sector	Employment (1962)		
			Nonbasic	Basic[a]	Total
Agriculture	A	1	8,760(60.0%)	5,840(40.0%)	14,600
Mining	B	2	688(100.0%)	---	688
Construction	C	3	24,822(100.0%)	---	24,822
Food	20	4	6,730(30.6%)	15,270(69.4%)	22,000
Leather, Apparel, Textiles	22,23,31	5	278(2.0%)	13,622(98.0%)	13,900
Paper, Lumber, Furniture	24,25,26	6	2,718(33.3%)	5,436(67.7%)	8,154
Printing and Publishing	27	7	4,440(26.9%)	12,045(73.1%)	16,485
Chemicals, Petroleum, and Rubber	28,29,30	8	531(10.0%)	4,779(90.0%)	5,310
Primary Metal and Glass	32,33	9	2,250(10.9%)	18,449(89.1%)	20,699
Fabricated Metals	34	10	1,124(6.0%)	17,610(94.0%)	18,734
Machinery, Engines and Turbines	351	11	357(3.0%)	11,553(97.0%)	11,910
Machinery, Farm	352	12	70(0.7%)	10,366(99.3%)	10,436
Machinery, Construction and Mining	353	13	270(2.0%)	13,265(98.0%)	13,535
Machinery, Metalworking	354	14	236(4.0%)	5,657(96.0%)	5,893
Machinery, Special	355,6,7,8,9	15	865(5.0%)	16,436(95.0%)	17,301
Electrical Machinery, Transmission, Distribution and Industrial	361,362	16	4,710(21.6%)	17,088(78.4%)	21,798
Electrical Machinery, Medical	364,369	17	60(2.0%)	2,972(98.0%)	3,032
Electrical Machinery, Household Appliances	363	18	56(2.0%)	2,725(98.0%)	2,781
Electrical Machinery, Communications and Components	365,366,367	19	531(4.0%)	12,738(96.0%)	13,269
Transportation Equipment	37	20	652(2.0%)	31,974(98.0%)	32,626
Instruments	38	21	185(5.0%)	3,513(95.0%)	3,698
Miscellaneous Manufacturing	39,19,21	22	138(2.0%)	6,763(98.0%)	6,901
Transportation	40,47	23	19,467(81.0%)	4,566(19.0%)	24,033
Communication	48	24	3,800(58.0%)	2,731(42.0%)	6,531
Utilities	49	25	5,192(90.0%)	577(10.0%)	5,769
Trade	50 to 59	26	123,075(98.0%)	2,510(2.0%)	125,585
Banking and Insurance	60-67 not, 65	27	16,946(80.0%)	4,237(20.0%)	21,183
Real Estate	65	28	5,553(98.0%)	114(2.0%)	5,667
Services	70-89 not, 80	29	64,625(96.0%)	2,693(4.0%)	67,318
Medical Services	80	30	13,850(78.0%)	43,838(22.0%)	57,688
Subtotal			312,979	289,367	602,346
Government		31	50,566(95.0%)	2,661(5.0%)	53,227
Total=			363,545	292,028	655,573

r = 1/Basic Employment / Total Employment) = 2.25

[a]*Employment associated with goods or services produced within the Region and marketed outside.*

Source: *SEWRPC.*

Basic Employment	292,028	45%
Nonbasic Employment	363,545	55%
Total Employment	655,573	100%

Appendix V

INTERNAL RESOURCE DATA SUMMARY

999100466	Parameter Value		Model Number				SIC	Industries
##XEQSDATAL		4						
	0.5786	DATA(8)	4	RFG	*	991	NI	AGRIC
	.03	DATA(9)	4	CINV	*	991	NI	AGRIC
	.08	DATA(10)	4	PRAW	*	991	NI	AGRIC
	.35	DATA(11)	4	PRAS	*	991	NI	AGRIC
	.25	DATA(12)	4	TR	*	991	NI	AGRIC
	2000.	DATA(13)	4	PRH	*	991	NI	AGRIC
	700.	DATA(14)	4	PRS	*	991	NI	AGRIC
	991.	DATA(15)	4	SIC		991	NI	AGRIC
	9.	DATA(16)	4	FNCI		991	NI	AGRIC
	0.53	DATA(8)	5	RFG	*	992	NI	MINING
	0.007	DATA(9)	5	CINV	*	992	NI	MINING
	0.1686	DATA(10)	5	PRAW	*	992	NI	MINING
	0.0421	DATA(11)	5	PRAS	*	992	NI	MINING
	0.52	DATA(12)	5	TR		992	NI	MINING
	2816.0	DATA(13)	5	PRH	*	992	NI	MINING
	18300.0	DATA(14)	5	PRS	*	992	NI	MINING
	992.	DATA(15)	5	SIC		992	NI	MINING
	9.	DATA(16)	5	FNCI		992	NI	MINING
	0.5145	DATA(8)	6	RFG	*	993	NI	CONST
	0.016	DATA(9)	6	CINV	*	993	NI	CONST
	0.317	DATA(10)	6	PRAW	*	993	NI	CONST
	0.0528	DATA(11)	6	PRAS	*	993	NI	CONST
	0.52	DATA(12)	6	TR		993	NI	CONST
	1660.0	DATA(13)	6	PRH	*	993	NI	CONST
	21000.0	DATA(14)	6	PRS	*	993	NI	CONST
	993.	DATA(15)	6	SIC		993	NI	CONST
	9.	DATA(16)	6	FNCI		993	NI	CONST
	0.61631	DATA(8)	7	RFG		994	NI	MFG
	.016	DATA(9)	7	CINV	*	994	NI	MFG
	.088	DATA(10)	7	PRAW	*	994	NI	MFG
	.044	DATA(11)	7	PRAS	*	994	NI	MFG
	.52	DATA(12)	7	TR		994	NI	MFG
	5080.	DATA(13)	7	PRH	*	994	NI	MFG
	12000.	DATA(14)	7	PRS	*	994	NI	MFG
	994.	DATA(15)	7	SIC		994	NI	MFG

9.	DATA(16)	7	FNCI		994	NI	MFG
0.49	DATA(8)	8	RFG		995	NI	EL UTL
0.163	DATA(9)	8	CINV	*	995	NI	EL UTL
0.215	DATA(10)	8	PRAW	*	995	NI	EL UTL
0.133	DATA(11)	8	PRAS	*	995	NI	EL UTL
0.52	DATA(12)	8	TR	*	995	NI	EL UTL
1940.0	DATA(13)	8	PRH	*	995	NI	EL UTL
103000.	DATA(14)	8	PRS	*	995	NI	EL UTL
995.	DATA(15)	8	SIC		995	NI	EL UTL
9.	DATA(16)	8	FNCI		995	NI	EL UTL
0.5183	DATA(8)	9	RFG	*	996	NI	OTHER
0.025	DATA(9)	9	CINV	*	996	NI	OTHER
0.138	DATA(10)	9	PRAW	*	996	NI	OTHER
0.149	DATA(11)	9	PRAS	*	996	NI	OTHER
0.52	DATA(12)	9	TR		996	NI	OTHER
3040.	DATA(13)	9	PRH	*	996	NI	OTHER
3240.	DATA(14)	9	PRS	*	996	NI	OTHER
996.	DATA(15)	9	SIC		996	NI	OTHER
9.	DATA(16)	9	FNCI		996	NI	OTHER
0.66	DATA(8)	10	RFG	*	01	A	
0.03	DATA(9)	10	CINV	*	01	A	
0.08	DATA(10)	10	PRAW	*	01	A	
0.35	DATA(11)	10	PRAS	*	01	A	
0.25	DATA(12)	10	TR	*	01	A	
2000.0	DATA(13)	10	PRH	*	01	A	
700.0	DATA(14)	10	PRS	*	01	A	
10.0	DATA(15)	10	SIC		01	A	
19.	DATA(16)	10	FNCI		01	A	
0.43	DATA(8)	11	RFG		02	B	
0.007	DATA(9)	11	CINV		02	B	
0.1686	DATA(10)	11	PRAW		02	B	
0.0421	DATA(11)	11	PRAS	*	02	B	
0.52	DATA(12)	11	TR		02	B	
2816.	DATA(13)	11	PRH		02	B	
18300.	DATA(14)	11	PRS		02	B	
1014.	DATA(15)	11	SIC		02	B	
36.	DATA(16)	11	FNCI		02	B	
0.5145	DATA(8)	12	RFG		03	C	
0.016	DATA(9)	12	CINV		03	C	
0.317	DATA(10)	12	PRAW		03	C	
0.0528	DATA(11)	12	PRAS		03	C	
0.52	DATA(12)	12	TR		03	C	

1660.	DATA(13)	12	PRH	03	C
21000.	DATA(14)	12	PRS	03	C
1517.	DATA(15)	12	SIC	03	C
37.	DATA(16)	12	FNCI	03	C
0.75	DATA(8)	13	RFG	04	20
0.0186	DATA(9)	13	CINV	04	20
0.088	DATA(10)	13	PRAW	04	20
0.044	DATA(11)	13	PRAS	04	20
0.52	DATA(12)	13	TR	04	20
5080.	DATA(13)	13	PRH	04	20
12000.	DATA(14)	13	PRS	04	20
20.	DATA(15)	13	SIC	04	20
27.	DATA(16)	13	FNCI	04	20
0.75	DATA(8)	14	RFG	05	22, 23 + 31
0.0152	DATA(9)	14	CINV	05	22, 23 + 31
0.215	DATA(10)	14	PRAW	05	22, 23 + 31
0.133	DATA(11)	14	PRAS	05	22, 23 + 31
0.52	DATA(12)	14	TR	05	22, 23 + 31
1200.	DATA(13)	14	PRH	05	22, 23 + 31
3000.	DATA(14)	14	PRS	05	22, 23 + 31
222331.	DATA(15)	14	SIC	05	22, 23 + 31
38.	DATA(16)	14	FNCI	05	22, 23 + 31
0.6	DATA(8)	15	RFG	06	24, 25 + 26
0.0364	DATA(9)	15	CINV	06	24, 25 + 26
0.138	DATA(10)	15	PRAW	06	24, 25 + 26
0.149	DATA(11)	15	PRAS	06	24, 25 + 26
0.52	DATA(12)	15	TR	06	24, 25 + 26
3040.	DATA(13)	15	PRH	06	24, 25 + 26
3240.	DATA(14)	15	PRS	06	24, 25 + 26
242526.	DATA(15)	15	SIC	06	24, 25 + 26
38.	DATA(16)	15	FNCI	06	24, 25 + 26
0.52	DATA(8)	16	RFG	07	27
0.0272	DATA(9)	16	CINV	07	27
0.167	DATA(10)	16	PRAW	07	27
0.147	DATA(11)	16	PRAS	07	27
0.52	DATA(12)	16	TR	07	27
2580.	DATA(13)	16	PRH	07	27
3020.	DATA(14)	16	PRS	07	27
27.	DATA(15)	16	SIC	07	27
38.	DATA(16)	16	FNCI	07	27
0.6	DATA(8)	17	RFG	08	28, 29, + 30
0.0374	DATA(9)	17	CINV	08	28, 29, + 30

0.0356	DATA(10)	17	PRAW	08	28, 29, + 30
0.0765	DATA(11)	17	PRAS	08	28, 29, + 30
0.52	DATA(12)	17	TR	08	28, 29, + 30
9890.	DATA(13)	17	PRH	08	28, 29, + 30
7770.	DATA(14)	17	PRS	08	28, 29, + 30
282930.	DATA(15)	17	SIC	08	28, 29, + 30
38.	DATA(16)	17	FNCI	08	28, 29, + 30
0.55	DATA(8)	18	RFG	09	32 + 33
0.0405	DATA(9)	18	CINV	09	32 + 33
0.21	DATA(10)	18	PRAW	09	32 + 33
0.0873	DATA(11)	18	PRAS	09	32 + 33
0.52	DATA(12)	18	TR	09	32 + 33
2180.	DATA(13)	18	PRH	09	32 + 33
5800.	DATA(14)	18	PRS	09	32 + 33
3233.	DATA(15)	18	SIC	09	32 + 33
37.	DATA(16)	18	FNCI	09	32 + 33
0.63	DATA(8)	19	RFG	10	34
0.0262	DATA(9)	19	CINV	10	34
0.154	DATA(10)	19	PRAW	10	34
0.0736	DATA(11)	19	PRAS	10	34
0.52	DATA(12)	19	TR	10	34
2510.	DATA(13)	19	PRH	10	34
6060.	DATA(14)	19	PRS	10	34
34.	DATA(15)	19	SIC	10	34
37.	DATA(16)	19	FNCI	10	34
0.58	DATA(8)	20	RFG	11	351
0.0357	DATA(9)	20	CINV	11	351
0.194	DATA(10)	20	PRAW	11	351
0.078	DATA(11)	20	PRAS	11	351
0.52	DATA(12)	20	TR	11	351
2170.	DATA(13)	20	PRH	11	351
7440.	DATA(14)	20	PRS	11	351
351.	DATA(15)	20	SIC	11	351
29.	DATA(16)	20	FNCI	11	351
0.64	DATA(8)	21	RFG	12	352
0.0214	DATA(9)	21	CINV ****	12	352
0.128	DATA(10)	21	PRAW	12	352
0.0963	DATA(11)	21	PRAS	12	352
0.52	DATA(12)	21	TR	12	352
3262.	DATA(13)	21	PRH	12	352
9350.	DATA(14)	21	PRS	12	352
352.	DATA(15)	21	SIC	12	352

28.	DATA(16)	21	FNCI		12	352
0.59	DATA(8)	22	RFG		13	353
0.0183	DATA(9)	22	CINV		13	353
0.216	DATA(10)	22	PRAW		13	353
0.161	DATA(11)	22	PRAS		13	353
0.52	DATA(12)	22	TR		13	353
2035.	DATA(13)	22	PRH		13	353
3200.	DATA(14)	22	PRS		13	353
353.	DATA(15)	22	SIC		13	353
29.	DATA(16)	22	FNCI		13	353
0.49	DATA(8)	23	RFG		14	354
0.0302	DATA(9)	23	CINV		14	354
0.26	DATA(10)	23	PRAW		14	354
0.1675	DATA(11)	23	PRAS		14	354
0.52	DATA(12)	23	TR		14	354
1865.	DATA(13)	23	PRH		14	354
3840.	DATA(14)	23	PRS		14	354
354.	DATA(15)	23	SIC		14	354
33.	DATA(16)	23	FNCI		14	354
0.56	DATA(8)	24	RFG		15	355 TO 359
0.0282	DATA(9)	24	CINV		15	355 TO 359
0.163	DATA(10)	24	PRAW		15	355 TO 359
0.122	DATA(11)	24	PRAS		15	355 TO 359
0.52	DATA(12)	24	TR		15	355 TO 359
2423.	DATA(13)	24	PRH		15	355 TO 359
4360.	DATA(14)	24	PRS		15	355 TO 359
3559.	DATA(15)	24	SIC		15	355 TO 359
36.	DATA(16)	24	FNCI		15	355 TO 359
0.5	DATA(8)	25	RFG		16	361 +362
0.0208	DATA(9)	25	CINV		16	361 +362
0.258	DATA(10)	25	PRAW		16	361 +362
0.1475	DATA(11)	25	PRAS		16	361 +362
0.52	DATA(12)	25	TR		16	361 +362
1665.	DATA(13)	25	PRH		16	361 +362
3240.	DATA(14)	25	PRS		16	361 +362
361362.	DATA(15)	25	SIC		16	361 +362
33.	DATA(16)	25	FNCI		16	361 +362
0.55	DATA(8)	26	RFG	*	17	364 + 369
0.0202	DATA(9)	26	CINV	*	17	364 + 369
0.2	DATA(10)	26	PRAW	*	17	364 + 369
0.23	DATA(11)	26	PRAS	*	17	364 + 369
0.52	DATA(12)	26	TR		17	364 + 369

1800.	DATA(13)	26	PRH	*	17	364 + 369
2000.	DATA(14)	26	PRS	*	17	364 + 369
364369.	DATA(15)	26	SIC		17	364 + 369
38.	DATA(16)	26	FNCI		17	364 + 369
0.67	DATA(8)	27	RFG		18	363
0.0175	DATA(9)	27	CINV		18	363
0.206	DATA(10)	27	PRAW		18	363
0.226	DATA(11)	27	PRAS		18	363
0.52	DATA(12)	27	TR		18	363
1825.	DATA(13)	27	PRH		18	363
1968.	DATA(14)	27	PRS		18	363
363.	DATA(15)	27	SIC		18	363
24.	DATA(16)	27	FNCI		18	363
0.5	DATA(8)	28	RFG		19	366 + 367
0.108	DATA(9)	28	CINP		19	366 + 367
0.1492	DATA(10)	28	PRAW		19	366 + 367
0.0885	DATA(11)	28	PRAS		19	366 + 367
0.52	DATA(12)	28	TR		19	366 + 367
2860.	DATA(13)	28	PRH		19	366 + 367
5820.	DATA(14)	28	PRS		19	366 + 367
366367.	DATA(15)	28	SIC		19	366 + 367
34.	DATA(16)	28	FNCI		19	366 + 367
0.6	•DATA(8)	29	RFG		20	37
0.0357	DATA(9)	29	CINV	*	20	37
0.128	DATA(10)	29	PRAW		20	37
0.032	DATA(11)	29	PRAS	*	20	37
0.52	DATA(12)	29	TR		20	37
3410.	DATA(13)	29	PRH		20	37
8050.	DATA(14)	29	PRS		20	37
37.	DATA(15)	29	SIC		20	37
37.	DATA(16)	29	FNCI		20	37
0.3358	DATA(8)	30	RFG		21	38
0.031	DATA(9)	30	CINV		21	38
0.157	DATA(10)	30	PRAW		21	38
0.128	DATA(11)	30	PRAS		21	38
0.52	DATA(12)	30	TR		21	38
2460.	DATA(13)	30	PRH		21	38
4950.	DATA(14)	30	PRS		21	38
38.	DATA(15)	30	SIC		21	38
34.	DATA(16)	30	FNCI		21	38
0.6	DATA(8)	31	RFG		22	39, 19, + 21
.05	DATA(9)	31	CINV	*	22	39, 19, + 21

0.232	DATA(10)	31	PRAW		22	39, 19, + 21	
0.06	DATA(11)	31	PRAS	*	22	39, 19, + 21	
0.52	DATA(12)	31	TR		22	39, 19, + 21	
1273.	DATA(13)	31	PRH		22	39, 19, + 21	
15100.	DATA(14)	31	PRS		22	39, 19, + 21	
391921.	DATA(15)	31	SIC		22	39, 19, + 21	
38.	DATA(16)	31	FNCI		22	39, 19, + 21	
0.4	DATA(8)	32	RFG	*	23	42	
0.0435	DATA(9)	32	CINV	*	23	42	
0.57	DATA(10)	32	PRAW		23	42	
0.1	DATA(11)	32	PRAS	*	23	42	
0.52	DATA(12)	32	TR		23	42	
900.	DATA(13)	32	PRH		23	42	
7800.	DATA(14)	32	PRS	*	23	42	
391921.	DATA(15)	32	SIC		23	42	
38.	DATA(16)	32	FNCI		23	42	
0.15	DATA(8)	33	RFG	*	24	48	
0.34	DATA(9)	33	CINV	*	24	48	
0.2	DATA(10)	33	PRAW	*	24	48	
0.03	DATA(11)	33	PRAS	*	24	48	
0.52	DATA(12)	33	TR		24	48	
1900.	DATA(13)	33	PRH	*	24	48	
103000.	DATA(14)	33	PRS	*	24	48	
48.	DATA(15)	33	SIC		24	48	
38.	DATA(16)	33	FNCI		24	48	
0.52	DATA(8)	34	RFG		25	49	
0.312	DATA(9)	34	CINV		25	49	
0.24	DATA(10)	34	PRAW		25	49	
0.0285	DATA(11)	34	PRAS		25	49	
0.52	DATA(12)	34	TR		25	49	
1940.	DATA(13)	34	PRH		25	49	
103000.	DATA(14)	34	PRS		25	49	
49.	DATA(15)	34	SIC		25	49	
38.	DATA(16)	34	FNCI		25	49	
0.28	DATA(8)	35	RFG		26	50	TO 59
0.0027	DATA(9)	35	CINV		26	50	TO 59
0.0446	DATA(10)	35	PRAW		26	50	TO 59
0.01885	DATA(11)	35	PRAS		26	50	TO 59
0.52	DATA(12)	35	TR		26	50	TO 59
9750.	DATA(13)	35	PRH		26	50	TO 59
28200.	DATA(14)	35	PRS		26	50	TO 59
5059.	DATA(15)	35	SIC		26	50	TO 59

32.	DATA(16)	35	FNCI		26	50 TO 59
.44	DATA(8)	36	RFG	*	27	60 TO 67
.0032	DATA(9)	36	CINV	*	27	60 TO 67
0.012	DATA(10)	36	PRAW		27	60 TO 67
0.0394	DATA(11)	36	PRAS		27	60 TO 67
0.52	DATA(12)	36	TR		27	60 TO 67
25600.	DATA(13)	36	PRH		27	60 TO 67
309000.	DATA(14)	36	PRS		27	60 TO 67
6067.	DATA(15)	36	SIC		27	60 TO 67
38.	DATA(16)	36	FNCI		27	60 TO 67
0.28	DATA(8)	37	RFG	*	28	65
0.011	DATA(9)	37	CINV	*	28	65
0.01	DATA(10)	37	PRAW	*	28	65
0.04	DATA(11)	37	PRAS	*	28	65
0.52	DATA(12)	37	TR		28	65
25000.	DATA(13)	37	PRH	*	28	65
300000.	DATA(14)	37	PRS	*	28	65
65.	DATA(15)	37	SIC		28	65
38.	DATA(16)	37	FNCI		28	65
0.5	DATA(8)	38	RFG		29	70 T 89 X 80
.05	DATA(9)	38	CINV	*	29	70 T 89 X 80
0.29	DATA(10)	38	PRAW		29	70 T 89 X 80
0.4	DATA(11)	38	PRAS	*	29	70 T 89 X 80
0.52	DATA(12)	38	TR		29	70 T 89 X 80
950.	DATA(13)	38	PRH		29	70 T 89 X 80
2400.	DATA(14)	38	PRS		29	70 T 89 X 80
7089.	DATA(15)	38	SIC		29	70 T 89 X 80
38.	DATA(16)	38	FNCI		29	70 T 89 X 80
0.32	DATA(8)	39	RFG	*	30	80
0.0635	DATA(9)	39	CINV	*	30	80
0.3	DATA(10)	39	PRAW	*	30	80
0.3	DATA(11)	39	PRAS	*	30	80
.3	DATA(12)	39	TR	*	30	80
800.	DATA(13)	39	PRH	*	30	80
10000.	DATA(14)	39	PRS	*	30	80
80.	DATA(15)	39	SIC		30	80
38.	DATA(16)	39	FNCI		30	80
.7	DATA(8)	40	RFG		31	
.2	DATA(9)	40	CINV		31	
.0	DATA(10)	40	PRAW		31	
.0	DATA(11)	40	PRAS		31	
.1	DATA(12)	40	TR		31	

.0	DATA(13)	40	PRH	31	
.0	DATA(14)	40	PRS	31	
.0	DATA(15)	40	SIC	31	
.0	DATA(16)	40	FNCI	31	
1.	DATA(8)	41	RFG	32	REG GOV
0.	DATA(9)	41	CINV	32	REG GOV
0.	DATA(10)	41	PRAW	32	REG GOV
0.4699	DATA(11)	41	PRAS	32	REG GOV
0.	DATA(12)	41	TR	32	REG GOV
0.	DATA(13)	41	PRH	32	REG GOV
0.	DATA(14)	41	PRS	32	REG GOV
0.	DATA(15)	41	SIC	32	REG GOV
0.	DATA(16)	41	FNCI	32	REG GOV