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## LARGE SCALE MODELS IN REGIONAL DEVELOPMENT PLANNING\*

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Regional economic models have been designed, redesigned, praised, and criticized in relationship to regional economic development planning. Despite their abundance in academic journals and monographs, relatively few have become incorporated into the realm of policy formation and planning.

This paper discusses the nature of economic development planning models used to facilitate state economic policy and decision making. First, the demand for economic information is considered. It is argued that what government and business decision-makers want and what economists think these decision-makers should have do not necessarily coincide. The second section of the paper discusses the nature of a family of models which have been implemented to facilitate state and local government decision making. The final section evaluates the role of economic models at the regional level and suggests some guidelines for future development. The paper draws heavily upon the models that have been made operational in the state of Kansas in the past five years.

## THE DEMAND FOR ECONOMIC INFORMATION

An economic development model from the vantage point of the user is essentially an information machine. The model generates information which can improve policy formation decisions. The user of such information has certain priorities with regard to information needs. What are the characteristics of the demand for economic development models?

In their recent book Leven, Legler, and Shapiro [9] level a broadside attack on the regional model building efforts of the past two decades --- "all of them do have one thing in common, namely, that they are not especially germane to the pressing problems at the regional level." This criticism raises the question of the relevancy of regional models to policy. The model builder has certain explicit or implicit policy objectives in mind in building development planning models. However, the origin of these objectives is not always clearly identifiable. Often it turns out that the least tenable assumption in the model building effort is the model builder's assumption that he knows what the policy maker wants and can use.

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Specifying the demand for economic information is an underdeveloped area. Abundant literature explains all of the information that can be provided by a wide spectrum of models. Yet, a weak link exists between policy maker and model builder.

The origins of the Kansas economic development planning framework came from expressed demands other than those of professional economists. In response to a sagging performance of the Kansas economy in the early 1960's the Governor appointed an Economic Development Committee to evaluate the needs of the state. One part of the recommendations called for the establishment of an Office of Economic Analysis to provide better information on the state's economy to guide policy decisions. A first task of the Office of Economic Analysis after it was established was to determine the type of economic information system which could best serve the needs of the state, both the government and the business community. A committee was assembled which included state agency heads, legislators, businessmen, labor leaders, and university faculty. National experts were also invited to some of the deliberations.

### Goal Specification

"To facilitate the maximization of the well-being of the people" is the vague phrase that often suffices to describe the objective of a state economic development program. More explicit goals expressed by the Economic Development Committee were as follows:

- A. To expand the volume of economic activity. An explicit goal of the state of Kansas is to increase the level of economic activity, particularly its total income and employment. The identification and development of new job opportunities is the charge of several pieces of legislation enacted in the past decade by the Kansas Legislature.
- B. To improve the economic welfare of state residents. An increase in economic activity will not necessarily raise the standard of living of state residents. An increase in real per capita income better reflects the extent to which Kansas residents realize an improvement in their level of living.

The distinction between these first two objectives underscores the fact that volume growth does not necessarily raise the per capita income of the state. In evaluating economic development priorities, this is often overlooked to the detriment of state development programs.

- C. To strengthen the proficiency of the public sector. The expanding development of a state's economy will influence the demand for government services and capital expenditures.
- D. To improve or conserve the environment of the region. The pollution of air and water is the most publicized kind of environmental

destruction; however, numerous other conditions influencing human environment must be recognized.

### Information Objectives

From these goals demands were formulated by the committee concerning the use of an economic information system.

First, the economic information system must be capable of multiple use to facilitate the maximum measure of state economic planning. The system must make possible an analysis of the impact of events and must provide consistent economic forecasts which would afford state and local government a better opportunity to relate their activities to the needs of the state and local areas.

Second, the study should provide a framework, reflective of state problems and needs, which will utilize the wealth of statistical information gathered by state agencies on an annual basis.

Third, the study should provide a frame of reference for partial studies. Investigations of particular aspects of the Kansas economy are constantly being conducted, and such studies can be enhanced by their reference to a general framework. Further, the study should indicate areas for additional research. Through such integrated frameworks, the total research efforts on the Kansas economy would yield increased returns.

Fourth, since the state's economy is continuously affected by changes in such factors as technology, government spending policies, and transportation rates, an information system should permit an identification of the impact of such changes. It should, then, provide the rationale for state policy decisions which could derive benefits from such changes or mitigate potential adverse effects. New industry frequently evolves out of research discoveries, and the ability to capitalize on these discoveries requires information as to how they might be fitted into a regional economy.

Fifth, the study should indicate the determinants of a priority system for economic development in the state of Kansas. Certain industries are crucial to expanding income and employment opportunities in the state. A few of these industries will continue to grow without extraordinary development efforts because of the locational advantages available in Kansas. By channeling funds into other select industries, greater returns will be realized, and through an adequate study of the determinants of "family" industry development, these select industries can be identified. Certain industries are structurally related in their inputs and in their product markets; thus, the existing structure of an economy encourages the growth of certain industries while virtually blocking entrance for others. A rigorous identification of these structural relations in a state's economy would direct development efforts into proper channels.

Sixth, the study should indicate future labor requirements to enable more

effective planning by the state's education system, particularly in the expanding area of vocational-technical training and retraining.

Seventh, the study's data should make possible reliable estimates of Kansas' export markets. This would provide valuable information to existing or new firms for expanding their markets. The data should also provide the information necessary to estimate those direct and indirect effects of changes in demand which affect the export of Kansas products.

The professional economist might not agree with the goals and related information objectives set forth by government and business leaders. Nonetheless, to ignore them is likely to produce an irrelevant model. In the interfacing between policy maker and model builder the focus now shifts to the supply side.

### THE SUPPLY OF ECONOMIC INFORMATION

The Kansas economic information system began with a primary data input-output study and then developed a series of related models. Some of the latter were designed initially but others were developed in response to needs which surfaced after the original model design. An implicit theme of this section is that although a regional input-output model has limits to its capabilities, it is nonetheless quite versatile in the face of an evolving demand for information and analytical capability.

#### Modular Concept

A perplexing problem facing the designers of a state economic model involves weighing the costs against the benefits of such a model. Clearly it would be desirable to construct an all-encompassing system which would yield a complete data spectrum along with analytical capability. But even if it were possible to specify such a model, operational model building faces a resource constraint.

The solution arrived at for the Kansas situation was to construct a model in stages, the first of which was the input-output system. From this the following extensions were developed:

- (1) Employment requirements. Numer of employees by industry for various output levels.
- (2) Occupational requirements. Current and projected occupational mix for each state industry.
- (3) Population. Derived from employment requirements and labor force participation rates.
- (4) Long-range projections. Output, employment, income, and population projections.

- (5) Public capital. Infrastructure requirements tied to the industry structure and population size and characteristics.
- (6) Public services. Demand estimates for public services stemming from the magnitude and mix of state industries and the characteristics of the population.
- (7) Revenue forecasting. Forecasts of revenue for state government by source of revenue.
- (8) Dynamic simulation. Simulations of the impacts over time of potential developments.

The modular concept has the additional advantage of capitalizing on the "demonstration effect." Since state economic development planning is in an early stage of development it is often difficult for state agencies to relate the planning activities to information requirements. If an all-encompassing model had been attempted at the onset, it would be difficult for the decision-makers to utilize the sudden surge of information. By constructing a system with "add-on" features this difficulty is minimized.

Figure 1 shows the elements of each of the models to be discussed. Work on the initial model began in 1966 and was finished in 1968. Work on the last model, the tax projection system, was only recently completed.

### The Interindustry Framework

The core of the Kansas economic information system is an input-output accounting system [3]. The basic transactions table contains 69 processing sectors, 7 final demand sectors, and 5 final payments sectors. The matrix was implemented essentially with data obtained from personal interviews with several thousand Kansas business firms.

In order to enhance the long run usefulness of this matrix an updating technique was designed using primarily state agency records (See [4]). New firms and out-of-business firms are identified annually. The out-of-business firms are deleted from the computer tape record file. New firms of significant size are interviewed and added to the file. Additionally, capital spending by corporations is obtained from state agency files. Firms showing large capital expenditures are expected to have either altered their technology or added a product line or both. These are interviewed and the new information replaces the old in the computer tape data file. New matrices are then obtained with a minimum of interviewing and expenditure. An integrated system of computer programs reduces the monumental task of building the original matrix to slightly more than a mechanical operation for the updating process. Figure 2 illustrates the nature of the updating process.

The volume of descriptive and analytical information provided by an input-output model needs little amplification. At least this paper will not devote space to the merits of the model per se. Rather the attention will focus on the broader framework.

Figure 1  
STATE ECONOMIC MODEL FRAMEWORK

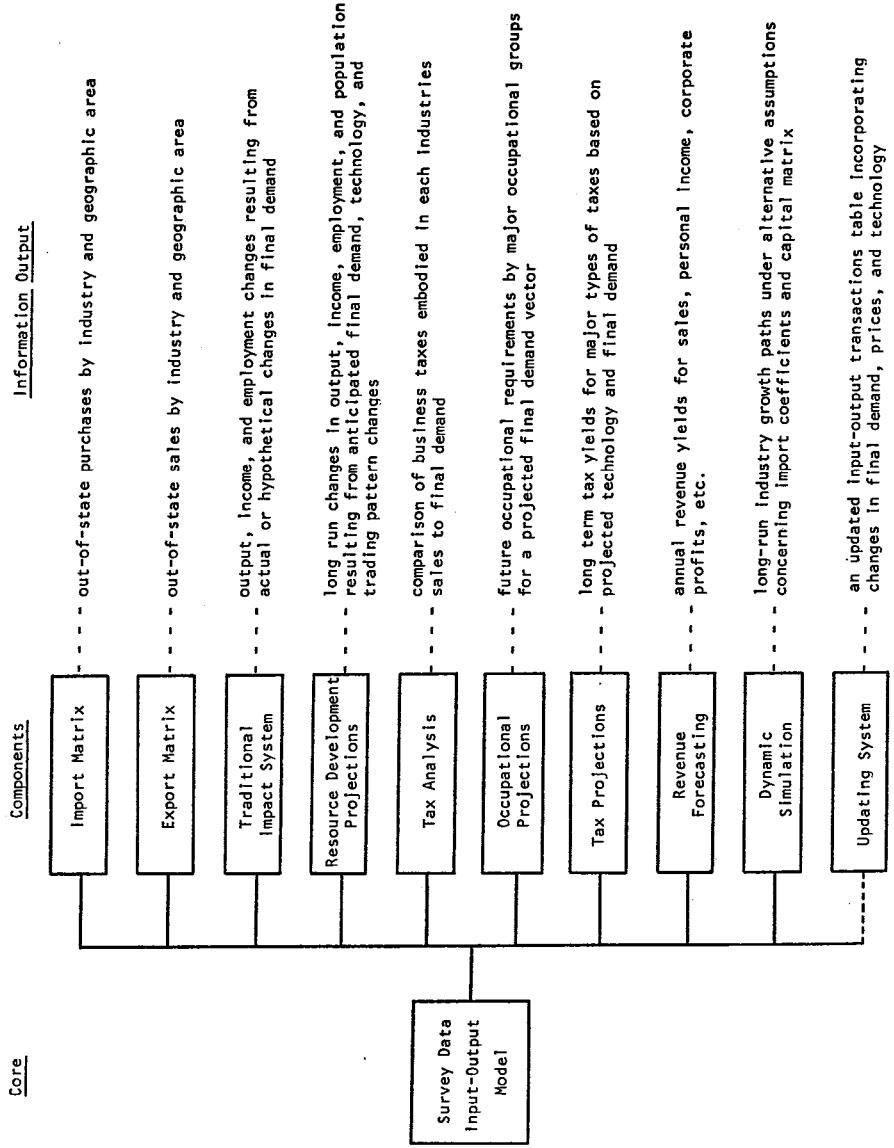
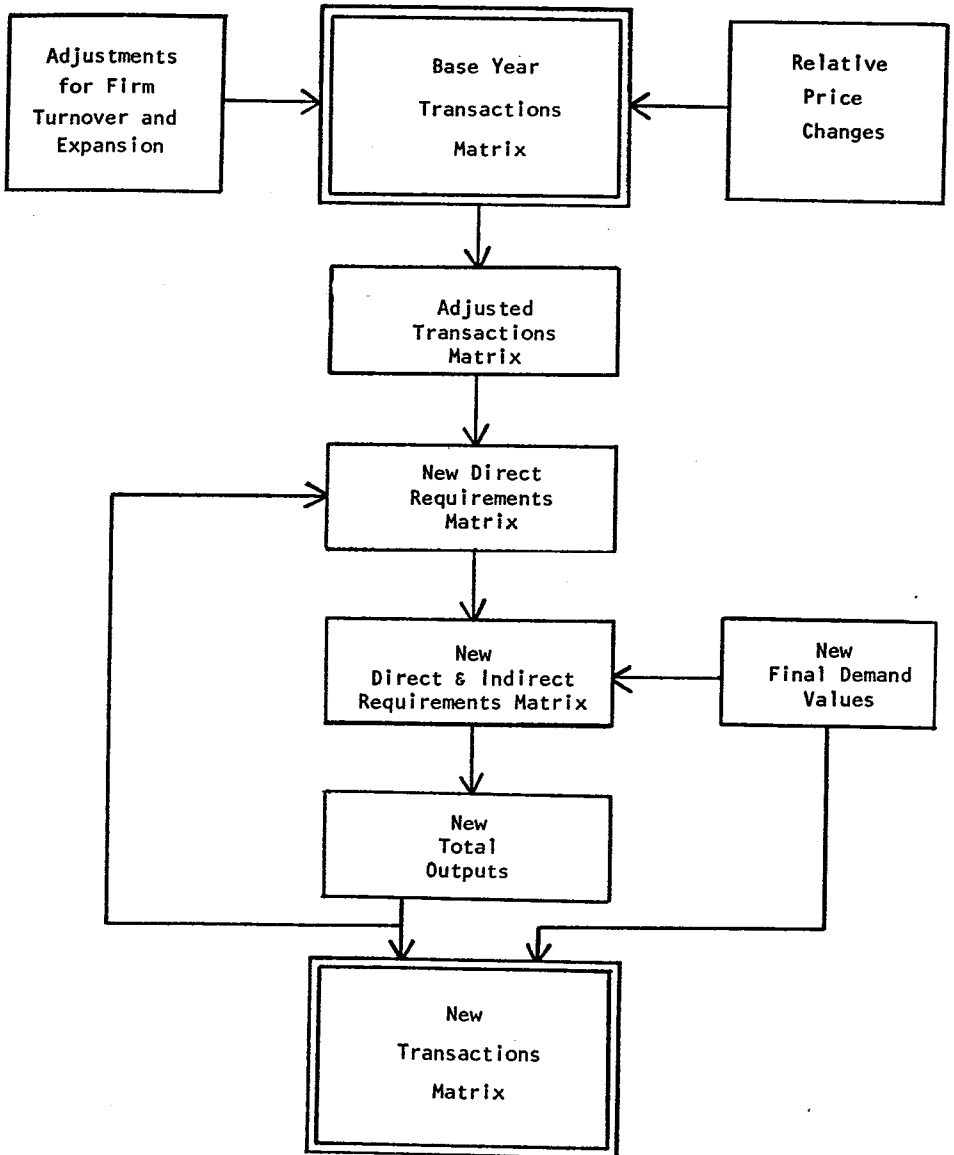


Figure 2  
Schematic Representation  
of Kansas Input-Output  
Updating Procedures





A unique feature of the Kansas I-O model was the construction of an import matrix and an export matrix. The import matrix detailed the sales of each out-of-state industry which was selling to each Kansas industry. The result was a matrix similar in size to the state transactions matrix. Similarly, the export matrix indicated the amounts that each state industry was selling to each national industry. Although these data have numerous uses such as market analysis and development potential identification, the two matrices are particularly useful for forecasting as outlined later in this section.

### The Impact Model Components

With the core of the model specified, attention may be turned to the impact system, the format for which is presented in Figure 3.

The impact model permits the identification of the effects of a multitude of events which will be felt by a variety of state industries. The components of final demand are the variables in the system. For instance, if the level of federal government spending is changed for any number of industries, the impact system can measure

- (1) The resulting output change for each industry in the state as well as the change in total state output and gross state product.
- (2) The resulting changes in personal income from each industry and the total change in state personal income.
- (3) The resulting changes in employment by industry and for the state.

Impact analyses have been conducted for dozens of actual and hypothetical situations including federal programs, new industries, construction projects, and energy shortages.

### Economic Projections Model

"We should all be concerned about the future because we will have to spend the rest of our lives there," C. F. Kettering once said. In order to effectively plan for the human and physical needs of an area, projections of the dimensions and characteristics of the region are vital. An abridged format of the Kansas forecasting model for state economic planning is presented in Figure 4.

The first stage in the projections model is the projection of the technology of the state's industries for the target period. Both time series and cross-sectional models are employed for this purpose. Time series data for input coefficients are available for the farming sectors. However, for the remaining sectors the cross-sectional "best practice" technique was used. This procedure assumes that the technology of the most efficient firms in the industry will become the average technology of the industry at some future date.

Projection of final demand is the next phase. The first component, consumer

Figure 3

SHORT RUN IMPACT MODEL

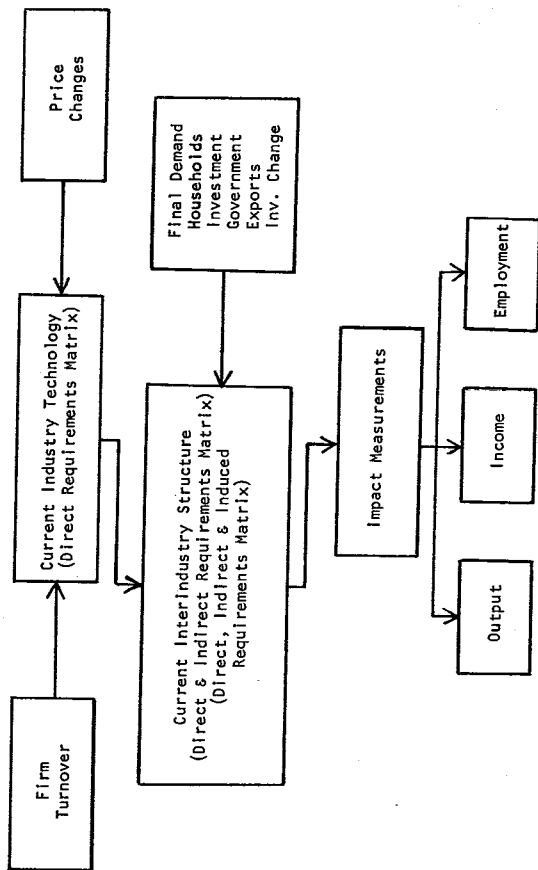
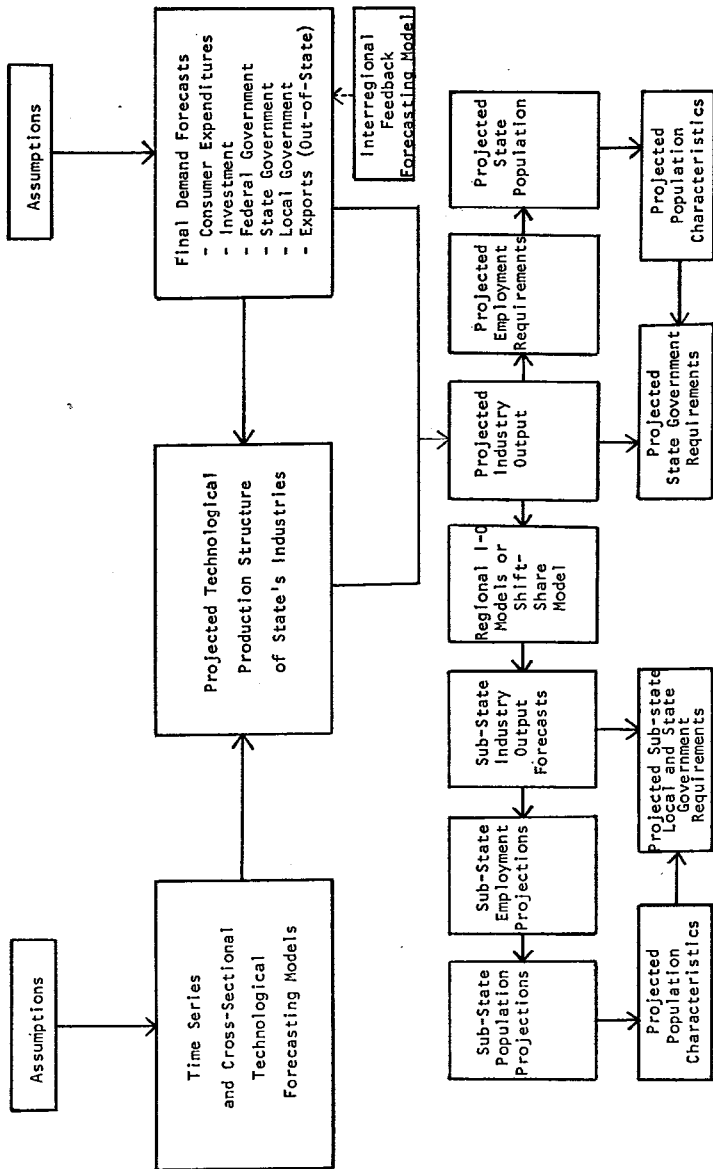


Figure 4

FORMAT OF INTERINDUSTRY PROJECTIONS MODEL FOR STATE ECONOMIC PLANNING



expenditures, which is often part of final demand, is actually included in the endogenous part of the matrix once changes in consumer spending patterns are projected. A similar procedure is used with respect to state and local government. Traditionally, these two sectors are considered exogenous, but for the purposes of the model they are viewed as being determined by the levels of activity in other sectors, rather than determining them.

The basic component of the final demand projection is the federal government and export category. By using the import and export matrices described above in tandem with the state table, a forecasting model can be formulated which measures feedback effects from the rest of the world. (See [5]). Employing the usual techniques of input-output matrix manipulation, the projected input structure and the projected final demand yield output projections for each industry.

Based on output/employee ratios, the output forecasts were transformed into employment forecasts for each industry. These employment forecasts in turn provided the basis for population projections. Sub-state projections for each of the planning regions also were undertaken.

The initial purpose of the long-range projections was to facilitate water resource development planning in the state. However, since the projections were developed in cooperation with several state agencies in addition to the Water Resources Board, they became designated as the official state planning projections. Long term demand projections for such factors as housing and energy were completed using the basic interindustry projections.

### Tax Analysis

A variety of analyses may be performed with a state input-output model to suggest development strategies. Multipliers, self-sufficiency analysis, and structural analysis are some of the more common approaches. A relatively new approach is the valuation of the state's business tax structure [1], [2].

The direct and indirect requirements matrix can be converted into a state tax matrix. Each entry of the state tax matrix shows the amount of state business taxes embodied in the purchases of each sector as each sector makes a one dollar delivery to final demand. Furthermore, each column sum of the tax matrix shows the total amount of state business taxes embodied in each dollar of sales to final demand by each sector. Thus, the state tax matrix takes into account the tax pyramiding in each sector as state business taxes are assumed to be shifted forward to the purchaser.

These state tax coefficients, which indicate the state business tax burden for each sector, can be used to determine the effect the state tax structure has on the competitive position of Kansas industries that compete in non-Kansas markets. Such an analysis of the Kansas business tax structure indicated, for instance, that the state tax structure does not favor the export base but that local taxes do. Tax analyses of this sort have appealed to legislative committees concerned with the state tax structure as well as agencies interested in development.

## Occupational Projections

The future labor requirements of a state's industries also have been projected with the aid of an input-output model. The projections contain two distinct components: output and occupational requirements. The procedure used in making output projections was explained earlier in the paper.

Since the mix of industry and rate of adoption of new technology varies among regions, the use of national occupational averages as base data or forecasts is questionable. Survey data of Kansas industries indicated a significantly different occupational structure than would have been obtained by using national estimates of occupational mix by type of industry [11].

In order to reduce this distortion, survey data were used to estimate the existing occupational structure of the Kansas economy. This was not possible for all sectors, i.e., retail and wholesale trade, and national profiles were employed.

The major technique to estimate future labor requirements by occupation type was the "best-practice" firm approach. The firms in each industry were arrayed according to several efficiency criteria. On the basis of this ranking the firms that were ascertained to be most efficient were used as indicators of the direction in which the industry was moving in terms of its future occupational requirements.

## Tax Projections

The planning of overall state economic development programs necessitates a long range view of tax revenues. Tax yields are a function of growth, change in economic structure, and changes in tax laws. The latter is unpredictable, but growth and change can be accounted for. A tax projections model using the input-output model as a base has recently been completed for Kansas [6].

Previous econometric state tax revenue forecasting techniques usually consisted of two steps. First, the income elasticity of tax revenues was estimated. Second, state income forecasts were utilized to project tax revenues from the income elasticities. Improvements in this methodology have included refining the constant income elasticity concept, using dummy variables to account for changing tax structures, and using principal components analysis to identify factors that explain the variation in tax revenues over time.

The input-output method for tax revenue projections also consisted primarily of two steps. First, state tax coefficients were computed. The Leontief inverse matrix was premultiplied by a diagonal matrix with state taxes per dollar of total output for each sector along the diagonal. The columns of the matrix formed by this product were summed to yield state taxes per dollar of final demand. Second, annual final demand projections were made and used to forecast state tax revenues on the basis of the state tax coefficients.

State tax projections were made on a sector by sector basis. Thus, changes expected to occur in the state's economy because of changing final demand were captured in the tax projections. Also, the use of a 1975 Leontief inverse matrix to compute state tax coefficients for the 1975 to 1980 period reflected changes expected to take place in the structure of the state's economy. These technological changes were also reflected in the tax projections.

Two problems encountered with the input-output methodology were the extent of forward tax shifting and changes in state tax laws. The shifting of taxes in the manufacturing sectors was reflected in sector tax parameters. These were estimated from the proportion of sector exports to states with higher overall tax rate structures than exist in Kansas. Taxes were assumed to be shifted if the exports were to states with higher tax structures. The other producing sectors were assigned a tax shift parameter on the basis of assumptions in previous studies. Changes in state tax laws were accounted for in the modification of state taxes per dollar of total output coefficients. Projected increases in tax revenues because of a tax law change were allocated to the manufacturing sectors on the basis of the existing distribution of the tax burden.

State business taxes were forecasted utilizing the above input-output methodology. Sales taxes were also projected using this method. However, sales taxes required that estimates of the sales taxes per dollar of total output for each sector be estimated from the transactions table for the state economy since the interindustry flows are net of sales taxes.

Personal income tax forecasts were made using a different methodology. Projections of the 1980 employment structure of the state from a previous study were used in conjunction with projected income level for each occupation in every sector to determine the number of taxpayers in each of several income classes in 1980. Personal income tax projections were then made on the basis of mean personal state income tax paid by each income-occupation class in 1968.

### Revenue Forecasting

The immediacy of short run problems all too often obscures any view of the future and consequently any planning for it. Thus, the policy maker and the policy implementor often find greater utility in an economic model that can improve their forecasts of short-run phenomena. Among such problems tax revenue forecasting generally looms as most important.

Input-output models despite their static nature have rarely been successfully applied to short run forecasting with a specified time frame. The popular short run impact studies have no time frame. But budgeting problems are concerned with performance within a specified time period. Thus revenue forecasts for one, two, and three years are the most critical.

In order to use an input-output framework for estimating annual tax receipts, measures of changes in final demand are necessary but these are also difficult to obtain. To facilitate this problem all final demand and final payments sectors

were made endogenous (including, of course, state and local government) except a combined federal government and exports vector. Increases in this external demand vector were then estimated from national growth data. The results of these calculations were business taxes and personal taxes which were then allocated to the relevant tax components on the basis of detailed survey data or past ratios.

This approach, which is a mixture of simplistic and complex components, has produced encouraging results. It compares favorably with two other approaches that have guided the estimating procedures in the past: (1) an econometric model, and (2) intuition and hunch. However, there is no rush to abandon any of these.

### Dynamic Simulation

An important extension of regional input-output models has been the development of a dynamic formulation to simulate economic development [10]. New firms have a different impact during the construction phase than they do after they start production. The dynamic model permits the calculation of these impacts by time period.

The basic Kansas input-output system was converted into a dynamic system with the addition of a capital matrix [7]. In addition to simulating the effects of a new industry, the dynamic simulation model has examined a potentially serious problem with regional models--the instability of trading patterns.

A plausible path of import substitution was introduced and industry growth paths were simulated and compared with similar growth paths assuming no import substitution (which is the common assumption even in dynamic models). The form of the import substitution dynamic simulation model is as follows:

Let the column vector  $X_t$  represent the  $N$  sectoral output produced in year  $t$ , and  $C_t$  the corresponding column vector of deliveries to final demand in year  $t$ . The structural characteristics of the economy are described by  $A_t$  and  $B_t$ , the square matrix of capital coefficients.

The direct interdependence within the economy in any two successive years can be described by the following general dynamic equation:

$$X_t - A_t X_t - B_{(t+1)} (X_{t+1} - X_t) = C_t$$

The second term on the left-hand side of the equation represents the current input requirements of all  $N$  industries in time period  $t$ . The time subscripts on  $A$  and  $B$  account for the dynamic nature of the model.

Let  $T_t = A_t + M_t$ , where  $T_t$  may be thought of as the total input coefficient or total technical coefficients. Then  $A_t = T_t - M_t$ .

The results indicated those industries which were most likely to be affected

by import substitution and the magnitude of resulting underestimation of long run growth poles.

## FEEDBACK EFFECTS

The variety of models discussed in the previous section have been received with mixed appreciation by the policy maker. Some models offered more than the policy maker expected and sometimes more than he wanted. Other models failed to yield any net benefits. This section suggests some of the lessons which might be gleaned from the modeling experience to date.

### Incorporation of Policy Instruments

For research to be supportive of policy it should realistically take account of the policy instruments actually available. The policy instrument linkage in many models appears weak or nonexistent. But considerable difficulty exists in the theoretical underpinnings to enable the construction of more specific models. Further, the anticipation of a totally automatic model into which dozens of policy alternatives can be fed seems beyond reach. The variety of forms which policy proposals may take is perplexingly large. For example, in an attempt to measure the probable effects of a change in the state tax laws to conform more closely to the federal, some 30 exceptions were considered in the tax impact model. The 30 alternatives were suggested by a legislative tax committee, accountants, and economists and seemed to represent the most probable alternatives. However, shortly after completing the project an additional 15 alternatives surfaced, ten of which ended up in the final legislation. The model was not constructed in anticipation of these additional alternatives because they had not been identified as possibilities. The model was a special purpose model. Since the alternative policy specifications may be quite large, models are likely to be more successful at a more aggregated level, even though such models are less satisfying to the policy maker.

### Interfacing

At the outset of the paper it was observed that many regional development models have been criticized for ignoring major policy problem areas. But the identification of objectives is not as serious as many economists suggest. A lack of interfacing between policy maker and model builder has rendered most models benign. The experience with the Kansas modeling efforts strongly reinforces this observation. Those models developed in conjunction with policy makers or implementors have proven successful, whereas those models developed on the assumption of what policy makers should have had their greatest impact on the demand for professional labor, computer time, and the paper industry. (There were, of course, some indirect and induced effects).

Two examples help illustrate the interfacing problem. The long run projections model was developed in conjunction with the potential users and resulted in substantial impact on decision-making in state government. The



occupational forecasting model, although at least as technically sound, was constructed without appreciable contact with the potential users until the results were submitted to them.

### Data Credibility

"Many would-be model builders, particularly of the academic type, concentrate all of their effort on mathematical or statistical methodology and expect the tedious data gathering task to be performed by someone else. Hence, models seem to be piling up everywhere, but very few are suitable for practical use" [8].

There seems to be little substitute for the arduous task of data gathering at the state and regional level. But because of the high costs of data collection considerable effort was devoted to developing the statistical sources of state agencies.

Economic data are perishable goods. A consistent flow of data is to be desired to perpetuate the utility of a model. But this continues to be a difficult task. Historically, states have tended to impute a low benefit-cost ratio to an investment in economic data and modeling. Hopefully, the efforts of the past few years will change that perceived ratio.

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