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ABSTRACT

A study was conducted to identify and organize a discussion of the most important issues to be considered in building or modifying an occupational employment projection system to best suit local area conditions and information needs. After a review of information-generating techniques in use by various public agencies, state offices and the Bureau of Labor Statistics (BLS), the various forecasting techniques were classified into four major approaches. These approaches are (1) the Occupational Employment Statistics (OES) program based upon the industry-occupation matrix used by the BLS; (2) regional econometric models used to represent the complex economic relationships among sectors of a local economy; (3) the regional input-output model approach, which describes in detail the inter-industry linkages (purchases and sales) within the local economy; and (4) employer surveys. It was concluded that, in general, neither regional econometric nor input-output models can significantly add to the overall quality of occupational employment projections that are currently being developed using the OES approach. Ten recommendations are made for future employment needs-trends projections research and practice. (KC)

Occupational Employment Projections for Labor Market Areas: An Analysis of Alternative Approaches

R&D Monograph 80

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This report was prepared by Dr. Harvey A. Goldstein of the Division of Urban Planning at Columbia University under contract No. 21-36-79-26 with the Employment and Training Administration, U.S. Department of Labor. Researchers undertaking such projects are encouraged to express their own judgement. Their interpretations or viewpoints do not necessarily represent the official position or policy of the Labor Department. The author is solely responsible for the contents of this report.

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FOREWORD

Over the part 10 years, econometric and input-output models, once limited to making national projections, have become available for making local area occupational projections. While the possibilities opened up by these new regional and local models are interesting, the cost of developing and maintaining them for particular labor market areas can be quite high. In addition, the apparent, though not necessarily actual, complexity of these models inhibits many people who should be involved in the forecasting process.

The purpose of this monograph is to give a balanced, nontechnical presentation of the advantages and disadvantages of econometric and input-output models compared with existing Department of Labor models for projecting local area occupational changes. The monograph is written for, and at the request of, local and State officials who are responsible for making local area occupational forecasts.

It should be noted that this monograph is the result of a collaborative effort on the part of the Employment and Training Administration, the Bureau of Labor Statistics, and the National Occupational Information Coordinating Committee.

BURT S. BARNOW
Acting Director
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and Development

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PREFACE

There are many issues to consider in assessing the relative strengths and weaknesses among alternative approaches to local occupational employment projections. This study has attempted to identify and organize a discussion of the most important of the issues to be considered in building or modifying an occupational employment projection system to best suit local area conditions and information needs.

The issues discussed are both highly technical and nontechnical. The treatment of the technical issues is entirely nonmathematical; no equations or mathematical formulas are contained in the text, as was requested by the Office of Research and Development, Employment and Training Administration, U.S. Department of Labor.

In reviewing the available techniques or approaches, it was not possible to identify *every* public agency, consulting firm, and university-based research group which may have been developing occupational employment projections or econometric models for that purpose. Instead we relied upon a number of different sources to provide leads in addition to those already known. These sources included officials and staff at the Employment and Training Administration (ETA), National Occupation Information Coordinating Committee (NOICC), the Bureau of Labor Statistics (BLS), as well as economic forecasters at various universities. In addition, we conducted a literature search for documentation of industry and occupational employment projection models in scholarly or professional journals.

Finally, we sent questionnaires to about 100 of the largest CETA prime sponsors and to every State Employment and Training Council to identify the utilization of any occupational employment projections developed with techniques other than those used by the respective State Employment Security Agency (SESA). Documentation of occupational projection methodologies other than those recommended in the Occupational Employment Statistics (OES) program used by SESA's was obtained from NOICC. Based upon a review of this documentation, several site visits and many telephone conversations were made in order to obtain more detailed information about techniques/models which had been employed.

The classification of the various forecasting techniques into four major approaches was based upon obvious methodological similarity, but also a desire to minimize the number of classes of approaches for simplicity's sake. Thus, for example, all economic forecasting models were grouped together, in spite of some significant structural differences among them. Also, the term "econometric model" is used somewhat restrictively here; it does not include the single-equation regression models used extensively by SESA's, but instead denotes the "full-specification" of a local economy. Except when *specific* applications or models of each approach are cited, the descriptions of each approach assume its "best practice," or state-of-the-art. In reality, of course, there are important differences between, say, the best econometric models and poorly constructed ones.

In general, it was not possible to compare the results of different projection techniques because rarely were any two or more applied under the same local economic conditions. For some particular models, tests of the accuracy of the projections were not documented at all. Also, it was well beyond the scope of this study to obtain the various projection models and conduct comparative tests of these with, say, a test data set. Thus, conclusions in the report about the relative accuracy of various approaches both in general, and in different types of labor market areas, are suggestive only.

The various approaches discussed in this monograph all deal specifically with making local area occupational projections. In the preparation of the monograph questions were raised about including a discussion of the Employment Service Potential Projects now being developed in several States. The ES Potential methodology makes use of State UI data to calculate current job accession and separation rates by firm and to measure the degree of ES penetration in local labor markets. While the ES Potential is an interesting and important administrative development for identifying target firms for the ES and for measuring ES performance, it is not a methodology appropriate for making local area occupational projections.

This report should not be considered as a substitute for the experience of local planners and policymakers and knowledge of local conditions in designing improvements in an area's occupational employment projection system. The report should be considered an informational resource which, when combined with experiential knowledge of local conditions, can help decisionmakers better adapt the occupational employment projection system to those local conditions and to local labor market information needs.

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SUMMARY

The need for the development of reliable, accurate, and timely estimates of future area labor market conditions parallels the increasing public and government concern for developing more effective means of matching labor supply with expected labor demand. Area occupational employment projections are the bases for effective planning and evaluation of employment and training programs and vocational educational curricula, for facility and equipment investment decisions, and for job counseling and job development, at the local level.

The techniques that have been used to develop area occupational employment projections have changed over the years in response to changing local labor market information needs and to the availability of better data. One of the earliest techniques was the area employer survey of future employment needs. The development of the industry-occupation matrix in the late 1960's enabled analysts to project occupational employment by first projecting industry employment and then using the matrix to translate the industry employment figures into a consistent set of occupational employment projections, based upon estimates of current industry staffing patterns. Throughout the 1970's BLS, ETA, and the SESA's refined and improved these procedures and data bases into the current Occupational Employment Statistics (OES) program. Also within the last 10 years, regional econometric models and input-output models have been developed for a small number of areas, and some of these have been suggested or developed for use in area occupational employment projection systems. They represent alternative techniques for projecting area industry employment, the first step in the occupation employment projection process.

Although many of the most important criteria for selecting the most appropriate approach, or techniques for an area's occupation employment projections system relate to the technical or mathematical characteristics of the alternative techniques themselves, the public policy context and area economic conditions are important to consider. The most important of these is Federal employment and training policy which strongly affects users' labor market information needs, including level of industry and occupational detail, frequency of projections, and length of projection period. The nature of the economic forces operating on local labor markets affects the choice of technique since some techniques can take into account the employment impacts of certain economic trends or shifts better than others. Many Federal Government policies have significant local industry employment impacts of their own. The desire to develop a capacity to test the employment impacts of alternative policies or future scenarios, and prior modeling efforts for the area are also important considerations.

The OES approach is based upon the industry-occupation matrix. A set of target-year area industry employment projections are first developed, using single-equation regression models or shift-share models. For the former case, there is one regression equation for each industry sector. The dependent (predicted) variable in each equation is the target-year employment in that industry. There is a small amount of flexibility in the choice of independent (predictor) variables; BLS recommends the target-year level of industry employment for

the U.S. (which BLS estimates using its own set of national growth models), and the lag of the dependent variable.

The industry-occupation matrix, developed from information on current industry staffing patterns collected in the OES survey of establishments, translates the set of industry employment projections into a consistent set of area occupational employment projections. Target-year job openings due to separations as a result of expected deaths and retirements are estimated separately using the national working-life tables, and these estimates are added to the estimates of net change in area occupation employment from the base year to the target-year, by occupation. The result is the target-year estimate of total job openings by occupation.

The principal advantages of the OES approach for an area occupational projection system include the full technical support of BLS, modest data requirements for calibrating the single-equation regression of shift-share models, and these models' simplicity and hence comprehensibility to users. The OES survey is proving to be a significantly improved and reliable source of staffing pattern information compared with the previously used decennial Census.

The principal disadvantage of the current OES approach is its unsuitability for conducting policy simulations or testing future scenarios for their employment impacts. The single-equation regression models as currently recommended by BLS may also be relatively weak in providing accurate projections in certain types of local labor markets: those which are cyclically unstable; have very strong interindustry linkages; and/or are growing at rates well above the national average.

Regional econometric models represent an alternative to the OES approach in the means by which the set of industry employment projections are developed. Regional econometric models are used to represent the complex economic relationships among sectors of a local economy, and between particular sectors of a local economy and "the rest of the world." Theoretically, by taking into account these complex economic relationships which exist in reality, an econometric model can take into account the impacts of more of the determinants of future local industry employment levels, and thus can lead to more accurate projections.

Regional econometric models require significantly more data (in time-series) for their calibration and use in projection (than the simpler models of the OES approach). A shortage of local economic variables with sufficient time-series observations frequently constrains the ability of these models to represent the complexity of the local economy. Attempts to compensate by using surrogate variables or by constructing data frequently lead to specification error or measurement error.

The principal advantages of using an econometric model approach are the models' potential sensitivity to a larger variety of factors which affect the local employment base, their ability to take into account indirect, or local interindustry effects, and their capacity for performing policy simulations, or testing the employment impacts of alternative future scenarios. These models theoretically are capable of including as much industry detail as is included in the industry-occupation matrix of the OES system. The effective constraint on industry detail in these models is data availability (for the independent variables).

The principal disadvantages of the econometric model approach, in addition to their greater data requirements, include substantial model and data base maintenance and upgrading costs, and their relative incomprehensibility to most users.

The regional input-output model approach represents a third means of developing a set of industry employment projections. An input-output model describes in detail the interindustry linkages (purchases and sales) within the local economy, and the trading relationships with the rest of the world. Based upon an exogenously estimated set of target-year *final demands* for goods and services produced locally, the model specifies the target-year level of output (production) for each local industry sector. Each local industry's output is translated into an employment requirement with the use of exogenously estimated, industry-specific labor/output ratios.

Regional input-output models require substantial and detailed data on the sales and purchases of all local industries. Very little of this is available as secondary data on a subnational basis. As a result national data must often be used instead, while costly primary data generation are still required for some industries. Estimates of target-year final demand is a difficult and costly task, and is highly subject to error. The technical coefficients in the models are generally well out-of-date due to the high cost of updating the data. A set of restrictive and often unrealistic assumptions limits the validity of the forecasts and can affect their accuracy. There is no specification error, however, since all economic relationships within the model are empirically determined. The principal advantage of input-output models is their ability to take into account detailed interindustry relationships among sectors of the local economy. The main disadvantages are the extremely high costs of calibrating and maintaining a model for a substate area.

Employer surveys represent an approach to generating occupational employment projections directly from employers' responses to questionnaires. Industry employment projections and an industry-occupation matrix are not needed. Many applications of the employer survey approach have included questions on estimated job replacement needs as well as expected target-year employment needs. In spite of the elimination of separate industry employment projections and the estimation of an industry-occupation matrix, the approach can still be costly. The advantages of the employer survey approach for developing medium- or long-term projections are relatively minor: they can be very easily adapted to fit local area conditions, and the means by which projections are generated are easily understandable to users. The principal disadvantages—low accuracy and low reliability—easily outweigh the advantages for medium- to long-term occupational projections. Employer surveys can have valid roles in generating other types of labor market information when sound, established survey research principles are followed.

It is concluded that, *in general*, neither regional econometric nor input-output models can significantly add to the overall quality of occupational employment projections that are currently being developed using the OES approach. There was no empirical evidence available which unambiguously demonstrated the superiority in forecasting accuracy of either regional econometric or input-output models to the single-equation regression models of the current OES approach. The only potential user information need which econometric or input-output models can better meet is the capacity for policy simulation or testing the area employment impacts of alternative future scenarios. The following recommendations and conclusions are made:

• In general, neither regional econometric models nor input-output models should be developed to replace single-equation regression models in the area industry employment projection element of the occupational employment projection system;

• if the policymaker desires the capacity to simulate or test the employment impacts of alternative policies or future scenarios, an econometric model would be needed;

• if an econometric model has already been calibrated for the labor market area, has an appropriate level of industry sector detail, and the costs of maintenance and operation can be shared by other agencies, then the SESA or other employment and training-related agency should procure the model's forecasts. The forecasts can be used as supplementary information and a basis for assessing and adjusting the projections from the OES system, or as the basis for developing an independent set of occupational employment projections;

• for a few labor market areas which display particularly unstable industry employment patterns, unusually strong interindustry linkages, and/or high rates of economic or population growth, an econometric model may well produce significantly more accurate results to justify the costs of developing a model;

• analyses by the SESA's and CETA prime sponsors with the support of BLS and ETA should be conducted to improve the selection of independent variables in the single-equation regression models currently recommended by BLS, on an industry-by-industry basis;

• a process of careful and insightful assessment and adjustment of industry employment projection which emerges from any statistically based model should be given greater emphasis at the State and local levels, and should be supported by appropriate Federal agencies;

• development and testing of alternative cost-efficient methods of generating or simulating area-specific matrices by the SESA's and SOICC's with the support of BLS should be continued and expanded in a larger variety of labor market areas.

• improved procedures for estimating job openings due to replacement needs should be developed. In particular reliable methods of estimating separations due to area out-migration and occupational mobility need to be included in the OES system;

- the relative strengths and weaknesses of the various elements of the OES system need to be empirically evaluated. Proposals for improving particular elements of the system should be made with the knowledge of the likely improvement of the system as a whole; and
- proposals to modify an area's occupational employment projection system based upon unmet users' labor market information needs should be carefully assessed to avoid compromising the theoretical or statistical validity of the projections. Proposals to increase the occupational detail of the projections should be based upon: (1) assessments of the capacity of the program and service delivery components of the employment and training system to utilize effectively a more detailed set of occupational employment projections; and (2) the information error in the data, due to misclassification of employers' job titles into OES occupational categories. Under no circumstances should industry or occupational employment projections be developed for sublabor market areas.

INTRODUCTION

Background

The need for accurate and timely projections of future labor market area conditions for employment planning and vocational education planning at the local and State levels has increased dramatically in the past 20 years. This increased need is reflected in the growing public and government awareness of the severe difficulties many groups and individuals have been facing in finding suitable employment in their communities. This awareness has been demonstrated most recently in the Comprehensive Employment and Training Act (CETA) of 1973 and subsequent amendments in 1978, and the Education Amendments of 1976. These pieces of legislation have authorized the funding of many new programs aimed at improving the match between labor supply and labor demand, at job creation in the public and private sectors, and at better coordination in the provision of labor market information needed to make rational decisions in the use of program funds and in individual job counseling.

Most States require their Employment Security Agencies (SESA's) to develop and disseminate long-term projections (5 years or more) of occupational employment. These projections are for the State as a whole and for larger labor market areas. The projections by the SESA's have been the primary source of medium- to long-term future labor market information on the demand side for State and local vocational education departments and CETA prime sponsors.

The technology that has been used to develop these projections has changed over the years. The earliest techniques were employer surveys. Employers were asked to list by occupation their current and expected target-year levels of employment. Area occupational employment projections were then developed by aggregating the survey responses by occupational category and taking into account the sampling frame. The Training Need Survey and Area Skill Survey, both examples of the employer survey technique, had serious shortcomings, however, and were replaced by the Industry-Occupation Matrix Technique developed in the 1960's.

The report of the President's Committee to Appraise Employment and Unemployment of 1962 (the Gordon Committee) recommended that new approaches to projecting occupational employment be developed, in recognition of the weaknesses of the employer survey technique. In response to the Gordon Committee report, BLS conducted a major study in which the methodology, and guidelines for use, of the industry-occupation matrix technique were developed. The results of the study were published as *Tomorrow's Manpower Needs* (TMN) in 1969. The new methodology represented a major shift in the way State and area occupational employment projections were to be developed. For the first time, statistically based mathematical models were being used, rather than "subjective" techniques which relied almost entirely on employers' expectations. Under this new methodology industry employment projections were developed using linear regression analysis. Shift-share models were later added as an alternative technique in response to a temporary shortage of time-series observations due to the change in the Standard Industrial Classification (SIC) code. In either case, these industry employment projections were then fed into the projected industry-occupation matrix of industry staffing ratios, and the matrix converted the industry employment projections into a set of occupational employment projections.

Since *Tomorrow's Manpower Needs*, a number of refinements have been made to the basic technique. The most important of these has been the conversion from the decennial U.S. Census of Population to the Occupational Employment Statistics (OES) survey for estimating current industry staffing patterns. In the meantime, however, a number of econometric and input-output models for States and large metropolitan areas were being developed for such purposes as tax revenue forecasting, impact analysis, and general regional economic-policy analysis. Among the local or regional economic variables which some of these models forecast were detailed industry employment levels. This offered the possibility of using fully specified econometric or input-output models to develop target-year industry employment forecasts which could then be fed into the industry-occupation matrix, in lieu of the industry employment projections developed from the much simpler models outlined in *Tomorrow's Manpower Needs*. The use of these more sophisticated models was seen by some as a way of increasing the accuracy of medium- and long-term area occupational employment projections.[1] As a result, administrators and planners of employment and training and vocational education programs, among others, would have available an improved, more useful labor-market information base.

Purposes and Intended Audiences of the Monograph

The primary purposes of this monograph are: (1) to review the relative advantages and disadvantages of alternative techniques currently available for developing local occupational employment projections; and (2) to recommend which technique(s) offer the greatest net benefits in the ongoing OES program development process in which BLS, ETA, SESA's, and the NOICC are currently involved. While this information is potentially of interest to a large number of groups and individuals involved in both public and private employment and training and vocational education efforts, the primary audience is intended to be decisionmakers in those agencies which either have the responsibility of developing area occupational employment and evaluation or facility investment decisions. In order for these people to help decide how the projections they develop or receive *might* be improved by employing alternative techniques or methods, we have addressed the following questions in the report:

1. What alternative occupational employment projection forecasting technologies are available?
2. What are the structural advantages and disadvantages of each?
3. Are there some types of labor market areas whose characteristics particularly enhance or minimize the advantages or disadvantages of a given technique?
4. What have been the experiences in the application of each of the techniques in terms of costs, meeting user needs, accuracy, etc.?
5. What are the technique/adjustment combinations which offer the greatest potential for improving the occupational employment projection system as a whole at the local level?

[1]The Department of Labor distinguishes the concepts of forecast(s) and projection(s) as follows: a forecast implies, "this is what is going to happen"; a projection implies the weaker, "this is what should happen if nothing unforeseen occurs." In this report, the term projection(s) will be used in the context of all official Department of Labor proceedings and programs, as well as in the context of other techniques which clearly belong to the weaker category. The term forecast(s) will be used in discussions of econometric and input-output models, however, since that is the term most often used in that literature (and since the documentation for these models often claims enhanced ability to take into account "unforeseen" occurrences).

Communication Between Providers and Users

A related purpose of the monograph is to help extend the bases for communication between those responsible for providing estimates of future labor market conditions and those who require these decisionmaking aids. The two communities often have conflicting objectives and interests, and even among users, there is a variety of information needs and requirements. Frequently these needs conflict or become too costly. Deciding such issues as the appropriate level of industry and occupational detail, geographic disaggregation, length of forecasting period, frequency of forecasts, etc. generally involves tradeoffs that must be carefully made.

Users, for the most part, are not particularly interested in the means by which forecasts are developed, but do care about timeliness, level of detail, accuracy, etc. Different techniques offer different limitations or constraints on these types of issues. Both providers and users need to understand better the tradeoffs between meeting an enlarged set of user needs on the one hand and preserving the reliability, validity, and cost-efficiency of the projections on the other. Such an understanding can help lead to locally initiated improvements and adjustments in the existing projection system to best meet local labor market conditions and labor market information needs.

Policy and Economic Contexts of Area Occupational Employment Projections

Although projecting occupational employment is primarily a technical activity, an assessment of it cannot be divorced from the public policy arena where the need and uses of this class of information are decided. Neither can occupational employment projections be discussed apart from the economic and political forces which act upon local labor markets and are responsible for the growth or decline of the employment base and for shifts in occupational demand. Indeed, if all local economies displayed highly stable employment bases, then there would be little need for an occupational employment projection system. It is beyond the scope of this report to describe the larger public policy and economic contexts comprehensively. But because occupational employment projection techniques cannot be assessed or evaluated, or recommendations for improvement made only on the basis of technical criteria, the most important of these contextual elements are identified and briefly discussed here.

The Policy Context

The realm of public policy which shapes the occupational employment projection system can be divided into three parts. The first is composed of those classes of government policies which are not directly related to employment and training, but frequently have significant impacts on the employment bases of labor market areas. Federal and State tax policy, incentives for industrial location and capital investment, public works and other counter-cyclical programs, regulatory policies in the areas of environmental protection, occupational licensing, occupational health and safety, international trade and tariff restrictions, transportation facility development, and national defense facility location are all policies which can have significant, though highly differential, impacts across labor market areas and among different sectors of the local economy. These policies stimulate or dampen economic (market) forces already at work. Concern for taking into account all relevant forces acting upon local employment bases motivates the development of alternative projection techniques.

Recently, the Federal Government, through the Office of Management and Budget Circular A116, directed all Federal agencies (except the Department of Defense) to develop urban impact analyses (statements) before initiating policy changes or drafting legislation which would have significant impact on urban areas, including employment impacts.[2] The directive was motivated by recognition that many policies or programs have unintended costs in sectors not directly related to the targeted areas or sectors. The idea of an urban impact analysis could be generalized or extended to an industry/occupational employment impact analysis.

The second arena includes public policy directly related to the collection, processing, analysis, and distribution of labor market information which becomes available for planning, administrative, and evaluative decisionmaking in CETA prime sponsors, vocational education programs, etc. The kinds of data collected, the classes of questions addressed, and the formats and levels of detailed aggregation are all public policy issues which profoundly affect the why's, how's, when's, and where's of occupational employment projection systems. Policy decisions on the forms of technical assistance, methodological guidelines, and overall funding levels for area labor market analyses have equally significant effects. Agencies such as the U.S. Bureau of the Census, the Bureau of Economic Analysis (BEA), BLS, ETA, the National Center for Education Statistics, and the new Department of Education, along with a variety of State agencies, follow policies based on interpretations of their constituents' needs, their legislative mandates, their own tradition, and sometimes the activities of other agencies.

To help coordinate and rationalize activities in the provision of occupational information among the various Federal agencies, and to coordinate Federal and State efforts, the NOICC-SOICC network was established by the Education Amendments of 1976. Its legislated responsibilities are to improve the coordination, cooperation, and communication in the development of occupational information systems (OIS) at the national and State levels. Since the OIS must include data on occupational demand and supply based upon uniform definitions, standardized estimating procedures, and standardized occupational classification systems, the opportunities for NOICC-SOICC to help shape and improve occupational employment projections in the future are considerable.

The third arena of public policy relevant to this discussion is that of employment and training, and vocational education policy itself. This is also where an environment of public acceptance of labor market information can be improved by encouraging broad participation of both private and public sector groups in helping to determine local information needs and in assessing the quality or accuracy of area occupational employment projections. The new Private Sector Initiative Program (title VII) of the 1977 CETA legislation, for instance, presents potentially new roles for private sector employers in determining target occupations for labor supply skill development. It is important that these determinations be based on sound analysis and reliable estimates of future local labor market conditions. Public policy concern for coordinated planning of economic development and employment and training efforts potentially could affect decisions about the most appropriate level of industry detail, the length of forecasting period, the desirability of a capability to conduct policy simulations. Here also lies the sensitive but important question of whether more accurate or more detailed projections would make more effective the planning of employment and training and vocational education programs. If there are more determinant barriers to increasing program effectiveness,

[2]Norman J. Glickman, "Methodological Issues and Prospects for Urban Impact Analyses," in Norman Glickman, ed., *The Urban Impacts of Federal Policies* (Baltimore: The Johns Hopkins Press) 1979.

arguments for large monetary investments to further refine occupational information systems may not be as compelling.

The Economic Environment: Sources of Employment Instability

The principal paradox of economic forecasting for areas is that for a more unstable local or regional economy, the need for reliable and accurate estimates of future labor market conditions for planning and policy-making purposes is greater, but so is the difficulty in generating such estimates. The basic reason for this is that all available forecasting technologies, ranging from the most naive to the most sophisticated, to some degree *project past trends into the future*. When the key forces acting upon a local labor market are unstable or unpredictable, assumptions about the continuity of basic economic conditions have less validity. In other words, the bases for the projections are less reliable.

Economic theorists are essentially in agreement about the *general* causes of aggregate and industry employment change in local economies: (1) changes in national aggregate demand brought about by inherent cyclical fluctuations and Federal counter-cyclical fiscal and monetary policy; (2) changes or shifts in demand for particular products due, for example, to changes in relative prices of substitute products or changes in taste; (3) relative changes in local wage rates and/or prices of other local factor inputs; (4) changes in the level and composition of the area population and labor force. These changes can have short term (e.g., seasonal), medium term (cyclical), and/or long-term (secular) impacts upon the local employment base. Employment program planners and vocational education curricula planners are not principally concerned with trying to respond to short-term fluctuations in occupational demand. The sources of instability of local employment bases which most concern employment forecasters and planners are those which are cyclical or structural in nature.

National business cycles cause changes in area industry employment, though differently among industries *and* areas. Each industry has its own characteristic cycle, and each local economy has its unique industry mix. Because the cyclical behavior of a local economy is nothing more than the composite behavior of its industries, the cyclical behavior of each local economy is unique.[3] There are other factors in addition to local industry mix: the extent of inter-industry linkages in the local economy and the local enterprise ownership structure (e.g., branch plants or single-plant firms). In spite of some variation in how a given local economy behaves in response to different national business cycles (e.g., in terms of amplitude, duration, lead or lag time), the behavior is sufficiently regular that, given the analytic methods available, it can be predicted with surprising accuracy how a local economy's employment base will change in response to a national recession and recovery, *if* the latter can be accurately predicted.[4] Unfortunately these tools are not utilized presently in most local occupational employment projection efforts.

Structural shifts are difficult to anticipate or predict because they are largely nonrepetitive. They can have sudden employment impacts whose effects endure for a long period of time. Even the most sophisticated projection or forecasting techniques are frequently unable to predict endogenously these shifts or their employment impacts; they must be predicted *exogenously*, i.e., outside the model.

As with national/international business cycles, long-term economic trends and structural shifts have differential employment impacts in local economies. Local economies have different ages of capital stock and physical infrastructure which make for differential levels of productivity and efficiency, different mixes of obsolescent industries and growth industries, different climates and leisure-time amenities, etc. The employment impacts of industry restructuring, capital, population and labor force migration trends, the shift to a service-oriented domestic economy, revolutions in communication and automation of work processes, and global energy scarcity will be felt differently in different areas. Plants will close in one local economy causing severe economic dislocation and job loss, while large, modern, new plants and facilities will open in small labor market areas, creating "boomtown" effects; while still other areas may become relatively immune or isolated from the impacts of some of these long-term trends and shifts. Since many of these impacts cannot accurately be estimated in any forecasting models to date, there will be an increasing need for analysts with concrete knowledge of the unique behavioral characteristics of a given labor market area. Every set of results from a projection or forecasting model is based upon a set of initial assumptions. The art of forecasting, in large measure, is the art of making correct starting assumptions about the economic conditions during the forecasting period.

[3]See Michael E. Conroy, *The Challenge of Urban Economic Development* (Lexington, Mass.: D.C.Heath) 1975, for a more detailed explanation and a technique for measuring local economic cyclical instability.

[4]See Georges Vernez, *et al.*, *Regional Cycles and Employment Effects of Public Works Investments* (Santa Monica, Calif.: The Rand Corporation, R-2052-EDA) January 1977, for an analysis of the behavior of a large sample of labor market areas and States over recent business and growth cycles.

ALTERNATIVE APPROACHES TO PROJECTING AREA OCCUPATIONAL EMPLOYMENT

Overview Of A General Occupational Employment Projection System

The general function of an occupational employment projection system is to produce an accurate and reliable set of forecasts of future job openings for the target year, by detailed occupation for the given study area. This is, however, the last element in a longer process. A general occupational employment projection system can be described as a set of five steps, or elements. Although not all of the approaches discussed in this report include all of these elements, the system shown in Figure 1 provides a useful general framework for viewing the logic of the process and for pointing out the differences among the alternative approaches.

Element 1: Industry Employment Projections

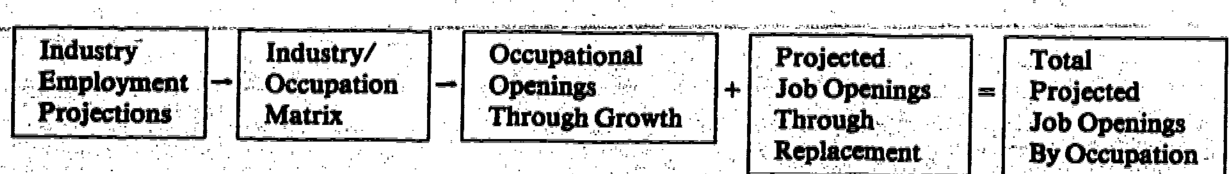
The aim here is to develop the best estimates of the target-year employment levels for each detailed industry in the study area. The means by which these estimates can be developed range from the "crystal-ball" approach, to simple trend analysis, to multi-equation economic models. Each of these techniques more or less involves the projection of historical trends (of industry employment levels) into the future. The principal differences among them lie in the degree to which one explicitly and systematically takes into account relationships among various causes of industry employment fluctuations and the amount of the fluctuations themselves.

The different local occupational employment projection approaches we have examined and evaluated in this report are distinguished primarily by the different means by which this first element is performed. The problems and limitations of the different techniques for projecting industry employment associated with the four major alternative approaches, along with suggestions for possible improvement, will be the subject of much of the remainder of this chapter and will reappear in subsequent chapters.

Element 2: The Industry-Occupation (Staffing Pattern) Matrix

The function of this element is to convert, or transform the industry employment projections developed in Element 1 into a consistent set of occupational employment projections. The matrix contains the distribution of jobs among occupational categories in

Figure 1. The General Occupational Employment Projection System



each industry sector for the study area. The number in each cell of the matrix refers specifically to the proportion of jobs in industry, i, composed of employees in a given occupation, j. The estimation of these numbers (proportions) for each cell in the matrix becomes the principal task in constructing the matrix. Data on the distribution of jobs in an industry by occupation are obtained through surveys of employers or from individuals (e.g., through the U.S. Census). Issues of appropriate level of industry and occupation detail, survey coverage, and means of projecting changes in the cell values from the base year to the target year are among the most important ones here. The OES program developed by DOL in cooperation with the SESA's has brought significant improvements to this element of the projection system, although some unresolved problems remain.

It should be noted that each of the major alternative approaches discussed in this report except the direct employer survey approach described later in this chapter include this element in their projection system.

Element 3: Occupational Openings Through Growth

After the industry staffing patterns have been estimated, it is possible to obtain a set of occupation employment projections for the study area. These projections will be consistent with the industry employment projections developed in Element 1. That is, the occupational employment projections will be only as reliable and accurate as the results of Element 1 and the estimation of the matrix in Element 2. Job openings resulting from growth are simply estimated by subtracting the base-year employment by occupation from the target-year projections by occupation.

Element 4: Projected Job Openings Through Replacement.

The results obtained in Element 3 are the target-year estimates of occupational employment for the study area *but do not include job openings caused by workers who leave existing jobs between the base year and the target year*. Such job openings occur for any number of reasons—retirement, out-migration, promotion, long-term illness, death, etc. Very often these job openings far outnumber the openings which result from new employment growth due to local economic development. Job openings through turnover caused by workers who leave their jobs do not represent net additional jobs in the local economy. However, to those responsible for helping to prepare or train future participants in the labor force for jobs that will actually exist, they are of equal concern.[5] The general procedures used for estimating job openings due to replacement needs have been developed by BLS and are discussed below.[6]

Element 5: Total Job Openings by Occupation

In this last element the results of Elements 3 and 4 are combined for each occupational category, to arrive at estimates of average annual job openings for the study period. These figures, which are adjusted if necessary, become the "target variables" for planning employment and training and vocational education programs, as well as serving as guideposts for monitoring changes in employment patterns in the study area.

In the following sections we review the salient characteristics, advantages, and disadvantages of the four major approaches to the local occupational employment projection system with frequent references to the *general* structure of that system, as described above.

The OES Approach

The current OES approach to projecting occupational employment for labor market areas has evolved from the basic design incorporated in the Bureau of Labor Statistics study, *Tomorrow's Manpower Needs* (TMN), February 1969. This study introduced the use of an industry-occupation matrix (often called the staffing pattern matrix), and this matrix is the heart of the OES approach. The matrix provided a systematic way of projecting occupational demands from independently derived projections of industry employment. This methodological advance was important because labor market theory had supplied no firm basis for estimating occupational employment directly. Techniques such as Area-Skill Surveys which attempted to do this were unreliable and often produced projections with large errors (see, for example, MacroSystems, Inc., 1974). On the other hand, existing economic theory was much better equipped to explain industry employment. If a reliable set of industry employment forecasts could be generated, the industry-occupation matrix could

[5]It should be noted that frequently openings due to workers leaving their jobs are filled from within a firm. The openings of this kind, in actuality, do not represent availability in the larger labor market. See Peter B. Doeringer and Michael T. Piore, *Internal Labor Markets and Manpower Analysis* (Lexington, Mass.: D.C. Heath) 1971.

[6]The reader should keep in mind that the BLS procedures do not attempt to account for all components of job openings through replacement. Deaths and retirements are covered in the estimates of age- and sex-specific separation rates by the working life table method. Job openings due to geographic or occupational mobility are not taken into account.

translate these projections into a consistent set of occupational projections.

With the introduction of the matrix technique, the Occupational Employment Statistics (OES) program was begun in 1970. This program is a cooperative effort involving primarily BLS and ETA and the various State Employment Security Agencies. Basically, the SESA's are responsible for implementing the OES program, which includes producing occupational employment forecasts for the State as a whole and for the larger labor market areas within the State. BLS is responsible for all technical and methodological aspects. It provides projections of national employment and computer-based statistical programs, as well as guidelines and general technical assistance to the SESA's. ETA has the responsibility for funding the OES program and administering and coordinating it at the Federal level.

The OES program has recently introduced several important improvements in the occupational forecasting system which will be discussed below. Also, the National Occupational Information Coordinating Committee and its State counterparts have begun to play an important role in improving the relationships between users' information needs and the supply of occupational information.

Although the OES program is built around the industry-occupation matrix, BLS also offers to cooperating SESA's technical assistance and a set of documented procedures for each of the other elements of the forecasting system. The particular design of each of the five elements in the OES approach is described below.[7] In the description of each element the emphasis will be on identifying particular advantages or disadvantages of the OES approach for developing occupational employment projections.

Element I: Industry Employment Projections

There is no single, required technique to be used here. The only constraint is that the industry detail be compatible with the industry detail of the industry-occupation matrix. BLS, however, recommends to the SESA's two classes of techniques: single-equation regression models and shift-share models. Detailed technical documentation for both, and a computer-based statistical procedure (DASIE) for the regression models are provided by BLS to the SESA's. BLS also provides to SESA's national industry employment projections developed from a national econometric model and a national input-output model.

Regression Models. The single-equation regression model is the technique most commonly used by SESA's to forecast local industry employment. There is one equation to predict the level of employment in each industry. In each equation, the level of employment in the given industry is the *dependent* variable (appearing on the left-hand side), and one or several independent variables (appearing on the right-hand side) are chosen as "predictors" of the dependent variable. If there is only one independent variable, then the model is referred to as a *simple* regression equation; when there are more than one, the model is called a *multiple* regression equation, data for all the variables in a time-series are collected and each of the equations are then *calibrated*. Calibration is usually performed using the statistical package provided by BLS (DASIE). The package uses a least-squares criterion for finding the straight line which best fits the time-series data. Regression coefficients are estimated in the calibration procedure. After calibration, the equations (models) are ready for making projections (except for any desired preliminary testing).

Shift-Share Models. A shift-share model decomposes an area's change in the level of industry employment into several mutually exclusive (and collectively exhaustive) components. There are several variations of shift-share models; each has a somewhat different combination of components. The so-called "classical shift and share," one of the most commonly used of this class of techniques, has three components to "explain" employment change during a given time period:

i. The national share projects the change in the area's level of employment in each industry proportionately to the change in *total national employment* (for all industries) during the same time period;
ii. The industry mix component projects the change in the local area industry employment proportionately to the change in national industry employment (same industry) for the same time period. This component takes into account the fact that employment levels in different industries change, in general, at rates different from the national average for all industries;
iii. The regional shift expresses the expected change in industry employment owing to the fact that the area's growth rate in industry employment may not coincide with the growth rate of the Nation as a whole in the same industry. This would be due, in turn, to the area's competitive advantages or disadvantages *vis a vis* all other areas. This is the so-called "shift" component.

[7] The reader should bear in mind that a comprehensive and highly detailed documentation of each BLS-recommended procedure is available from various BLS publications listed in the bibliography. A replication of this amount of technical detail is beyond the scope of this report.

The model "works" by simply adding the three components.[8] The result is the expected change in the area's industry employment between time t (the base year) and t + 1 (the target year). The data requirements to perform this analysis are exceedingly simple: (1) actual total national employment at the base year and an independent forecast for the target year; (2) national industry employment at time t - 1 (or prior, but recent, observation), at time t (the base year), and at t + 1 (an independent forecast for the target year); and (3) the area's level of industry employment at time t - 1 and at time t. Other variants of the classical shift and share model have somewhat different, but still rather undemanding, data requirements.

Issues in the Use of Single-Equation Regression and Shift-Share Models.

Although the techniques themselves are relatively simple, there are a number of issues that must be carefully thought out if they are to lead to reliable and accurate industry employment projections to be fed into the matrix. Among the most important of these are: a) the level of industry disaggregation; b) the choice of the *particular* model form; c) if the single-equation regression models are to be used, the choice of independent variables in each equation; d) the appropriate length of the forecasting period; and e) a procedure for assessing and adjusting (if necessary) the output of the chosen model. Each of these is discussed in turn.

a.) The question of what is the most appropriate level of industry detail depends upon several factors: the level of industry detail of the industry-occupation matrix to be used for the particular labor market area; the availability of detailed time-series data; the size and distribution of area industry employment, i.e., loss of statistical reliability (confidence); and the homogeneity of staffing patterns among related industries. Very simply, one should aim for the highest level of detail available in the area's staffing pattern matrix, subject to to the constraints or limitations above.

b.) The choice between one of the several shift-share models and the single-equation regression model is actually an empirical and pragmatic determination: the technique which produces the most accurate forecasts should be adopted. While the shift-share models generally require less (and more accessible) data, the data requirements for single-equation regression models are still relatively modest and do not normally pose an availability problem. Both shift-share and single-equation regression models require exogenous national employment forecasts, but these are regularly provided by BLS to SESA's and other forecasting groups.

The single-equation regression model is a more versatile technique than the shift-share models. Because one can select from among a wide choice of possible explanatory (independent) variables, there are greater possibilities for adapting the model to capture the particular determinants of industry employment in a given labor market area. There is little option in the choice of components among the various shift-share models.

Unlike shift-share models (which are mathematical identities), regression models need to be statistically calibrated. Furthermore, it takes some knowledge and familiarity with inferential statistical methods to be able insightfully to interpret the results of regression models (particularly multiple regression models); no such specialized knowledge is required to interpret the results of shift and share models. The calibration of single-equation regression models should not be a major problem because of the technical assistance and statistical software package (DASIE) provided by BLS. Local labor market analysts probably have some need, however, for additional guidance in interpreting the results of regression models.

Finally, there is a generally shared opinion among experts that when single-equation regression models are thoughtfully specified, they tend to produce more accurate industry employment forecasts than shift-share models. Both types of models rely on recent historic industry employment trends to project into the future, but the accuracy of shift-share models is more highly dependent upon the stability of only one recent time period (from t - 1 to t). Regression models, on the other hand, are generally calibrated over a longer period, include many more time-series observations, and hence tend to be more stable. Also the ability to choose a particular explanatory variable which captures an important but unique determinant of local industry trends may significantly improve forecasting accuracy when the behavior of the local industry shows a tendency to develop from the behavior of the same industry at the national level.

c.) The specification of a single-equation regression model is important because it strongly affects the model's forecasting accuracy. BLS has recommended that two or three particular explanatory variables be used in each forecasting equation: (1) the "lag" of the dependent variable—local industry employment for which data on actual levels are available (at time t, or t - 1); (2) the target year estimate of the level of industry employment at the national level; and (3) some measure of recent local aggregate economic growth (population change, change in the size of the local labor force, etc.), or rate of growth *vis a vis* that of the U.S. as a whole.

All three of these classes of explanatory variables are rather coarse, and implicitly assume a highly stable local employment structure including: (1) a stable rate of

[8] In using this model (or any other, for that matter) the labor market analyst makes the final determination of what the projections shall actually be: There is an opportunity to "adjust" the numbers which emerge from the model. The opportunities for adjusting the output from statistical-based models are discussed at several points below.

change of local industry employment; (2) a stable share of national industry employment; and (3) a stable rate of change of the size of the local economy (population) in proportion to that of the U.S. *For those local economies (and industry categories within those local economies) which have traditionally displayed such highly stable patterns, we would expect models specified with these particular explanatory variables to lead to relatively accurate projections*. There are, however, many labor market areas and industry categories which have not exhibited such stability in recent periods. For these cases single-equation regression models require explanatory variables which are more sensitive to unique local conditions in order to produce acceptably accurate industry employment forecasts.

Greater technical assistance from BLS in the form of a handbook with suggestions for selecting the most appropriate explanatory variables could lead to measurable improvement in the forecasting accuracy of single-equation models.

d.) In general, different employment and training-related programs require information on expected area labor market conditions at different periods into the future. There is a range of appropriate lengths of projection periods. Currently most SESA's are producing 5-to 10-year projections. The techniques discussed here are not sufficiently sensitive instruments to be used to develop reliable short-term projections (generally periods shorter than 5 or 6 quarters). However, there is no inherent reason why single-equation regression models or shift-share models cannot be used to develop area industry employment projections for, say, 2-to 5-year projection periods. For these medium-term projections, the important factor to be taken into account in model specification is the pattern of stability or instability of local industry employment over business cycles. Alternatively, knowledge of how local industries behave over business cycles can be used in a series of systematic adjustment to the output of the models. As the length of the projection period increases after 3 or 4 years, the inherent disadvantages of single-equation regression models relative to econometric models become relatively insignificant. This is in large part due to the inability of any forecasting or projection model to foresee and incorporate many of the events which play important roles in determining long-term employment levels.

e.) The OES program provides some limited guidelines for evaluating and, if necessary, adjusting the set of industry employment projections obtained from either the regression or shift-share models. This process is called *finalizing* labor market area industry employment projections before their "input" into the industry-occupation matrix (Element 2). The desirable elements here include (1) determination of the "reasonableness" of the forecasts based upon economic and noneconomic assumptions developed for the forecast period; (2) analysis of the model's output by a panel of economists and labor market analysts with familiarity with the behavior of the local economy and local industry trends (the panel should include representatives of the local business community, labor unions, trade organizations, and Government agencies); (3) adjustments for any last-minute developments such as announcements of new capital investment decisions, plant closings, etc.

No matter which technique is used for generating industry employment projections, the process of finalizing the projections by qualitatively assessing the performance of the model used is a crucial and necessary task. Yet the relative importance of the possible qualitative assessments depends upon the particular technique which was actually used to develop the projections. In the case of single-equation regression models and shift-share models, the testing of the reasonableness of the model's projections with economic and noneconomic assumptions developed for the national and local economy for the projection period takes on increased importance. This is because these classes of industry employment projection models are not policy-sensitive instruments; they cannot "test" different future scenarios.

Element 2: The Industry-Occupation Matrix

As mentioned, the I-O matrix is the heart of the OES program. It is the element of the system which has received the most attention by BLS.

Very simply, the industry-occupation matrix is a technique which is used to convert a set of industry employment projections into a set of occupational employment projections. The matrix itself contains information about the staffing pattern of each industry, in the form of ratios of the number of employees in a given occupation in a given industry to total employment in that industry. The OES program has improved the procedures and data base used in estimating these occupational ratios,[9] and thus strengthened the occupational employment projection system as a whole. The most salient characteristics of the I-O matrix technique, and relevant BLS procedures for developing and improving the matrices are described below.

Updating the National and State Matrices. One of the major problems and sources of forecasting error with the Census-based matrix was that the staffing pattern ratios for all detailed occupations in all industries could generally be updated only every 10 years.[10] The OES-

[9]See Max L. Carey, "Evaluating the 1975 Projections of Occupational Employment," *Monthly Labor Review*, June 1980, pp. 10-21.

[10]In actuality, Current Population Survey (CPS) data were used to update *parts* of the matrix (industries with relatively large employment) in intercensal years. The sample sizes of the CPS intersensal data were generally small, however, and were, in any event, *national* samples.

survey is conducted by participating States over a repeated 3-year cycle, with approximately one-third of the covered industries sample-surveyed every year. Even allowing processing time, no portion of the OES survey-based matrix will be more than 2 to 3-years out of date. This more frequent updating of the matrix reduces inaccuracy in the projection system because actual staffing pattern changes in a given industry are likely to be significantly less within a 2 to 3-year time period than in a 10 to 11-year period.

Level of Detail of Industry Sectors and Occupational Categories. The OES-survey is capable of providing a larger and more detailed set of staffing patterns than the decennial Census could provide. Industry sectors are disaggregated to the 3-digit SIC level (currently 368 such sectors) while about 1,500 different occupational categories are available in total. For any single industry sector, however, no more than 200 occupational categories are available on the survey questionnaire (although the particular 200 occupational categories, of course, vary industry-by-industry). This limitation requires the use of several residual, broad occupational categories on the survey questionnaire (e.g., *all other clerical, all other operatives*, etc.). An estimation procedure exists to reallocate the data in the residual occupational categories back to the much larger number of detailed categories in the matrix. This procedure reallocates on the basis of the proportional contribution of each of the detailed occupational employment to the more aggregate occupational category (e.g., clerical, operatives, craftsmen, etc.). Information for this is normally obtained from the previous decennial Census. There has not yet been any systematic testing of the accuracy of this reallocation procedure. Since, however, the size of the residual occupational employment levels has tended to be small, the size of the error introduced by this procedure is likely to be insignificant.

Using a more detailed set of industry sectors reduces projection error from at least one important source because the heterogeneity in staffing patterns among closely SIC-coded industries will be reduced. Many analysts believe that there is substantial variation in staffing patterns among "similar" industries at even the 3-digit level of the SIC code. A more detailed set of industry sectors, however, may require much larger samples to achieve statistical reliability, or may not even be possible in States where a particular industry category is not highly represented. On the other hand, there are other classifying variables, such as establishment size, which, for a given industry sector, will help to reduce the heterogeneity of staffing patterns.

The high degree of detail of occupational categories in the OES survey-based matrix makes it possible to have an equally high level of detail in the occupational employment projections. Yet there are at least some questions about the desirability and need for more highly detailed occupational employment projections, given the quality of the information base and propensity for nonsampling error on the one hand, and, on the other, the capacity of the actual employment and training, and vocational education delivery systems to effectively utilize more detailed information.

First, in regard to the information base, there may be a substantial but unknown amount of nonsampling error in the classification and reporting of occupational titles. Many establishments have their own idiosyncratic occupational codes which may not coincide with any of the several official Federal classification systems, particularly the classification system used on the OES survey questionnaire. Whenever an establishment uses a different internal coding system, a "cross-walk" must be performed and this introduces error. The more detailed the set of occupational categories in the OES matrix, the larger the potential error. Ironically, there is a tendency to assume that a more detailed set of occupational employment projections, which a more detailed matrix can help develop, is correspondingly more accurate. But in the presence of this kind of nonsampling error of the input data, the opposite may well be true. The optimal level of detail depends upon the accuracy of the information obtained in the OES survey.

The response capacity of actual employment and training programs to highly detailed occupational forecasts involves, in part, the relationship of occupational categories to skill requirements. Employers "demand" a specific set of skills. To meet this need, occupation employment projections ideally should be projections of future labor needs (skills) requirements. While occupational classification systems are designed, in part, to reflect different sets of skill requirements, there are numerous groups of occupations which require many of the same set of skills and educational background. Different occupational titles are used to distinguish such items as seniority, wage levels, previous position, etc., in addition to skill requirements. Also, skill requirements are becoming increasingly homogenous in the rapidly expanding white-collar but nonprofessional occupational groups: clerical and sales workers. It is probably not the responsibility of the occupational employment projection system to translate estimated occupational demand into demand for labor skill classes, but the discrepancy remains a problem for many users.

Industry Coverage of the OES Survey. The respondents to the OES survey are establishments, whereas the respondents in the decennial Census are workers or other members of workers' households. Except for variations in establishments' occupational classifications as discussed above, responses by establishments are generally considered to be the more reliable of the two. Not all establishments, however, are included in the universe when designing the sample.

Only those establishments covered under the States' Unemployment Insurance (UI) laws are included, which means only nonagricultural wage and salary workers. Adjustments to account for the other classes of workers (which are proportionally small) are based upon information from other sources.

One other item about industry coverage is pertinent. In the OES survey-based matrix there are three separate government industries: Federal, State, and local (including county). In the old Census-based matrix, employment in the government sector was allocated to the appropriate separate private-sector industry categories. The change reflects the increasing quantitative importance of the government sectors as a source of employment, and the recognition that staffing patterns in the government sectors do not necessarily coincide with those in private industries.

Generating Labor Market Area Matrices. In the initial rounds of State and Area occupational employment projections (Interim Projections Program in 1972-1973), the staffing patterns which were used for developing area occupational employment projections were those represented by the Census-based national matrix. Here the State and area projections were developed using a base period (1970) and projected (1980) national matrix following "Method A."[11] State and area matrices had not yet been operationally developed.

In the second round of the State and Area Projections Program, 1975-1977, occupational employment projections were made for States and labor market areas over 200,000 population, using staffing pattern matrices based upon the employment data for the *particular* area in the 1970 Census. The staffing pattern matrices which were generated for labor market areas with 50,000-249,999 population were based on industry staffing patterns of the "balance-of-State," again taken from the 1970 Census. In the latter, the area was too small to arrive at statistically reliable matrices from employment data for that area. By using the "balance-of-State" staffing patterns instead of the national matrix or even the particular State's matrix, however, the resulting matrix would be more likely to reflect the actual staffing pattern of the smaller sized labor market area. For the case of States and the larger labor market areas, "Method B" was used to develop projections using a base period matrix and projected matrix. For the smaller labor market areas, "Modified Method A" was used.

In both "Method B" and "Modified Method A," however, the updating is based upon *national* change factors. "Pure" local area staffing pattern matrices were never developed.

With the switch to the OES survey, there may no longer be a need for updating the matrix using any of the methods mentioned above. The OES survey provides a capability for generating area-specific matrices for the larger LMA's but not directly for the smaller SMA's because of insufficient cell size. It would be necessary to greatly expand the States' OES sample or, alternatively, over-sample in each of the smaller labor market areas to achieve statistical confidence in the resulting matrix. Both alternatives involve considerably greater expense and would not be budgetarily feasible in many States.

An alternative approach--the simulation of area matrices-- is being studied in several States. The early results of tests of their accuracy have been mixed. The approach involved using the relevant State staffing pattern matrix but adjusted for the labor market area's unique detailed industry mix and distribution of size of establishment in each local industry. Independent studies have shown that staffing patterns among firms within a given industry differ, most importantly, by the size of the firm. By knowing the size-of-firm distribution and industry mix of the labor market area from the ES 202 series, and the different staffing patterns for different firm size classes in each industry at the State level, local area matrices can be "simulated" from the State matrix. The assumption which must be made is that the local area staffing patterns of local industries is similar to the staffing patterns of industries statewide for the same size-of-firm classes. Currently the States of Colorado, New Hampshire, New Jersey, Oregon, Texas, and Utah are using this simulation approach for the development of matrices for smaller LMA's. In general, the approach offers the greatest applicability in primarily rural and non-metropolitan States.

Reviewing and Adjusting the Results of the OES Survey. Review of the employers' responses to the survey by experienced analysts can reduce nonsampling error before the information is used to calculate the staffing pattern ratios in the matrix itself. Analysts who have become familiar with the typical staffing patterns and production processes of a group of industries (e.g., food processing, business services) can readily identify a firm's responses which substantially deviate from the typical pattern. They can then check for reporting errors or possible misclassification of the firm in the SIC code by contacting the employer. In the process of doing this over several years in the same labor market area, the analysts can become very familiar with the unique staffing patterns of locally represented industries on a firm-by-firm basis.

[11] See U.S. Bureau of Labor Statistics, *Occupational Employment Statistics Handbook*, April 1979, pp. 46-47 for a description of these and related techniques, or, alternatively, U.S. Bureau of Labor Statistics, *Tomorrow's Manpower Needs*, Vol. I, BLS Bulletin No. 1606, 1969.

Element 3: Occupational Openings Through Growth

The output of the OES survey-based matrix is a a set of occupational employment projections consistent with the finalized industry employment projections in Element 1. This set of occupational employment projections are converted to expansion (contraction) needs by subtracting, for each occupational category, the base-year occupational employment level from the target-year projection.

Element 4: Projecting Replacement Needs by Occupation

A significant proportion of the total job openings that occur for a given occupation during a projection period are due to labor force separations. A *separation* occurs when a worker leaves his/her job for any number of reasons--retirement, long-term illness, death, childbirth, out-migration, occupational mobility, etc.

When a separation occurs, either the worker is replaced by someone else, or the job is eliminted. If the job continues to exist, then a job opening due to replacement is created. In general, there can be job openings in a given occupation even in areas in which there is no net occupational employment expansion. In estimating job openings due to replacement, we are, in actuality, estimating, for each occupation, the proportion of the jobs that exist in the base year in which there will be a separation. Since separations occur for a number of different reasons, it is really necessary to estimate separately each *component rate* of the total separation rate. Some of these component rates are highly stable (retirement, death) over time and across States and areas (computed by age and sex), while others may vary significantly either by area (out-migration), by occupation (occupational mobility, long-term illness), or by industry *and* area (layoffs).

In the OES system, only separations due to deaths and retirement are estimated. Other separation components are not estimated because of either data unavailability or methodological weaknesses. Separations due to deaths and retirements are currently estimated with the use of occupational separation rates using the "working life table" method.[12] This method estimates State occupational separation rates as functions of national sex- and age-specific separation rates (not occupationally specific), and State age- and sex-specific levels of occupational employment. This latter information is obtained from the latest decennial Census. In this BLS procedure, it is implicitly assumed that each separation which occurs as a result of a death or retirement will result in a job opening during the same time period. If in actuality the job is eliminated, then the information shows up in the results of Element 3, as a contribution to employment decline.

When the occupational separation rates have been estimated, an estimate of annual separations by occupation is calculated by multiplying the *average occupational employment level* during the study period by the relevant occupational separation rate. The *average occupational employment level* during the forecast period is the midpoint of the base-year occupational employment level and the projected target-year level (from Element 3). The estimates of job openings due to replacement are represented by the estimates of annual separations.

Problems With the Method. There are two principal problems with the methods used in the OES approach for estimating area replacement needs. First, the sex- and age-specific separation rates are national rates and are not disaggregated by occupation. It is generally known that different occupations have different separation rates owing to such employment factors as health and safety, labor union representation, wage and salary level, level of welfare benefits, pension and health care benefits, previous training and education required, etc. Moreover, some of these factors vary considerably across different regions and States.

The second problem is that there is no account for variations among LMA's in quit rates due to decisions to move from the area. When calculating separation rates for the Nation as a whole, the inter-area migration component of the separation rate can essentially be ignored. At the State level it becomes a greater concern, and at the area level quits due to decisions to migrate can be sizable proportion of total turnover. We know that while residential mobility has been increasing considerably in the post-World War II period there are labor market areas which are generally areas of net in-migration and other areas of net out-migration. Yet the aggregate net-migration rate for an area does not even tell the whole story. There can be considerable variation among an area's migration rates by occupational category.

There is currently no systematic method in the OES system of estimating area quit rates due to out-migration (by occupation) or estimating separation rates due to occupational mobility. Projecting job openings due to replacement needs for labor market areas can be improved by developing procedures for estimating separation rates using at least State data, and also by examining variations in individual components of the separation rate (death, retirement, disability, childbirth, and quits due to decision to migrate) across States and labor market areas. More frequently collected and more accessible migration data at the area level is needed before local labor market analysts can significantly im-

[12] For a detailed description of this method see U.S. Bureau of Labor Statistics, *Tomorrow's Manpower Needs*, Supplement 4, "Estimating Occupational Separations from the Labor Force."

prove the accuracy of the estimate of this component of the separation rate.

Element 5: Forecasts of Total Job Openings

Total job openings in a given occupation are composed of: (1) job openings due to local employment expansion (or job closings due to contraction); and (2) job openings due to replacement needs. Since total job openings are forecast for a study period—between the base year and the target year—and the study period varies in length depending upon users' labor market information needs, projections of total job openings in the OES approach are calculated as *annual* job openings. Replacement needs in Element 4 were calculated on an annual basis since the occupational separation rates were estimated on an annual basis. In Element 5, the set of occupational employment projections from Element 3 are converted to average annual expansion (contraction) needs by dividing the difference between base-year employment levels and target-year levels by the number of years in the projection period. This figure, when added to the annual replacement need figure, gives the area's total annual job openings in a given occupation during the projection period. When this is done for each occupational category in the I-O matrix, the resulting set of figure represents the final product of the occupational employment projection system.

Econometric Models of Local Labor Markets

Econometric models comprise the second category of the major approaches for developing area occupational employment projections. In most applications to local occupational projecting, econometric models lead only to industry employment projections—Element 1. Hence, the econometric approach is not a comprehensive one.

Econometric models are nothing more than a set of equations which together describe the behavior of the local economy. Among the equations are those whose dependent variable (on the left-hand side) is the level of industry employment. In general, however, these particular equations cannot be solved without simultaneously solving all the other equations, since industry employment levels are only one link in a chain of logical relationships among a larger number of economic variables. This differentiates econometric models from the single equation regression techniques discussed above. The simultaneous solution of the equations invariably requires the use of large-capacity (expensive) computers. A hypothetical, but by no means a typical, set of relationships among local economic variables pictured in a local econometric model is shown in Figure 2. The relatively complex picture of the local economy represented here should be contrasted to the rather simple picture represented by the single-equation regression models described above.

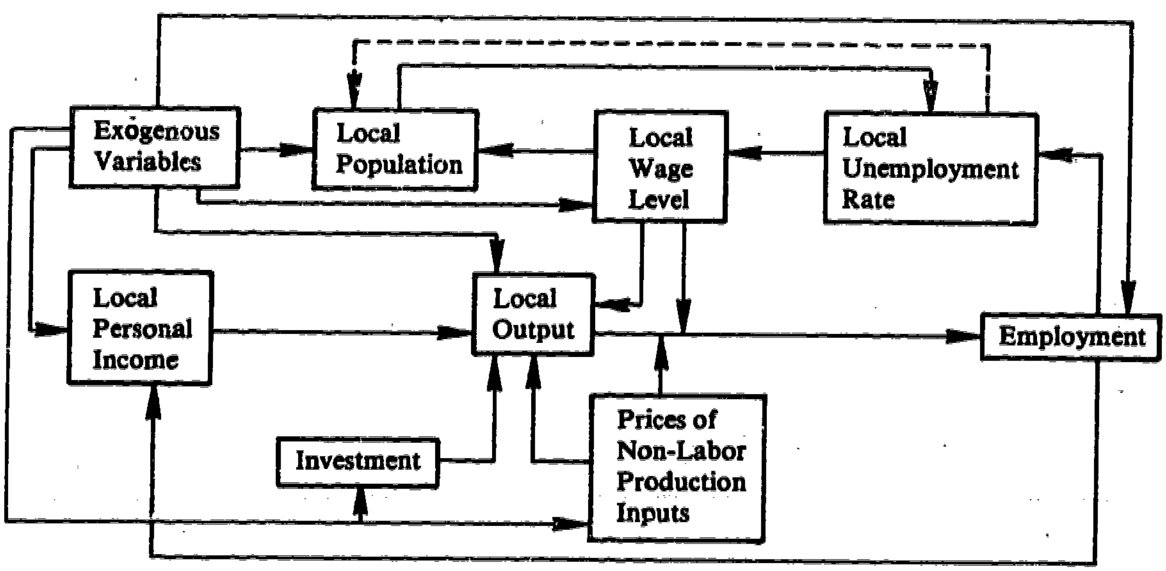


Figure 2. An Econometric Model's Picture of a Local Economy

The process of building an econometric model for forecasting purposes is not unlike that of constructing single-equation regression models. It is only more intricate and expensive. Briefly, the steps include model specification, data collection and assembly, model calibration, model testing, and respecification and calibration if necessary, before the model is ready for actual forecasting.

Model specification means identifying the most appropriate structure of the model to fit particular purposes and special needs. It also includes the selection of the independent, or explanatory variables in each equation. Good model specification relies almost as much on experience in the art of modeling (i.e., knowing what works) as on urban/regional economic theory.

Data collection and assembly entails having values for all variables in historical time series. Frequently some of the specified variables do not exist in sufficiently long time-series, and so "surrogate" variables have to be used, or constructed. The alternative is to go back and respecify parts of the model. Model calibration means "fitting" the model to the historical time-series data which describe the behavior of the local economy and the important exogenous forces which have acted on it. More specifically, it entails estimating each of the regression coefficients (sometimes called the structural parameters of the model) in every equation of the model.

The two most frequently used statistical techniques for calibrating an econometric model are called ordinary-least-squares (OLS) and two-stage-least squares (TSLS). In the calibration phase the model builder has the first opportunity to know how accurate the model is likely to be when it is to be used for forecasting. A poor "fit" here will cause the model-builder to go back and consider an alternative specification.

A model should be tested outside the calibration period before it is used for forecasting in the public policy realm. Testing outside the calibration period means seeing how well the model can forecast local employment for time periods in which actual data is available, but which were not included in the original fitting of the model to the date. Often this requires a time delay of several years between final calibration and "operationality." Because of this delay, testing frequently does not take place before the model is actually put into operation. In the sections below we discuss in greater detail the most important characteristics of these models, or issues, with regard to their usefulness in a local occupational projection system. The first set of issues deals with technical characteristics of the econometric models in the occupational projection process, and some of the results to date.

Technical Characteristics

Output Information. Econometric models of local labor markets represent an alternative means of completing Element 1 of the occupational projection system. *That is, the relevant output of these models is a set of estimated levels of industry employment for the target-year for the labor market area.* Although theoretically the other elements may be included as separate submodels, in most applications they are not. In any event, a technique for converting the set of industry employment projections into a consistent set of occupational employment projections must be appended to the core econometric model in this approach. The core econometric model should be seen as an alternative only to the single-equation regression models or shift-share models or other industry employment projection techniques, and not as an alternative to the OES system as a whole.

Data Requirements. Econometric models require two kinds of data for their calibration and use in employment forecasting. The first is an historical time-series of every economic variable specified in the model. This is necessary for calibrating the model, i.e., for estimating the model's parameters. The second type of required data are target-year forecasts of all independent variables. This is necessary for actual forecasting after the model has been calibrated and tested.

On a general level, the above data requirements are the same as for single-equation regression models discussed earlier. Yet, even though the *kinds* of data which are required are the same, the actual data requirements for developing and utilizing fully specified econometric models are significantly more severe. This is true for two reasons: (1) there are a larger number of national *and local* economic variables specified in an econometric model; and (2) because a more complex "picture" of the local economy is being drawn by the model, a larger number of time-series observations for each variable is required to maintain a given number of statistical degrees of freedom. Indeed, most of the important problems which have hindered the development of subnational econometric models to date have revolved around the availability of data. These problems have been compounded in the development of substate models.

Many of the economic variables which regional economic theory would indicate should be included in the model specifications are, on a subnational level, available only annually. Because of the use of annual data there are relatively few observations available for many economic variables at a subnational level. The paucity of observations sharply constrains the complexity of the equation structure of the model and the number of independent variables in any given equation (often to one or two). The fact that there are fewer economic variables available in *any* consistent time series for substate areas further constrains the model specification. Both problems lead to errors of specification and thus reduce the model's forecasting accuracy.

There are several strategies which model builders utilize to help overcome these data availability problems, but each commonly leads to either alternative specification error or measurement error. One strategy is to simplify the equation structure and to reduce the complexity of relationships among the various economic variables. As was mentioned above, this leads to specification error.

A second strategy is to use national economic variables in lieu of their local counterpart as independent variables, or, alternatively, to use some "share" model to estimate a local variable from a national variable. There are historical time series developed for a very large number of economic variables for the U.S. over an extended period, ensuring a large number of observations. Moreover, national econometric models can be utilized readily and relatively reliably to forecast target-year national-level economic variables. Among these are models developed by the Bureau of Economic Analysis in the U. S. Commerce Department and the economic growth model package developed by BLS. The principal problem of this strategy is that in addition to misspecifying economic relationships, it reduces the advantages of developing local econometric models in the first place. A third strategy is to use surrogate variables in cases where the preferred variables do not exist in sufficient time-series, or to construct a time-series from incomplete information using such mathematical techniques as interpolation or extrapolation. The former leads to specification error, the latter to measurement or information error.

In due course there will be a sufficient number of annual observations of variables collected and published for substate areas to allow for greater complexity in equation structure. The rather narrow range of local economic variables in a consistent time series, and inadequate methods of reliably forecasting target-year values of local economic variables used as independent variables, however, will constrain the development at moderate costs of accurate, sufficiently detailed, and locally sensitive econometric models.

Finally, almost all local econometric models must be linked in some fashion with a national model to obtain target-year forecasts of national-level independent variables. The degree of coordination between the development of a local model and a national model depends upon the modeling design strategy chosen (see below). The larger, private economic forecasting firms with models of the U. S. economy have the capacity of building local models which are satellites of the national model. This has the advantage of ensuring consistency and compatibility. In any event there is, of course, a fee for purchasing the services of these private economic forecasting groups. The BEA and BLS national models, on the other hand, may not provide a sufficient range of national-level variables required as input to the local model.

Level of Industry Detail. Can local econometric models lead to a more detailed set of industry employment forecasts than other approaches? The level of industry detail is constrained primarily by the availability of input data for model calibration and secondarily by some model design strategies.

The ES 202 data files are among the most detailed industry employment information in consistent time-series available for labor market areas (although it must be supplemented, as discussed above). The level of industry detail of the published ES 202 data varies, however, by the size of the labor market area, due to the problem of statistical reliability of small samples. Thus the smaller the labor market area, the less industry detail one can design into the model. Frequently one is constrained to the 1-digit SIC level for small labor market areas, while the 3-digit SIC level is theoretically possible for the largest areas.

Most subnational econometric models which have been developed to date are highly aggregated (macro-models) with industry sectors defined at the 1-digit SIC level *at best*. These models, however, have not been developed with the intention of their being utilized in the occupational employment projection system. The models recently developed at the University of Arizona by Taylor, *et al.* demonstrate that there are no serious limits to designing and specifying highly detailed econometric models *aside from the data availability problem*. Of course, there are other considerations which determine the *optimal* level of industry detail (the same as those discussed in the preceding section of this chapter).

Length of Forecasting Period. As discussed earlier, accurate projections of occupational employment and hence industry employment forecasts, are often needed for various lengths of forecasting periods.

Subnational econometric models have usually been designed to address short-term and medium-term information needs. The usual recommended maximum forecasting period is 2 to 3 years. This period is consistent with that of most national models, as well as government and private sector concern for the capacity to anticipate cyclical fluctuations in employment and investment levels for effective triggering of counter-cyclical programs. Many econometricians admit that the theory of local economic behavior is not sufficiently advanced to specify forecasting equations correctly for periods beyond 2 to 3 years. Longer term growth/decline cycles (e.g., 4 to 10 years) or secular trends are much more difficult to predict. While some forecasting models are technically capable of producing longer-term forecasts recursively in quarterly or annual increments, the forecasting error is usually significantly higher. In general, the longer the forecasting period beyond, say 6 to 8 quarters, the larger the error.

This does *not* necessarily mean that long-term forecasts with econometric models are less accurate than with, say, single-equation regression models. Rather, the factors which econometric models can best take into account—the set of complex relationships among sectors within the local economy—are often not the most crucial factors in determining long-term industry employment change. Thus for 5-year industry employment forecasts, econometric models lose a good proportion of their structural advantage over single-equation regression models.

Sensitivity to Unique Local Labor Market Conditions. One of the principal advantages of econometric models in the local occupational forecasting process is their potential ability to take into account unique local conditions which affect industry employment levels. Single-equation regression or shift-share models, as we have seen, lack this ability.

There is little question that econometric models can be designed to be more sensitive to local labor market conditions than single-equation regression models. There is much greater flexibility in the specification of the individual equations, which permits the selection of appropriate local economic variables as explanatory variables. On the other hand, many of the local factors which often play a considerable role in determining levels of industry employment are nonrepetitive events or results from "irrational" (i.e., noneconomic) decisions. Other kinds of local conditions which affect employment levels may be "qualitative" in nature and thus cannot be easily incorporated into an essentially highly quantitative methodology. Our ability to predict these kinds of events, impacts, or conditions is weak. At best, probabilistic or stochastic modeling approaches would be required. Such modeling techniques are available, but we frequently have no basis for correctly determining what the probability distribution of these kinds of events occurring actually may be.

The kinds of unique local labor market conditions which have been demonstrated to affect significantly industry employment levels tend to be industry-specific. We know, for instance, that there are often considerable variations in growth trends in a given industry among different labor market areas. Plants in the same industry have differential levels of efficiency owing to differences in the age of fixed capital, size of the facility, and relative locational advantages/disadvantages. They also have different mixes of functions in the overall production process (actual production, distribution, administration, marketing, etc.) and these functions change over time. Industry trends measured at the national level will only coincidentally predict local trends in the same industry, and only if the local firms exhibit "average" behavior among all firms/plants in that industry nationally.

It is evident, on the basis of discussion above, that the capability of including a larger array of local economic variables in the models' equations will improve the sensitivity of the model to unique local conditions, and *can* (although not necessarily) improve forecasting accuracy. The low degree of disaggregation in industry classification that is possible with current secondary data sources for labor market areas, however, hides much of the uniqueness of local industry behavior. That is, the broader the industry classification used, the less sensitive the model can be, not because of the structure of the model, but because of the limits of the data. *The issue here is that local economic data must be improved before the potential ability of econometric models to take into account unique local industry behavior can be more fully utilized.*

Alternative Model Design Strategies: Satellite or Endogenous. Fully specified subnational econometric models all take into account two classes of economic relationships: (1) those among area economic variables (e.g., area income, output unemployment, population, industry employment, etc.) and (2) those *between* national economic variables and economic variables for the area. Models vary, however, in the emphasis given in their design to each class of relationships. Two different strategies have emerged for building regional models:[13] the "satellite" approach and the "endogenous" approach.

In the satellite approach, the regional model is driven basically by a national model. The national model makes target year estimates of key national economic variables (including national industry employment), and these are fed into the regional model as key independent variables in the equations. The relationships in this approach are uni-directional—*from* the national *to* the regional. The key linkages between the national and regional economies are in estimating regional exports and imports of goods and services (by industry sector). Exports are expressed in the form of a demand equation for the region's goods as a function of national economic activity (and relative prices); imports depend upon the relative prices between goods produced in the region and the prices of imports. Regional price and wage rates, in turn, are tied to *national* economic variables (*vis a vis* local labor market conditions); regional capital formation is determined, in large part,

[13] "Regional" is used here to distinguish *national* models from *subnational* models—LMA's, SMSA's, or States. The word "local" can be substituted for "regional," but the discussion applies to *all* subnational econometric models.

by *national* money market conditions, etc. The theory underlying this approach to regional economic models is that the ups and downs of the region's economy are heavily determined by fluctuations in the national economy.

The endogenous approach assumes that the regional economy has its own development path apart from what is occurring nationally. That is not to say that the performance of the national economy does not affect the region's economy. Indeed a national model is still used to estimate target-year national economic variables. Rather, relative emphasis distinguishes the two regional econometric modeling strategies. On the one hand, emphasis is placed on the dependency of the region upon the national economic performance, while on the other, those local factors and economic relationships which determine the region's unique development path are emphasized. Accordingly, a larger percentage of the independent variables in the various equations of the endogenous type are regional level variables; the structure of the regional model is not constrained to be analogous to any national model. There is somewhat more flexibility to emphasize selectively the key sectors of the regional economy and the particular relationships between economic variables which may have special importance regionally. In this modeling approach, for instance, regional wage rates may be more strongly determined by *local* labor market conditions, and regional capital formation may be less dependent upon *national* interest rates and more dependent upon area population migration trends.

There are advantages and disadvantages to each strategy. The principal advantage of the "satellite" strategy lies in the fact that, compared with regional models, national models are more reliable (having proven themselves in repeated testing), have a larger number of time-series observations for more stable parameter calibration, and have stronger theoretical bases. Hence a given regional model can borrow from the strengths of a good, proven, national model when designed analogously and linked as a satellite to it. A related advantage is assured consistency of all regional economic variables with their national counterparts. Finally, the data requirements of the satellite approach, while not trivial, are less formidable. The main disadvantage is the imposition of a theoretical relationship between the national economy and the regional economy which may *or* may not hold for a given local or regional economy.

In the endogenous strategy, the principal disadvantage is the weaker data base. Many of the independent variables are regional. The scope of regional economic variables available in reliable, consistent time series data is limited compared with economic data at the national level. Moreover, even when available, the number of observations is considerably smaller. As a result of the weaker data base, the parameter estimates may be less stable, and if so, poorer forecasting results would be expected. The principal advantage of this approach is the greater flexibility in the model's structural design, and in the specification of the individual equations.

All of these issues aside, there are good examples of each modeling strategy in existence. Each has its own strong advocates among the economic modeling community. Which strategy is better depends mostly upon an analysis of the behavioral characteristics of the regional economy in question, and, in particular, upon the local economy's relationship with the performance of the national economy. In labor market areas like Detroit or Pittsburgh, for instance, the key sectors—durable goods manufacturing—are export industries with national markets. Demand for locally produced goods and, hence, local income and employment are thus strongly tied to *national* business and growth cycles. Here, by choosing the satellite strategy, one correctly would be choosing to emphasize the importance of national demand effects as the key determinants of local economic variables, including industry employment. In other labor market areas, such as Atlanta or Denver, the regional economy is not so much tied to national markets for locally produced goods and services, but to a regional market. The key factors here are population in-migration, residential construction, tourism, and the like. Much of the high economic growth rate in the respective regions has been "built-in," and so a satelite-type model would probably systematically underestimate output and employment growth in both the Atlanta and Denver economies. An endogenous-type model would probably outperform a satellite-type regional model, in spite of a disadvantageous data base. For regions which fall closer to the middle (of the two extremes of high sensitivity and very little sensitivity to national economic performance), the satellite-type modeling strategy probably should be preferred because these models are easier to build and less costly to update, and are less likely to yield poor results, the latter by virtue of their linkage and dependency upon a proven national model.

Consideration of Supply Side Factors. The growth or decline in markets for goods and services produced locally are not the only determinants of employment change by industry and by occupation. The *availability* of labor—by skill level and by wage demand—often plays a determining role in the location and expansion plans of firms. Supply side factors are considered in forecasting job openings through replacement as discussed above, but the question here is whether local econometric models used in the occupational employment projection process take the availability of labor into account in forecasting industry employment.

Most econometric models are demand-oriented. They implicitly assume that there will be adequate supply of all factor inputs, including labor. Yet there are several types of situations where this will not always be the case and where a labor supply component of a model would be needed to develop accurate forecasts.

One typical case, most apt to occur in the older manufacturing cities, but also found in areas where the durable goods manufacturing sector is now suddenly developing (e.g., the Southwest), involves shortages of highly skilled, blue-collar workers. These shortages have been cited in industry surveys as factors preventing expansion of operations when demand is running high, and eventually causing out-migration of plants to labor market areas with a more adequate labor supply. Training programs have not, in general, adequately met this problem for a variety of reasons, including inadequate labor market information.

Similarly, in the very rapidly growing areas of the West and Southwest—the energy boomtowns, and similar places—labor supply factors can have important effects on employment levels by industry. Here across-the-board labor shortages, not restricted to one group of occupations, can slow down employment growth which would be forecasted to be higher with a demand-oriented model.

Some model builders (e.g., see Alper, 1978; or Taylor, *et.al,* 1979) have dealt with this problem by building a separate labor supply submodel based upon demographic (birth and death rates by cohorts) and migration trends, and attaching the submodel to the main, demand-oriented model. With proper linkages, the demand and supply components would be solved simultaneously. The ensuing forecasts would reflect the impact of supply side constraints, if any. An alternative strategy would be to include certain supply side factors directly into the main "demand" model as a set of factor price variables. This assumes that demand will be affected by the price of factor inputs which in turn would reflect real constraints.

From the point of view of occupational employment projection purposes, however, there is a good reason not to let anticipated manpower shortages affect the forecasted level of employment: to do so would defeat the purpose of using projection models to identify occupational shortages. Other supply side constraints (e.g., gasoline or energy shortages) would still be included, however. On the other hand, this places a great deal of responsibility on the Employment and Training system "to deliver" so that unrealistic expectations of job openings are not encouraged.

In any event, there are several different strategies for taking the supply side into account within econometric models, despite a lack of attention to the supply side to date.

The Utility of Econometric Models for Policy Analysis. One major reason for building subnational econometric models is to predict the impact of proposed public policies or other exogenous events (e.g., a threefold increase in the price of crude oil) upon regional economic variables such as output, income, employment, etc. Forecasting and policy analysis with forecasting models are not the same, however. When one is interested in forecasting only, the relevant question is: "What will be the future level of employment in industry? When one is interested in doing policy analysis, the question becomes: "How would the level of employment in industry be affected by policy X or event Y?" To undertake policy analysis, one needs a technique which simulates the relevant dimensions of the initial policy or exogenous event itself, and takes into account all indirect as well as direct employment impacts and describes how an exogenous shock gets transmitted throughout various sectors of a local economy.

Fully specified local econometric models potentially are well-equipped to measure indirect employment impacts of policies or exogenous "shocks" because of the emphasis placed on local sectoral interrelationships and linkages. However, the ability of econometric models to adequately simulate the relevant dimensions of the policy or shock varies. Models have practical limits in terms of the variety of policies and exogenous events and the level of detail to which they can be sensitive. Policy analysis of this type is very difficult to perform in general, even at the national level with good national models.

It should be noted that an increasing number of State and local governments are employing econometric models in the budget planning process to test the impact of proposed legislative changes, policy initiatives, and other foreseeable exogenous economic events on local or State government revenue bases. It is likely that the ability to forecast the impacts of policy decisions on detailed industry employment will increase as models are designed increasingly for use in the policy analysis process.

Public Management Issues

The use of an econometric model for local area occupational forecasting requires resources and/or commitments for: (a) updating and maintaining the data base and the model; (b) interpreting and adjusting the results; (c) providing clear, readable documentation of the model to nontechnical staff and to the various user groups; and (d) coordinating the preparation and dissemination of forecasts with those of other local agencies and groups involved in local area economic forecasting.

Updating and Maintaining the Data Base and Model. There are three aspects to consider here. First, as is common with all other forecasting approaches based upon future projections of historical trends, it is necessary to add new observations in the time-series as they become available and, on the basis of the new observations, to recalibrate the model. This, in general, should lead to marginally more accurate forecasts, since the calibration period becomes longer and the structural parameters in the equations should become more stable.[14]

Second, the more recent observations help the analyst identify recent structural trends in the local and/or national economy. These may suggest, in turn, the advisability of respecification of some of the individual equations in the model.

Third, there is a need for an ongoing monitoring of the accuracy of the model's forecasts. While there is a time lag in the availability of *actual* employment data with which to compare the forecasts, monitoring the forecasting accuracy on an industry-by-industry basis can reveal weaknesses in the specification of individual equations. For instance, the accuracy of a model tends to vary over phases of business cycles. The accuracy during local expansion periods may be significantly lower than during periods of local contraction or around so-called "turning points." Such findings would point to changes in the model which might improve future forecasts during similar cyclical phases.

All of the above suggest that a staff econometrician—either on a consulting basis or "in-house"—is still needed after the model has been properly calibrated and put into operation. It is difficult to pinpoint the required staff time; it would vary considerably depending upon the complexity of the model, the frequency of forecasts, and whether policy simulations or impact analyses would be undertaken. Roughly speaking, the level of effort might be anywhere from a one-quarter to a full-time position. Of course, if other public agencies could use the same model for their own needs (e.g., a department of revenue, an economic development agency, etc.) then the costs of maintaining and updating the model could be shared.

Interpreting and Adjusting the Results of Econometric Models. As discussed earlier, industry employment forecasts obtained from statistically based models (be they single-equation regression models, shift-share models, input-output models, or fully specified econometric models) should be scrutinized by local labor market analysts and others familiar with the unique behavior of the particular labor market. Forecasts should be assessed and, if necessary, adjusted before they are adopted as "official" and fed into the next step in the occupational employment projection system.

When the econometric approach is used, special treatment should be taken in the assessment and adjustment process, because of the relative nontransparency of econometric models. That is, it is difficult to see readily how a set of output figures are derived on a logical, step-by-step basis. To most untrained in econometric modeling, the output figures seem to emerge from a "black box."

One way of helping to "demystify" the results of econometric models is to perform a series of sensitivity analyses after a model has been fully calibrated, and routinely when new information about the behavior of the local economy is incorporated into the model. In performing a sensitivity analysis, one measures the responses in the level of output variables (i.e., industry employment forecasts) to small (unit) changes in the level of any variable or estimated value of a parameter appearing in any of the model's equations. Particularly noteworthy is the sensitivity of the model to small changes in the level of those independent variables which have the greatest likelihood of having significant measurement error. It is also interesting to know the sensitivity of the model's forecasts to various structural parameters (i.e., regression coefficients) to take into account possible sampling or specification error. The results of the sensitivity analyses would be the equivalent of the specification sheet of an audio component or the test results of a new aircraft design—they each attempt to describe aspects of the behavior of the particular "black box." This information gives the analyst and users a better clue as to how "far off" the forecasts might be under slightly altered target-year conditions.

Interpreting and assessing employment forecasts of econometric models requires special attention also because a given model may be significantly less accurate under certain macroeconomic conditions, e.g., during contractions or around "turning points" of business cycles. This is a form of specification error, but it may not be diagnosed unless the model has been tested under a variety of such conditions (the same potential problem is equally relevant to the industry employment projection models recommended by BLS). Relatively small forecasting errors during stable periods can sometimes lull one into an unjustified confidence in the performance of a model. To repeat, it is recommended that an econometric model should be tested thoroughly with data describing a variety of local economic conditions before the model is put into operation.

Because the issue of credibility and public/user acceptance becomes more critical in the case of econometric models owing to their nontransparency, a thoughtfully designed assessment/adjustment process should include the participation of users in panel seminars to review and discuss the forecasting results. Bringing in local labor market "experts" representing different vantage points (e.g., the business community, labor, academia, and local and State government) to discuss the validity of the assumptions which underlay the forecasts, and to compare the model's forecasts with the more intuitive,

[14]More precisely, this is true if the underlying structural relationships among the variables are not shifting. If they are, one might want to discard the oldest observations before recalibration.

experience-based "forecasts" can build trust. It may also lead to the formation of an advisory group to the model builder, who may not be as intimately familiar with the unique characteristics of the local labor market. This group can often suggest a more realistic set of assumptions about local conditions which, when fed into the model, could produce a more "realistic" set of forecasts.

Documentation of the Model. The form and content of the model's documentation can be important factors in the degree of user/public acceptance of the model's forecasts. The *technical* documentation typically describes the overall structure of the model (i.e., how the different components fit together) as well as the detailed specification of the individual equations. In addition, data sources for all variables will usually be listed, the calibration process may be described, and the comparisons of the model's forecasts with actual employment data during the calibration period are likely to be made, using standard measurements of forecasting accuracy. The technical documentation is addressed primarily, however, to fellow econometricians, not to policymakers or other "lay" users of the output.

When an econometric model is to be used in the occupational forecasting system, a second type of documentation is needed. It should describe in clear language the structure and logic of the model, guidelines for its use (e.g., the questions it can legitimately address, the demands we can reasonably make on it), as well as guidelines for interpreting its results. Ideally, this type of documentation should be written by the model builder in collaboration with a highly knowledgeable practitioner labor market analyst who is sensitive to user groups' information needs. This collaborative effort could help to insure that the questions mentioned above are discussed at the appropriate level and with appropriate language. Such a "nontechnical" documentation may help to increase the credibility of econometric models by making them more accessible to the various communities of users.

Coordination with Other Forecasting Groups. Different projection or forecasting techniques will, in general, produce different "numbers" for the same labor market area for the same target-year. Having competing sets of forecasts for the same area and target-year (e.g., one using the OES approach, the other an econometric model) should not necessarily pose a problem. In fact, the situation may help to focus the assessment and review process. If the differences, however, are not managed within a coordinated setting among the several groups or agencies which have produced the different sets of forecasts, the credibility of *all* forecasting efforts may be diminished. At the same time users can be left in a state of confusion with no informed basis for evaluating which sets of forecasts are "better."

While there is no general "formula" for implementing a coordination process among different "competing" groups, it is possible to point out several of the most important points in the process where contact and coordination can be most beneficial:

a. *At the stage of making initial assumptions about what contextual economic conditions are likely to remain stable and which are likely to change.* Frequently the model-builder has greater access to the national forecasts made regularly by several economic forecasting groups and U.S. Government agencies, and to assessments of the assumptions which underlay these. On the other hand, State or local labor market analysts frequently have had more experience in viewing how the local labor market has reacted idiosyncratically to exogenous national and international economic changes as well as to changes in government policy initiatives. If this knowledge is shared with the staff or consultants responsible for operating and interpreting the results of the model, the model may be based on a stronger set of initial assumptions.
b. *At the stage of evaluating and interpreting the model's forecasts.* Bringing in the appropriate SESA labor market analysts (in addition to other experts) can help significantly in attempting to answer the question, "Do these numbers make sense based on what we know from local experience?" Discussion here may diminish the differences in the several sets of forecasts or possibly exacerbate them, but at least the bases for the differences will be clarified.
c. *At the stage of publication and dissemination of the model's forecasts.* References to other agency's or groups's forecasts and a somewhat brief explanation for the differences (if they are significant) could reduce the confusion for users and help them be in a slightly better situation from which to evaluate which sets of forecasts are likely to be "better." Accordingly, measures of the "track record" of the respective forecast-groups should also be available to users to aid in the evaluation process.

Utilization of Econometric Models in Local Projection Systems

At least 25 fully specified econometric models have been developed for States and perhaps a somewhat smaller number of substate areas. A large majority of these models are highly aggregated (macro), and thus are not suitable for use in the occupational employment projection system.[15] Many of the State models are public university-based, and are used routinely by State governments for forecasting tax revenues as part of the budgetary planning process. Of the substate models, several have been developed and maintained by large banks and other institutions; these are used both for internal investment planning and as a corporate and investor service. A majority of the substate models have been developed by large economic forecasting groups which have well-known models of the U.S. economy (e.g., Chase Econometrics, Wharton, EFA, Data Resources, Inc.). Many of these substate models, however, are "share models" of State or national models, so they are not truly local models. To date, only perhaps 8 to 10 models have been developed *specifically* for use in local occupational employment projecting systems.

A growing number of State employment and training councils use industry employment forecasts from models developed for more general purposes and this information is provided as a service to CETA prime sponsors in the State. We discovered only one SESA (New Jersey) that was itself operating a fully specified econometric model for area industry employment forecasts in lieu of, or in addition to, the single-equation regression models recommended by BLS. On the other hand, a larger number of SESA's regularly receive area industry employment forecasts from econometric models operated by other State agencies, universities, or private firms as a basis for checking and adjusting their own industry employment forecasts. To our knowledge, no CETA prime sponsor has been using an econometric model on its own, but again a number of them receive output from models operated by others. These forecasts serve as an additional labor market information source.

Of the econometric models developed specifically for use in local occupational employment projection systems, we are aware of none, as of this date, which are being used in that capacity. Six of these models were developed at the University of Arizona's Division of Economic and Business Research as part of a single research project (Taylor, Denzau, and Oaxaca, 1979.) The models were built for the Tucson, Phoenix, San Francisco, and Springfield-Holyoke-Chicopee (Mass.) SMSA's, the Southeast Utah Economic Development District (EDD), and the Mid-Cumberland, Tenn. EDD (which encompasses Nashville).

The project sought to demonstrate the feasibility of developing endogenous-type models for highly different types of labor market areas out of a single prototype design. This approach attempts to capture the advantages and avoid some of the disadvantages of both the satellite strategy and the endogenous strategy. The models' structure emphasizes the endogenous factors which directly and indirectly help to determine area industry employment, but by constructing each model as a design variant of a prototype with a *general* specification, the costs of building a model of a particular labor market area might be significantly lower than "starting from scratch" each time. The prototype, or general specification, is sufficiently flexible to allow for different levels of sectoral (industry) detail, and for different sets of independent or explanatory variables in almost every equation, for different labor market areas.

While it is true that there are some substantial savings in generating endogenous-type models from a prototype (one of the principal attractions of the satellite approach), a large effort is still required to: specify the particular, local model; collect or, in many cases, construct data for local economic variables; and then calibrate and test the specified model. These tasks are required in all econometric model efforts, but the costs of data collection/construction in endogenous type models becomes an even larger proportion of the total costs. For this component there are few economies (savings) using the prototype strategy.

A notable feature of the University of Arizona's models, which stems from their development for use specifically in local occupational forecasting, is a highly detailed labor supply submodel which emphasizes differences in labor force participation rates (by age and sex, though not by skill) and net area migration of the labor force. This emphasis on labor supply is usually missing in regional econometric models not built for use in the occupational employment projection process.[16] In these cases the employment forecasts are valid only if it turns out that there are no labor supply constraints.

The only other effort (of which we are aware) to develop econometric models of labor market areas specifically for use in occupational forecasting is the Labor Market Information (LMI) project at the University of Michigan-Wayne State University's Institute for Labor and Industrial Relations.[17] Models for Detroit and Denver were built to provide industry employment forecasts for a larger local labor market information system. The two models were built from the same prototype, but in this case the prototype was not of the endogenous type, nor did it allow for full-specification of a local economy. Instead the model is essentially a set of single-equation regression models (not unlike those currently used in the OES approach) with minimal interlinkages *among* the industry sectors in the local economy and heavy reliance on levels of national industry employment. The relatively strong emphasis placed on the manufacturing sector was fairly well-suited to a labor market like Detroit's, but not to Denver's.

[15] I.e., target year employment levels by detailed industry are not forecasted.

[16] At the University of Tennessee, however, a labor supply submodel was constructed and linked to a model of the State originally built with the principal purpose of estimating State tax revenues. Neil Alper, *A Methodology for Integrating a Labor Supply Model into a Regional Econometric Forecasting Model*, Working Paper No. 61 (Knoxville: College of Business Administration, The University of Tennessee) 1978.

[17] Malcolm S. Cohen, *On the Feasibility of a Labor Market Information System*, Vol. 2 (Washington: Manpower Administration, U.S. Department of Labor) June 1974.

There appear to be several reasons why the models developed specifically for the local occupational projection system have not been used by those public agencies responsible for providing occupational projections for States and areas (although one must be cautious in generalizing with so few examples). In the case of the LMI model developed for Denver, there is some evidence that communication broke down and distrust eventually developed between the model builders and users/cooperating public agencies with responsibility for providing local labor market information. It also appeared that the model, as designed, would not provide any additional information or analytic capabilities not already available. Underlying this assessment was the opinion of evaluators that the prototype originally designed for Detroit was not particularly appropriate for a local economy such as Denver's.

In the case of the University of Arizona models, there have been no serious questions raised about either the theoretical validity or forecast accuracy of the models. They, in fact, represent the state-of-the-art of endogenous-type regional econometric models, and are the most detailed (by industry) models yet developed for substate areas. The principal issues are: (1) the lack of model documentation which would help make the models more accessible to public policy officials; and (2) the relatively high cost to an agency of setting up the model in-house, maintaining and updating the data base, and periodically recalibrating the model.

The lack of nontechnical documentation prevents users from being able to access clearly whether the information from the model would meet their respective needs. Also, the absence of a manual listing or describing in logical steps the kinds of local labor market analyses, data construction, adjustments, and validity checks which are required in the normal operation, makes these models seem intimidating. The perception an administrator would reasonably get is that a highly trained econometrician would be required on a nearly full-time basis to maintain the forecasting effort and that no other staff, let alone users, would understand what is involved. Because of the models' endogenous design, the data collection costs are more severe than the "average" regional econometric model. Many of the local economic variables have to be constructed because they are not normally collected and published regularly in consistent time-series by government agencies.

A review of the literature and public documents and an informal survey of state employment and training councils and CETA prime sponsors point to the conclusion that, when econometric models have been used in the local occupational projection system, they most frequently have been developed for other purposes, and accordingly are operated by nonemployment and training-related agencies. Furthermore, the industry employment forecasts from these models generally are not "fed" through an I-O matrix to produce a consistent set of occupational employment projections. Rather, the information from the models is used as a check on forecasts obtained by other techniques and/or as an information base for helping analysts or planners to assess their own assumptions about the likely future developments in the local economy.

Input-Output Models

Input-output models represent a third alternative approach for forecasting State and area industry employment. When incorporated into the occupational employment projection system, input-output models meet the requirements of Element 1 only. Similar to an econometric model, an input-output model is a representation, or "picture" of the structure of a region's economy. But the particular kind of picture described by an input-output model is different from that provided by an econometric model. An input-output model describes the interindustry flow of goods and services within the region's economy and the flow of goods and services between the region and the rest of the world (exports and imports).

The Basic Structure of an Input-Output Model

An input-output model is constructed using information on total purchases and sales of each industry group in the study area for 1 year. The information is organized in an input-output table, with each row of the table representing the distribution of the product (output) of a particular industry to other local industries and to final users (final demand). Each column, on the other hand, represents the distribution of purchases (inputs) for a given industry. The purchases are from other industries (raw materials and intermediate goods) as well as from households (labor). Figure 3 shows the organization of the input-output table into a set of rows and columns. The input-output table is frequently referred to as the interindustry transaction table.

A given cell of the table (e.g., 3rd row, 2nd column in Figure 3) represents the value, in dollars, of goods and services that local industry group 3 sold to local industry group 2 during an annual period.

In constructing an actual, operational input-output model, the table described in Figure 3 is mathematically transformed into what is called a technical coefficient matrix, where the new cell values represent the *ratio* of purchases by one industry (e.g., industry 3) from another (e.g., industry 2), to the total value of local production of the former industry (industry category 3).

	Purchasing Industry								
	1	2	3	4	•	•	•	N	Final Demand
1	X_{11}	X_{12}	X_{13}	X_{14}	•	•	•	X_{1n}	Y_1
2	X_{21}	X_{22}	X_{23}	X_{24}	•	•	•	X_{2n}	Y_2
3	X_{31}	X_{32}	X_{33}	X_{34}	•	•	•	X_{3n}	Y_3
4	X_{41}	X_{42}	X_{43}	X_{44}	•	•	•	X_{4n}	Y_4
•	•	•	•	•					
•	•	•	•	•					
•	•	•	•	•					
N	X_{n1}	X_{n2}	X_{n3}	X_{n4}				X_{nn}	Y_n
Households (Labor)	X_{h1}	X_{h2}	X_{h3}	X_{h4}				X_{hn}	
Other Value Added									
Total Production	X_1	X_2	X_3	X_4				X_n	$\Sigma_j Y_i$

Figure 3. An Input-Output Table

The ratio is called the technical coefficient, and represents in the example the relative importance to industry 2 of the input from industry 3. For our purposes, however, there is no conceptual difference between the representation of the structure of the local economy by either the interindustry transaction table (Figure 3) or the technical coefficient matrix.

In an input-output model, the local economy as a whole is "driven" by the set of final demands for goods and services of all local industries (Figure 3). This set of target-year estimates of the final demand for goods and services for each local industry must be expressly determined before the model can be put into operation. With these estimates, the model can forecast the total amount of goods and services each local industry group would have to produce to satisfy the input requirements of other technologically linked industries in the local economy, as well as to satisfy direct household consumption, exports, etc. *Once the total output requirements of each local industry are forecasted, then the labor requirement for each local industry can be estimated using a table of labor/output ratios*. These ratios are estimated using national industry time-series data with the potential for introducing a local "correction" factor. The process just described is shown graphically in Figure 4. The most salient implications of the use of input-output models and their advantages and disadvantages *vis a vis* other industry employment forecasting or projection techniques are discussed below.

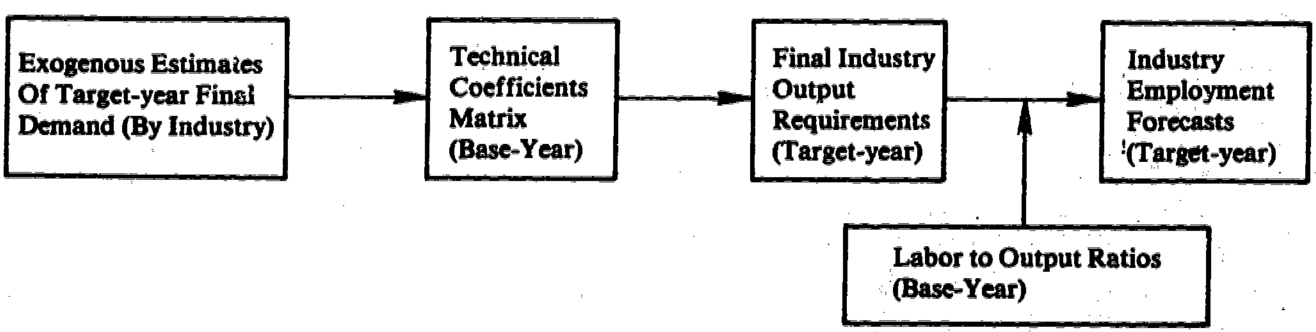


Figure 4. The Input-Output Approach: From Estimates of Final Demand to Industry Employment Forecasts

Data Input Requirements

Exogenous estimates of target-year final demand for each sector of the regional economy are made by estimating the regional share of each of the six components[18] of the target-year projections of gross national product (GNP). The U.S. Bureau of Labor Statistics and the Bureau of Economic Analysis in the U.S. Commerce Department have responsibility for providing projections of GNP by component, for each industry group, but the rest would be left up to State and/or local economic analysts. In order to estimate the regional share of each component of the projected GNP, time-series for such variables as population, income, dollars of plant investment, export, and classes of government expenditures for the study region must be constructed and compared with time-series for these variables at the national level. Out of this comparison, a trend in the regional share of the national totals can be estimated, and this can, in turn, be used to assign regional shares of the exogenously estimated components of GNP. Regional totals of final demand by industry sector can then be estimated by adding up the components of the regional share of GNP, which have been calculated above by industry sector (including household sector).

The major problem in the outlined procedure is that many of the variables at the regional level are not available in a consistent time-series. When the region is a labor market area or some other substate area, the data availability problem is even more severe. In any case, it is often necessary to make a series of assumptions or extrapolate to use surrogate variables. Even when this can be reasonably and reliably done, consistency between regional and national control totals is difficult to maintain. It would not be overstating the case to say that estimating a set of regional final demand figures to "drive" the input-output model is an extremely painstaking and costly task for most State and/or local agencies to undertake by themselves. Alternatively, the set of regional final demand figures might be obtained through an economic forecasting group with a linked national-regional econometric model (but then it might make more sense to use the econometric models to estimate regional industry employment directly). A third alternative which is not presently available but might be in the future, is the routine projected estimation of final demand by industry for substate areas. Karen Polenske at M.I.T.'s Department of Urban Studies and Planning has been involved in estimating State shares of GNP up through 1963.[19] This process could be extended to the larger SMSA's, and either a university-based group, the Bureau of Labor Statistics, or the Bureau of Economic Analysis could undertake the responsibility.

The second major data input problem is the estimation of regional technical coefficients. Most regional economists believe this problem is more severe than that of estimating final demand. In estimating a region's technical coefficients, one needs to know the inputs which are supplied from within the region for each regional industry.[20] Secondary data on industry purchases and sales needed to calculate technical coefficients are not collected or published at any subnational level (including the State level). At the same time, collecting primary data on the origins of purchases and destinations of sales (as well as on payments for wages and salaries and other value added) is extremely costly since it requires a large sample, highly detailed firm information, and a high proportion of personal (firm) interviews. The costs of collecting, editing, and checking the information received present an additional burden.

To avoid the high costs of collecting primary data, the technical coefficients in the national input-output table are often used for most regional industries, adjusted by the size of each industry in the study area (measured by industry output). However, this strategy is not considered valid for estimating the technical coefficients in industries such as agriculture, mining, and construction because their technologies are highly sensitive to certain regional locational differences. Direct survey methods are needed where these industries represent a significant share of the region's economy. Yet even for those manufacturing and service industries whose technologies are considered to be relatively insensitive to the area characteristics, there is considerable error introduced when adjusted national coefficients are used. This is principally because of the considerable range of product mix within any industry group at the level of industry detail (usually 2-digit SIC) which is reasonable (in terms of data availability) for the study region.

The technical coefficients for the study area are not frequently updated due to the high costs. We do not know very well the rates at which the coefficients change over time, for instance. The reestimation of national input-output tables has taken place only approximately every 7 years, and there is normally a *very long* lag between data collection and publication (e.g., in 1980, the latest available tables contain 1972 technology data). Thus 1985 target-year industry employment forecasts would be based upon a technological structure which is at least 13 years out-of-date. The long lag places strong limitations on the maximal appropriate length of an input-output model's forecast period.

[18] The six components of GNP are personal consumption expenditures, gross private capital formation, net inventory change, net exports, State and local government net purchases of goods and services, and Federal Government purchases.

[19] See Karen Polenske, *et al. State Estimates of the Gross National Product, 1947, 1958, 1963* (Lexington: Lexington Books) 1971 and other references to this work in the Bibliography under Input-Output Approaches.

[20] In a *regional* input-output model, the rest of the U.S. is considered as a single export and import region. In multi-regional input-output models, one needs to know the total input requirements for a region's industries regardless of the origin of the input.

Degree of Industry Detail

Although theoretically there is no limit to the number of industry sectors in an input-output model, data availability, statistical reliability, and, to a lesser degree, computer storage limitations, place practical limitations on the degree of industrial disaggregation. When national input-output tables are used to estimate regional coefficients, the degree of detail in the national model places a constraint on the maximum level of detail in the regional model. The most commonly used and probably the most reliable national model, the U.S. Department of Commerce's 1972 Input-Output Model, has a 496-industry technical coefficient table. No regional model approaches this dimensionality. The State input-output tables developed at M.I.T. have 79 industry sectors, and represent about the maximal practical size for most State and substate models.

The dimensionality of the industry/occupation staffing pattern matrix in Element 2 of the local occupational forecasting system represents the *maximum usable* level of detail in input-output models. Since the OES survey-based matrix is large enough to accommodate industry groups at the 3-digit SIC level (currently 368 industry groups), there is no effective constraint in this case. Stated differently, most available subnational input-output models will not be able to take advantage of the level of industry detail available in local occupational employment projection systems.

The more important issue is selecting the most appropriate industry group definitions. Different aggregations of, say, 3- or 4-digit SIC industries, can increase or decrease the amount of error in the estimation of technical coefficients due to heterogeneity of products included in the individual industry groups. Heterogeneity will almost always be a general problem in constructing technical coefficient tables regardless of the region's particular industry mix. But taking into account the area's industry mix at a highly detailed level (e.g., 3- or 4-digit SIC level) before defining, say, the 79 industry groups of the M.I.T. models will help to minimize the error caused by product heterogeneity. The amount of flexibility in defining the region's industry groups, though, depends upon the level of detail of industry data that is available or can be reliably generated. That, in turn, depends upon the size of the regional economy. For a smaller economy, less detailed industry data will be available. Furthermore, there is a tradeoff between increased level of industry detail and lower statistical confidence of indirectly estimated technical coefficients. The smaller the region (in terms of average number of firms per industry group), the less industry detail permitted at a given, acceptable confidence level.

Length of Forecasting Period

Input-output models are used for both short-term impact analyses and for long-term forecasting. The principal limitation of using input-output models for long-term forecasting has already been mentioned: The technical coefficients are based upon data already, in general, considerably out-of-date; and no practical, reasonable-cost means exists for reliably forecasting changes in the technical coefficients for State and substate areas. Not much is known about the amount of error inherent in using out-of-date technical coefficients in labor market areas whose industries and industry mix have been changing at different rates.

A shorter lag between collection of the data and publication of the table at the national level could significantly improve the situation, but the enormity of the tasks involved in constructing accurate input-output models from primary data limits the degree to which "turn-around" can be realistically reduced. In summary, because the accuracy of input-output models depends so heavily upon the technical coefficients, and because there is a reasonable basis to conclude that changes in technology and a region's industry mix can be significant between the actual base-year and the target-year, the results of the model are questionable for forecast periods longer than, say, 5 years.

Public Management Considerations

Like econometric models, input-output models require considerably larger staffing and coordination efforts on the part of State and local public agencies than do less sophisticated techniques. The public agency has the choice of constructing, operating, and maintaining an input-output model entirely "in-house" or contracting out each or all of the services to private or university-based economic forecasting groups. If another agency already has a model operating, then there are economies to be gained in sharing it. The efforts of groups such as the one at M.I.T. will make *State* input-output tables more accessible to potential users, but the local staffing effort will still be considerable. Input-output models of any detail must be computer-based, and the computer storage requirements of highly detailed models are considerable (frequently more than for econometric models). Thus, accessibility to a computer with large data storage capacity is another consideration. Roughly speaking, the level of expertise for constructing and maintaining an input-output model is comparable to that for econometric models, but the level of effort is significantly greater.

Coordinated and cooperative effort of public agencies and private groups is important for acceptance of the model's results. The reader should refer back to similar discussion of econometric models above. Broad-based cooperation may be even more important in obtaining reliable data in a timely fashion for input-output models, since a much larger percentage of the data is at a micro-level (i.e., individual firms) than is the case for econometric models.

Sensitivity to Exogenous Factors

The principal advantage of econometric models and input-output models over single-equation regression models or shift-share models is that the *detailed* impact of changes in a variety of exogenous factors upon local area industry employment can be more readily traced. The exogenous factors may include "uncontrollable" events such as oil boycotts or large plant closings, or public policy changes, such as trade restrictions, tariff adjustments, fiscal and tax policies, industry subsidization, etc. The greater the variety of exogenous factors to which the model is sensitive, the greater its potential for taking uncertain future events into account in providing area industry employment forecasts.

Input-output models can test alternative future scenarios on area industry employment by appropriately adjusting elements of the final demand vector (e.g., a large increase in Federal Government purchases locally). The "new" set of final demands (by industry) is fed through the input-output table and a new set of industry output figures, reflecting the estimated change in final demand, emerges. The industry employment/output ratios are then used to arrive at the induced changes in the set of industry employment demands. Comparison of this latter set of industry employment forecasts with those arrived at under the assumption of "no change" would indicate the net effect of the change in the exogenous factor upon area industry employment.

Where prospective changes in exogenous factors can be translated directly into changes in final demand, input-output models have distinct advantages over single-equation regression models and even econometric models for simulating and tracing the transmission of interindustry effects. The advantage stems directly from the structure of the input-output model. When the change in an exogenous factor cannot be translated directly into a change in final demand (e.g., commodity price changes), then an econometric model may offer advantages in tracing the impacts because of its greater structural flexibility.

Relative Accuracy of Industry Employment Forecasts

To test the accuracy of a particular application, the model's target year estimates of industry employment are compared with the actual levels (when the figures are available) and measures of forecasting accuracy can be computed. It is not possible to test the relative accuracy of an input-output model *vis a vis* other forecasting techniques unless the techniques being compared are "run" for the same area and during the same time period.

Comparison tests of an input-output model with a set of single regression equations have been described by Rowan (1976). The 1980 Massachusetts State employment projections of the Multi-Regional Input-Output Model (MRIO) were compared to those of a set of single-equation regression models used by the Massachusetts Division of Employment Security. The latter were "standard" BLS-recommended industry employment projection models. The base year for the MRIO projections was 1970 (using 1963 technical coefficients) while the base year for the Massachusetts DES projection was 1973. The different base years give the MRIO a slight disadvantage but, overall, the comparison should still be valid.

The forecast results of the two models were quite different. The MRIO projections were generally higher, due largely to an assumption of a full-employment economy. Using actual figures for an intermediate year as a basis for measuring the models' accuracy, the MRIO model projected the correct direction of employment change for 45 of 68 industries, while the regression models projected the correct direction for 48 of the 68 industries. The MRIO model tended to systematically over-predict employment in the nondurable manufacturing sectors—those very industries which have been leaving Massachusetts for reasons of relatively high prices of factor inputs (i.e., labor and energy). On the other hand, the industries for which the MRIO model was more accurate were in the durable goods manufacturing sector—industries in which employment, on the average, grew in the State during the forecast period.

The preliminary conclusion from this is that input-output models are inferior to single-equation regression models in predicting employment changes due to long-term, but steady, trends such as changes in an area's relative cost advantages. On the other hand, input-output models more accurately predict employment change induced by interindustry effects and shorter-term (cyclical) trends. Based upon only the Massachusetts tests during the 1970-1980 period, neither input-output models nor regression models have demonstrated unambiguously superior forecasting results over the other.

Explicit and Implicit Assumptions Underlying Input-Output Models

Generally speaking, the more "structured" a forecasting model, the stronger the limiting assumptions about the real world which have been incorporated into it. The problem with having stronger assumptions is that the model's results have less validity—the assumptions about the real world do not "hold up." Compared with econometric models (and certainly compared with single-equation regression models), input-output models are highly structured. The limiting assumptions of most input-output models include: constant returns to scale; marginal inputs equal to average inputs; fixed technical coefficients through the forecast period; a homogenous set of inputs for each industry group in the matrix; no financial market impacts on production; no input substitution; and no capacity constraints. In addition, most applications of input-output models make the simplifying assumption of full employment conditions during the forecast period. To the extent that the national economy will not reach full employment in the target-year and/or the local area will lag behind the Nation, then there will be a systematic upward bias in industry employment forecasts, and in occupation employment projection when the results of the input-output models are fed into the staffing pattern matrix.

There is one distinct advantage, however, to the high degree of structure in input-output models, compared with econometric models. In the latter there is both sampling error in the estimation of the structural parameters (i.e., regression coefficients), and specification error in the choice of the independent variables in each equation. In input-output models, there is sampling error (i.e., the estimation of the technical coefficients) but no opportunity for specification error, since all of the structural relationships (interindustry linkages) are empirically—rather than theoretically—based.

Summary

- Input-output models are capable of producing highly detailed industry employment forecasts for a given area. These can then be fed into a separately estimated staffing pattern matrix to obtain occupational employment forecasts.
- The data requirements for constructing a sufficiently detailed input-output table (technical coefficient matrix) are severe. Coefficients that have been estimated for the national economy are often used instead, after certain adjustments for local industry mix. The high cost and lengthy process of updating the table means that the coefficients generally will be well out-of-date.
- An econometric model for the U.S. must be used in the process of exogenously estimating the area's share of GNP for the target year. This is a prerequisite for deriving a set of final demand estimates by industry sector. The availability of critical data for subnational area units frequently makes these tasks difficult and costly.
- Input-output models are more appropriate for short-term forecasting or impact analysis. They offer advantages for conducting policy-simulations ("what if . . ." questic when the effects of the policies being tested can be translated directly into changes in the set of final demand estimates.
- Compared with econometric models, input-output models require more restrictive and, in some instances, less realistic assumptions about the real world. These can undermine the validity of the models' forecasts. On the other hand, there is no model specification error since the structural relationships among the sectors of the area's economy are empirically based.
- Limited comparative tests of the accuracy of an interregional input-output model and a set of single-equation regression models have not provided evidence to show that input-output models produce more accurate employment forecasts. Single-equation regression models were more accurate for those industries following a long-term secular trend: there is a *tendency* for input-output models to overestimate employment due to the frequent assumptions of a full-employment economy and no input substitution of capital for labor.

The Employer Survey Approach

Introduction

Prior to the development of the National/State Industry-Occupation Matrix System (U.S. Bureau of Labor Statistics, *Tomorrow's Manpower Needs*, 1969), area occupational employment projections were obtained primarily from employer surveys. Because there were no systematic and consistent means of converting industry employment forecasts into occupational employment projections, estimates of target-year occupational employment were generated directly from local employers' responses to questions of target-year occupational employment levels for their establishment.

In terms of the occupational employment projection system presented earlier, Elements 1 and 2 are eliminated in this approach. Estimates of job replacement needs during the projection period can be included in the questionnaire as a separate item; in this way, the employer survey approach can be used to estimate total job openings by occupation for the target year.[21]

The employer survey is a *general* approach with many possible variants. Two of the most important examples are the Area Skill Survey Technique and the Occupational Training Information System (OTIS).

The guidelines for the Area Skill Survey were developed by the U.S. Labor Department's Bureau of Employment Security, but considerable latitude and initiative was left to the individual SESA's in making adjustments and revisions to suit State and local conditions. The OTIS program was first developed in Oklahoma in the late 1960's to meet the information needs of the State vocational education program and involved the State Departments of Industrial Development, Vocational and Technical Education, the Employment Security Commission, and the Manpower Research and Training Center at Oklahoma State University. It was subsequently developed, with some important differences, in Kentucky. Funding for the Area Skill Survey program was formally rescinded by DOL in 1975 and the manpower demand subsystem of the OTIS program has been replaced by the OES program in both States.[22] The shift away from the employer survey approach was due primarily to the development of the industry-occupation matrix and to the poor evaluations which the employer survey approach had received. The approach is still used for identifying current and projecting very short-term job openings in specific target industries.

The discussion below refers primarily to the Area Skill Survey Technique[23] and the OTIS program,[24] but is intended as a description and evaluation of the employer survey approach in general.

Attributes of the Sample and Questionnaire

The survey is one of area employers. The source listing can be those establishments which submit reports to the State Employment Service in compliance with the Unemployment Insurance Code, or it can be much less formal or reliable, such as a local Chamber of Commerce or a Dun and Bradstreet listing. The choice of the source listing of the universe of employers will determine the degree of sample bias or representativeness.[25] This in turn will strongly determine the validity of the approach as a means of making an independent set of forecasts of local occupational employment or of independently checking the accuracy of an earlier set of forecasts.

The survey instrument can be either a mail questionnaire or a questionnaire filled out in a personal interview. The Area Skill Survey Technique used both a mail questionnaire (with an opportunity for the respondent to call the SESA if there were any questions) and personal interviews. The choice of instrument varied by area. For the OTIS program, one State (Oklahoma) used a mail questionnaire with a telephone and/or personal interview followup option, while the other State (Kentucky) used personal interviews almost exclusively. It has been a tenet of survey research that the reliability of the responses and the return rate itself are higher with personal interviews. Neither of these expectations was borne out in the OTIS experience, while the differential in costs proved to be enormous ($28 per employer in Kentucky as compared with $6 per employer in Oklahoma, for approximately the same information).

In both survey instruments the employer was asked to provide two basic information items: (1) the number of employees on the payroll as of a specific reference period (base years); and (2) their *best estimate* of the number to be employed in the establishment in each occupation in the target-year. A third item, the estimate of replacement needs during the period was provided for, but this information was found to be unreliable in many cases.[26] Extra items might include age and sex of the employee, or particular minimal training/education requirements for each occupational category.

Principal Problems with the Employer Survey Approach

There are or have been at least eight problems with employer surveys as a basis for estimating target-year occupational employment: (1) the unreliability of employers' classification of jobs into occupational titles; (2) nonprovision for employment expansion due to new firms; (3) lack of consistency and uniform procedures from area to area; (4) a tendency for employers to make future estimates based upon their current "psychology;" (5) inability of some employers to provide target-year employment estimates; (6) a record of low accuracy; (7) low cost-efficiency; and (8) some

[21] Employer surveys have been and are currently used to provide other types of area labor market information. The focus of the discussion of the employer survey approach here is directed at those surveys which ask an employer to *forecast* occupational demand. Other uses of employment surveys will be mentioned briefly below. For a more comprehensive discussion, see *Jobs in the Private Sector: Use of Labor Market Information* (Washington: Employment and Training Administration, U.S. Department of Labor) 1980.

[22] See *Labor Market Information in the Federal-State Employment Service System*, Report by the Advisory Committee on Research to the U.S. Employment Service (Arnold Weber, Chairman), (Washington: Employment and Training Administration, U.S. Department of Labor) February 1968, pp. 17-18.

[23] See, for instance, Odessa Dubinsky and Donald Mayall, "Forecasting Area Labor Demand from Employer Survey Data: The Area Skill Survey Technique," *American Statistical Association, Proceedings of the Social Statistics Section*, 1966, pp. 464-467, and Colette Moser, "An Evaluation of Area Skill Surveys as a Basis for Manpower Policies," Ph.D. dissertation, University of Wisconsin, 1971 (also as a final report to the Office of Research and Development, Employment and Training Administration, U.S. Department of Labor).

[24] Macro Systems, Inc., *Evaluation of the Occupational Training Information Service (OTIS)*. Prepared for the Economic Development Administration, U.S. Department of Commerce, May 1974.

[25] Of course, the sample could be deliberately stratified, by, say, size of establishment, and different sampling proportions used for different strata. In that case, the sample would not be a representative one, but appropriate adjustment factors would ensure minimal sample bias.

[26] See Dubinsky and Mayall, *op cit.*

duplication of effort with the OES. These problems are explored in more detail below.

1. Maintaining the reliability of employers' classification of jobs into occupational titles poses problems. Different employers, in general, have their own set of occupation titles with job descriptions. Many do not classify their jobs at all. Ensuring consistency across all employers' responses while still maintaining a sufficient level of discrimination between occupations is by no means an unsolvable problem, but it is a time-consuming, and thus costly, one. It is unrealistic to expect all employers to take the effort to translate their occupational titles into one of the Federal Government codes (e.g., SOC, DOT, the Census), especially where the number of occupations is large. The principal alternative is for, say, State ES analysts to be responsible for the translation, firm-by-firm, within broad industry groups having similar staffing patterns. Because this cannot be done other than on a firm-by-firm basis, it becomes a very costly alternative. In the OES program the same issue arises in the OES survey for updating the Industry-Occupation matrix. But in the OES program, resources for designing and administering a survey instrument with controls on employers' responses (to ensure a high level of consistency) and for careful checking of individual responses by analysts familiar with industry-wide staffing patterns for the particular labor market area (see the section on the OES Approach above).

2. Growth in the level of employment due to the location of new establishments in the area during the forecast period cannot be taken adequately into account in employer surveys. While the relative importance of this component of employment change (*vis a vis* change due to expansion or contraction of existing establishments) varies by labor market area and industry sector, it is too important to ignore or even to estimate nonsystematically. Existing employers cannot be expected to have or to give candid responses to questions about likely occupational employment growth due to the location of new establishments, so these items usually are not included in employer surveys. Instead, when employer surveys are the principal information base for occupational forecasting, analysts need to estimate this missing component of employment change by assumption (a fixed proportion of estimated change in occupational employment due to expansion, a straight-line extrapolation, etc.).

3. The Area Skill Survey program was plagued by a lack of consistency and of uniform procedures from area to area, even though there were general guidelines issued by DOL. Employer surveys designed and implemented without any guidelines specifying the universe to be centered, the sampling design, appropriate consistency checks, etc., would not allow meaningful area comparisons and may lose validity and acceptance because of any nonstandard procedures. While problems of consistency and uniformity in data collection and statistical procedures are not inherent to the general approach, employer surveys often are used for reasons peculiar to individual areas or States and are designed to meet rather specific information needs. Thus, they tend to lack consistency and uniformity across areas.

4. Another source of error in the use of employer surveys for projecting occupational employment is the tendency for employers to base estimates of their future occupational demand upon their current "psychology." This refers to the effect of current conditions in the national and regional economy upon perceptions of future growth or decline. Not all employers look objectively at their future employment expansion needs. Some will have access to economic forecasts prepared by private economists or government agencies while others will not.

5. A related problem is the inability or unwillingness of some employers to provide any estimates of target-year occupational employment. First, in the case of local offices of branch plants, local managers may not know corporate plans for expansion or contraction of local operations. Second, many firms, for any number of reasons, may be unwilling to divulge their future plans. These kinds of nonresponses will generally lead to biased estimates, or other errors will be introduced by labor market analysts having to make assumptions about the employment trends of nonrespondents.

6. The five problems above in large part explain the relatively low accuracy record of employer survey approaches in projecting area occupational employment. The Macro Systems evaluation of OTIS found that between 60 percent and 75 percent of individual employers did not increase the accuracy (of their forecasts) which would have been obtained with a simple no-change extrapolation; the average forecast error was 36 percent in Oklahoma and over 30 percent in Kentucky. More importantly, over 50 percent of the surveyed employers in each State had a forecast error equal to or greater than the actual change in the establishment's employment, and in Kentucky the average error was nearly 90 percent greater than the actual change.

When the individual employers' forecasts were aggregated for individual substate planning regions (by occupational categories), the average errors for all regions were only 6.0 percent in Oklahoma and 4.7 percent in Kentucky. However, when compared with the actual *regional change* in occupational employment—a far more important statistic for planning purposes—the error was over 50 percent in Oklahoma and over 100 percent in Kentucky. Further analyses by Macro Systems indicated that the size of forecast error was largely independent of industry and size of firm. Moreover, the finding that Kentucky OTIS forecasts were not more accurate than those of Oklahoma at the individual firm level indicates that personal interviews may not necessarily lead to more accurate responses than mail questionnaires.

7. Employer survey approaches are not as cost-efficient for generating information on future labor market conditions as is sometimes believed. The degree of cost-efficiency is a function of the ability to routinize all relevant steps of the information collection, checking, coding, and processing steps. Small sample surveys tend to be less cost-efficient because the costs of setting up an efficient procedure are fixed, i.e., do not depend upon sample size. There is also a substantial difference in costs between the two principal survey instruments, the personal interview and mail questionnaire with telephone followup. In Oklahoma, the cost of field data collection was approximately $6 per employer; in Kentucky the collection cost for roughly the same information was $28 per employer. On this basis, Macro Systems estimated that the total field cost for a complete (100 percent) census of Kentucky's wage and salary employees would be about 1.2 million dollars (for early 1970's). The conclusion is that if employer surveys are to be conducted, the primary survey instrument should be the mail questionnaire, reserving personal interviews for perhaps only the largest employers.

8. Given the information now available through the OES program, developing employer surveys for projecting area occupational employment is, in most cases, largely redundant. The OES survey is now in operation in nearly all the States. BLS has devoted resources to its statistical reliability, extending its coverage, and ensuring its consistency of administration and processing among all participating States. The information obtained from employer surveys which is directly relevant to occupational forecasting is redundant *in content* with that gained from the OES survey. Moreover, where employer surveys are administered, employers are being asked to supply the same information to two separate government agencies for ostensibly the same purposes. For projecting occupation employment in most areas the OES survey will very likely yield significantly more accurate, reliable, consistent, and thus more *useful* information than almost any employer survey approach.

Advantages of the Employer Survey Approach

The employer approach to projecting medium- or long-term occupational employment has several advantages, but unfortunately they stem from the same characteristics which give rise to many of the problems and limitations cited above. Briefly, these are: (a) the ability to adapt and adjust the design of the sample, survey instrument, and other procedures to meet unique, local labor market information needs; and (b) the opportunity for building greater cooperation with private sector employers in providing information about local labor market trends and for gaining greater private sector acceptance of the area's occupational employment projections.

Both these characteristics are desirable, but not if they bring with them a lack of procedural consistency and uniformity as well as bias and low accuracy in the estimates themselves. Moreover, these advantages can be gained in other approaches without compromising the validity, reliability, and accuracy of the process. For example, the capacity of local labor market analysts to identify peculiar short-term and long-term, local trends can be developed, and private sector employees can be included on panels to assess the area's industry and occupational employment projections from more systematic and reliable methods.

On the other hand, there are other purposes besides the projection of area occupational employment for which employer surveys might be developed but with proper concern and care for valid, standard survey research procedures. ETA has compiled a guide directed to Private Industry Council (PIC) staff and other practitioners which identifies how and under what circumstances employer surveys can be used reliably to meet the information needs of users where there are gaps in existing labor market information sources. Some of these potential uses include: obtaining information on the structure of internal labor markets and promotion, hiring, and training practices of local firms; the number and occupational characteristics of existing job vacancies in the local labor market; and employer attitudes toward existing employment and training programs of the local CETA prime sponsor and other agencies.[27]

[27] *Jobs in the Private Sector: Use of Labor Market Information*, op. cit.

COMPARATIVE ANALYSIS OF ALTERNATIVE APPROACHES

The most relevant characteristics of the major approaches to projecting area occupational employment have been described in the preceding chapter. In this section the approaches are compared along the dimensions, or criteria, which are most important for the policymaker to consider. These dimensions include advantages or disadvantages stemming from the structure of each technique or model, the economic structure of the labor market area for which the projections are to be developed, other intended purposes of the projection/forecasting system in the public policy arena, and prior development of projection or forecasting models for the area.

Structural Criteria

Data Requirements

Because they are structured the most rigidly, and represent local interindustry relationships with the greatest detail, input-output models have the most severe data requirements of all the approaches considered. The unavailability of secondary data on interindustry sales and purchases and trade with other regions for substate areas often requires the substitution of national-level data (with some strong assumptions), which diminishes the reliability of the model's forecasts, or local industry surveys, which are costly. There is little reliance on time-series data, however, and so the paucity of time-series observations does not limit these models. Exogenous estimates of the area's share of the components of GNP for the base and target-years will usually require the use of a national econometric model.

The data requirements of fully specified econometric models are less stringent than those of input-output models, although still considerable compared with the OES requirements. Flexibility in structure permits alternative specifications in response to data unavailability. Until recently, the development of reliable econometric models for subnational areas was severely handicapped by the small number of time-series observations, but this is no longer a serious problem. Target-year estimates of national economic variables from a compatible econometric model for the U.S. are almost always required to "drive" the local model.

The OES approach is a comprehensive occupational employment projection system. The industry employment forecasting element of that system uses single-equation regression models or shift-share models. These techniques require time-series data on local area industry employment as well as on the predictor (explanatory) variables. The degree of data availability depends upon which predictor variables are chosen. Frequently the lagged dependent variable and industry employment nationally (for the target year) are selected and they are both readily available (the latter from BLS). Single-equation regression models could be improved by testing alternative sets of predictor variables industry-by-industry. This would require somewhat greater effort in obtaining the necessary data.

The employer survey approach requires little, if any, processed data. Instead the technique generates primary, survey information. If the sample is large, there can be considerable time and costs involved. The survey instrument also affects the cost of data acquisition: mail and telephone followups are about one-quarter as expensive as personal interviews per respondent.

Comprehensiveness

Econometric and input-output models represent more sophisticated techniques for producing area industry employment forecasts or projections (Element 1). When incorporated into an occupational employment projection system, an industry staffing pattern (Element 2) must still be used to transform the set of industry employment forecasts into a set of occupational employment projections (Element 3). Some econometric models will have a staffing pattern matrix and a job turnover submodel "built in" to ensure compatibility and consistency, but they represent the same techniques as developed by BLS and used in the OES program.

The OES approach is a comprehensive one—all elements of the forecasting system are included. This means that maximal compatibility and consistency in the definition of industry and occupation categories, as well as input data, can be maintained through the entire process.

Employer surveys, unlike econometric or input-output models, lead directly to estimates of target-year occupational employment but they represent a shortcut to the general occupational employment projection system outlined earlier. Surveys have frequently asked employers to estimate target-year total job openings by occupation directly, bypassing estimates of target-year industry employment and also eliminating the need for a staffing pattern matrix.

Sensitivity to Exogenous Factors and Policy Variables

Econometric models, and to a lesser extent, input-output models, usually are sensitive to a wider variety of exogenous factors which may have important impacts on a local employment base. In the case of econometric models, the sensitivity can be built directly into the individual equations at the stage of model specification, since there is a relatively large degree of flexibility in the choice of independent variables in a given equation. Variables which specifically measure certain exogenous factors or policies can be chosen in equations in which the dependent variable has been demonstrated to be particularly sensitive to certain exogenous factors.

Input-output models are also considered to be potentially sensitive to exogenous factors. Here, however, the exogenous factors or policies must first be "translated" into target-year estimates of final demand. Because this translation is not always straightforward or direct, there are some classes of exogenous factors or public policy changes to which an input-output will not show sensitivity. This is particularly disadvantageous if the exogenous factor or policy has an effect of inducing substitution between labor and another factor of production (e.g., capital or energy).

The OES approach is not particularly sensitive to many exogenous factors or policies because: (a) the independent variables are limited in scope and variety; and (b) single-equation regression models cannot "pick up" indirect employment impacts transmitted from other sectors of the local economy. Only if the impacts of the exogenous factors of policies are reflected in the target-year (exogenous) forecast of national industry employment will the models take into account these employment impacts, given the usual specifications of the equations. On the other hand, even with alternative sets of independent variables, the sensitivity of single-equation regression models is limited by their ability to take into account most indirect employment impacts.

The employer survey approach transcends *some* of the sensitivity limitations of the other approaches because it is not constrained by a formal structure or the need for operational variables. The flexibility of the approach allows for a wide variety of exogenous factors or policies to be considered, although the approach provides no theoretical framework for gauging what the employment impacts might be.

Costs of Effort

The cost of an occupational projection system is a function of: (a) the amount and type (primary or secondary) of data required for calibration and projection; (b) the frequency of updating; (c) the amount of in-house expertise or consulting services required to maintain, operate, and interpret the results (which is a function of the relative degree of sophistication of the model used); and (d) the amount of coordination required or desired with other public agencies or private groups (for data acquisition, acceptance of projections by different user communities, qualitative/subjective "input" by outsiders, etc.).

In descending order of average costs of effort are input-output models, econometric models, and the BLS-OES approach. The costs of employer surveys can vary considerably, depending in large degree upon the size of the sample, the number of industry sectors surveyed, and whether the information is collected through personal interviews (of employers) or by mailed questionnaire. Personal interviews, of course, are very expensive. Employer surveys through mail questionnaires can be relatively low cost, but depend upon how subsequent stages of data processing are organized. With input-output models and econometric models, as national and State-level economic measures are substituted for local economic measures of variables, the effort becomes less costly (but less reliable). An intermediate cost-approach is to use more spatially aggregated data (e.g., State) where secondary data on local economic variables are not available, but to adjust this data carefully for local conditions. The ability to do this depends upon the degree of insight, knowledge, and experience of local labor market analysts. The same kind of process of "adjustment for local conditions" is equally applicable to the OES approach.

Transparency and Comprehensibility

The ability of various users untrained in applied statistics or econometrics to understand the "logic" by which the projections are obtained can be an important factor in acceptance and subsequent use of the forecasts. It can also be an important factor in gaining the close cooperation of groups such as local business leaders, or other public officials in obtaining information on which to base initial assumptions about future local economic conditions, and in assessing the set of industry or occupation employment projections before proceeding to the subsequent stages. In order of increasing transparency and comprehensibility are econometric models, input-output models, BLS-OES approach, and the employer-survey approach. The format and clarity of the written documentation for the particular model, however, is an important factor in its comprehensibility. Very good documentation, for example, can help make a complex econometric model seem reasonably understandable. Separate documentation needs to be provided to analysts and forecasters on the one hand, and to less technically sophisticated user groups on the other. The provision of very good documentation of the latter type needs to be given much more emphasis, regardless of the particular approach. In practice, however, it is more reasonable to expect that with equal levels of quality of documentation, the OES approach and the employer survey will be more understandable to the majority of interested users than econometric or input-output models.

Relative Accuracy

It is difficult to compare rigorously the relative accuracy of the various forecasting approaches based only upon results to date. This is because, in general, the projected estimates can only be compared with the actual figures during a given test period in a given labor market area. In general we do not know how alternative techniques would have performed under the same conditions. There have been several cases where the estimates from alternative models have been available for comparison, but too few to draw *definitive* conclusions.[28] We can make only tentative judgments about the relative accuracy of the various approaches and must remember that there can be wide variation in accuracy *among* models of the same general approach.

Most experts agree that employer survey-based occupational employment forecasts have not been useful because of their low accuracy. *Among econometric models, input-output models, and single-equation regression models of the OES approach, there has been no clearly superior technique.* Based on the limited empirical evidence and our theoretical insights, we can hypothesize that, in certain labor market area classes and for certain local industry sectors, econometric models will produce more accurate forecasts than single-equation regression models. In other conditions, there will be very little difference in forecasting accuracy. The same would hold for input-output models *vis a vis* single-equation regression models. The potential for improving the accuracy of input-output models by better adjusting for local conditions is not as large as that for econometric models or single-equation regression models.

That econometric or input-output models do not yield unambiguously superior forecasting results is due, in large part, to one single fact. The factors most responsible for instability in local employment bases are exogenous, remain outside the structure of all the major approaches, are highly unpredictable, and are not likely to lend themselves to systematic treatment by economists or policy analysts in the forseeable future. This problem arises more from the underdevelopment of theories of the behavior of national and local economies rather than from the state-of-the-art of forecasting techniques themselves. It suggests that, to improve local occupational forecasting, *increased emphasis should be placed on local labor market analysis.* Particular attention should be paid to studying how different exogenous factors have affected the local area's employment base (industry and occupational levels and mix) both in that area and in similarly behaving labor market areas.

The relative structural advantages and disadvantages of the four major approaches are summarized in Table 1.

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[28] See Henry Fishkind and R. Blaine Roberts, "Two Methods of Projecting Occupational Employment," *Monthly Labor Review*, May 1978, pp. 57-58, for comparisons of accuracy between a fully specified econometric model and a BLS-recommended set of single-equation regression models, and Ruth B. Rowan, *Meeting State and Area Occupational Needs: The Industry-Occupational Matrix System*, Massachusetts Division of Employment Security, May 1976.

TABLE 1. SUMMARY OF COMPARATIVE ADVANTAGES AND DISADVANTAGES OF ALTERNATIVE APPROACHES TO OCCUPATIONAL FORECASTING

Approach	Data Requirements	Comprehensiveness	Potential Sensitivity to Exogenous Factors and Policy Variables	Costs	Transparency and Comprehensibility	Forecasting Accuracy
BLS-OES	Low to Medium	Complete (Elements 1 to 5)	Low to Medium	Low	Medium	Fair to Good
Econometric Models	High	Industry Employment Projections (Element 1)	High	High	Low	Good
Input-Output Models	Very High	Industry Employment Projections (Element 1)	Medium to High	Very High	Low to Medium	Good
Employer Survey	Medium to High	Direct Occupational Employment Projections (Element 3)	Low	Low to High	High	Poor

Local Economic Structure and Alternative Projection/ Forecasting Techniques

A given projection/forecasting approach will yield better results for some types of local labor markets than for others. That is because each approach emphasizes or deemphasizes different factors which influence local economic variables, and each local labor market to some extent has its own unique behavioral characteristics. These characteristics make labor market areas respond differently to such factors as general economic development trends, national business and growth cycles, shifts in national and international economic structure, changes in government fiscal, monetary, and regulatory policy, capital and labor migration patterns, and changes in technology.

Much less is known about the complex relationships in local economic structures than in the national economy. Nevertheless, it is possible to identify several key dimensions of local economic structure which help explain how different local employment bases respond to the different kinds of trends, discrete events, or structural shifts mentioned above. These dimensions can be summarized as: (1) the area's relative stability over national economic cycles; (2) area industrial structure; and (3) area migration trends and aggregate population/economic growth.[29] We briefly discuss each of these dimensions and suggest which forecasting techniques are best suited for particular *types of labor-market areas*, where the types are loosely defined with respect to these three dimensions of local economic structure.

The focus here will be to identify those labor market area types where either econometric or input-output approaches might well produce significantly more accurate target-year estimates of area industry employment than the single-equation regression models recommended by BLS.

Cyclical Stability of the Labor Market Area

Every local labor market area is affected by national business and growth cycles, although the severity (amplitude) and duration of these cycles, as well as the relationship of the local economy to the national average (lead or lag), varies from one labor market area to another. The particular manner in which a given labor market area responds to these exogenous cycles depends, in large part, upon the industry mix in the labor market area, the degree of local interindustry linkages (industry agglomeration), and the stage of the life-cycle of the key local industries. Economic analysts have calculated measures of local economies' stability over business and growth cycles.[30]

Suffice it to say that the greater the instability (measured in degree of fluctuations of aggregate area employment) of the local economy, the less accurate will be *any* of the statistically based projection or forecasting models since all except employer surveys rely upon historical data. The BLS-recommended single-equation regression models, however, would perform relatively worse than fully specified econometric models under more unstable economic conditions. The former place heavy emphasis on a constant proportional relationship between changes in the national and local levels of industry employment. Thus, even when exogenous

[29] These will be offered as hypothetical and suggestive descriptors rather than as rigorously analyzed and empirically validated ones. Attempts at LMA classifications have been made by other researchers (e.g., Vernez *et al.*, *op. cit.*) but the classification criteria have been too restrictive for the purposes of this report.

[30] See, for example, L.J. King, "Spatial-Temporal Patterns in Employment Growth" in *Growth and Change*, 3: 37-42, 1972, and Georges Vernez, *et al.*, *op. cit.*

BLS projections of national economic conditions take into account expected cyclical fluctuations in national economic activity, local divergences from the national average are not taken into account. Fully specified econometric models, on the other hand, can potentially include explanatory variables (leading indicators) in the various equations which better reflect or predict cyclical fluctuations in local employment (e.g., interest rates, bond rates, unemployment rates, construction activity, etc.). But for labor market areas whose cyclical behavior is relatively similar to the national average, fully-specified econometric models are not likely to produce significantly more accurate industry employment forecasts than the BLS-recommended models. Input-output models can be sensitive to the effects of cyclical fluctuations on local employment levels only to the extent that the exogenous estimates of the local share of GNP take into account the fact that labor market areas respond differently to national cyclical fluctuations.

Local Industry Structure

Labor market areas vary considerably in terms of industry mix, the types of products exported, and the degree of local interindustry linkages. Together these dimensions describe an area's industry structure. Areas with different industry structures respond differently to both national and local industry impacts and to general economic development trends. Different projection/forecast techniques will be more or less accurate in a given local labor market depending, in part, upon the way in which the technique takes into account these aspects of local industry structure.

First, the type of industry mix directly affects the area's response to cyclical fluctuations. This was discussed above. The degree of local interindustry linkages refers to the extent to which local firms depend upon one another for purchases of inputs or for markets. A low degree of interindustry linkages means that a high percentage of the local firms' input requirements are met through purchases from firms located *outside* the local economy, and vice versa. In a local economy characterized by relatively strong interindustry linkages, changes in the employment level in one industry due, say, to a sharp drop in national demand, will strongly affect the employment levels in other local industries. On the other hand, in a local economy with weak interindustry linkages, changes in employment levels in one local industry will have only minor impacts on other local industry sectors.[31]

The implications of this discussion for choosing industry employment projection techniques are clear. In areas of weak interindustry linkages, there is no strong need for models which emphasize indirect local employment impacts (such as econometric or input-output models). In these areas the "indirect" effects on employment will be minimal and econometric or input-output models would not significantly improve upon the accuracy of single-equation regression models. Conversely, econometric or input-output models would perform significantly better than the single-equation regression models recommended by BLS in areas with rather strong interindustry linkages. There is evidence, however, that the number of such areas is declining as growing vertical integration and functional specialization of plants become characteristic of an increasing number of industry sectors.

The nature of the markets of the major export industries is also a factor which affects the ability of a particular technique to estimate accurately an area's future industry employment. Whether the markets for the major export products are primarily regional or national/international gives some indication of the extent to which the local economy is integrated into the larger national and international economic system or is relatively autonomous, or isolated from the larger system. Where local industries are more closely linked to national markets and the national and international economic system, an econometric model is less likely to improve significantly the forecasts of the BLS-recommended models. This, again, is due to the emphasis placed in the latter on the levels of national industry employment as predictor variables.

There are of course some classes of exceptional cases. One important one is the case of a local economy with a single dominant industry tied to national and international markets, which is highly concentrated (i.e., oligopolistic), but also highly volatile. Many of the extractive industries (e.g., petroleum, copper, coal) fit this description. To accurately project industry employment in these areas requires a sophisticated *industry-specific econometric model*. Yet the level of uncertainty of future market conditions is so great in these circumstances that even the best of these models frequently produces large forecasting errors.

Similarly, those areas in which key industries are particularly sensitive to change in public policies (e.g., dependent upon government contracts) or have a high degree of absentee-ownership of local enterprises (e.g., a large proportion of branch plants of multi-plant firms or units of conglomerates) present potential problems for the single-equation regression models of BLS. In the former case, econometric or input-output models might be desirable for their capacity to test the employment impacts of alternative future scenarios. In the latter case, however, the use of econometric or input-output models would not necessarily lead to better forecasts

[31] There is no easily calculable measure of strength of local interindustry linkages. Regional input-output tables give sufficient information to devise one, but the tables are not generally available. For the purposes of this report, this dimension of local economic structure must be viewed in a qualitative and comparative manner.

because so many plant expansion, contraction, or shutdown decisions are based on other than strictly economic criteria.

Area Migration Trends and Aggregate Population/Economic Growth

Population migration is a very important factor or component of an area's aggregate economic growth rate. The size and composition of the net migration to/from an area affects both the demand and supply sides of the local labor market. The demand for locally produced consumer goods and services will be sharply affected by significant in- or out-migration. Sufficiently increased demand here will increase the demand for labor in the retail and service industries, as well as in construction. On the supply side, in-migration can leave some shortages in certain occupations, which in turn could put a brake on new job creation in certain industries. In-migration, on the other hand, can have different kinds of impacts depending upon the labor force participation, skill levels, and age and sex composition of the in-migrants. When, for instance, the rate of in-migration of members of the labor force exceeds the capacity of the local economy to create jobs, the local unemployment rate will rise, having a generally depressive effect on the local wage structure. This can induce a substitution of capital for labor in some industries, thus having a positive effect on employment levels. In other industries, the long-term effect on employment can be the opposite.

The demand for public services and facilities and thus local tax levels are also generally affected by high rates of in- or out-migration. What the specific effects will be, and how they will affect the employment base depends upon the type of in- or out-migration (labor force participation, age and sex composition), and cannot be generally stated. To the extent that present and prospective area private sector businesses do consider area tax levels and quality of public services in their assessments of local business climate, migration patterns can have a secondary effect on industry employment through stimulating or retarding economic development.

In general, for areas with high net population migration rates, the need is greater for some type of demographic submodel to help project change in area population, and its impacts on local labor supply and on the demand for local consumer goods and services. Since area migration rates in many areas which have been growing well above the national average tend to be volatile *on an annual basis*, it is unlikely that single-equation regression models would be able to forecast accurately the direct or indirect impacts of area population migration on industry employment levels using only a "local share of national growth" variable.

Fully specified econometric models have the potential capacity to include equations of a separate submodel which estimate such variables as target-year population, labor force participation by age and sex, unemployment rates, etc. Important first-round and indirect effects of area population change on industry employment can be taken into account, depending upon the specification of the individual equations and the demographic detail of

TABLE 2. A TYPOLOGY OF LOCAL LABOR MARKET AREAS AND RELATIVE ACCURACY OF INDUSTRY EMPLOYMENT PROJECTION TECHNIQUES

Local Inter-Industry Linkages	Net Area Migration Rate	Highly Stable (Relatively Unaffected by National Cycles)		Similar to National Average		Highly Unstable	
		Nat'l/Int'l Export Product Markets	Regional Export Product Markets	Nat'l/Int'l Export Product Markets	Regional Export Product Markets	Nat'l/Int'l Export Product Markets	Regional Export Product Markets
Weak	Average or Below						
	Well Above Average					E	E
Average	Average or Below						E
	Well Above Average			E	E	E	E
Strong	Average or Below					E, I-O	E, I-O
	Well Above Average			E, I-O	E, I-O	E, I-O	E, I-O

E indicates likelihood of significant improvement in accuracy over the BLS-recommended models with a fully specified econometric model.
I-O indicates likelihood of significant improvement in accuracy over the BLS-recommended models with an input-output model.

the labor supply variables. The University of Arizona models (Taylor, 1979) and the University of Tennessee model (Alper, 1978) offer good examples of how demographic trends and labor supply can be included in estimations of area industry employment.

Input-output models do not take into account population growth due to migration or changes in labor force composition. Such factors must be exogenously estimated and translated into the final demand component and household (production) sector. A separate population projection model or econometric model normally would be needed for that purpose. Employer surveys would not be able adequately to take into account the impact of changes in the area population upon industry employment demand.

A typology of labor market areas based on the dimensions discussed above is presented in Table 2. The table helps to summarize under what conditions econometric or input-output models might be expected to produce significantly better target-year estimates of industry employment than BLS-recommended models. Since typologies of real-world situations deliberately oversimplify in order to sharpen or clarify differences, *the information in the table should be considered suggestive only.*

Other Information Needs

The selection of the most appropriate techniques for a local occupational employment projection system should depend upon the particular information needs of policymakers and planners. In most applications, the primary question motivating occupational employment projections has been, "What is the best estimate of the number of total job openings, by occupation, in a given target-year"? The answers to this question potentially help program administrators to undertake medium- and long-term planning of employment and training programs, to "rationally" invest in facilities and equipment, to plan voc-ed curricula, etc. The general aim of medium- and long-term employment projections has been to strive for an optimal match of area human resources to an estimated future demand for labor. Each of the major approaches we have reviewed is a means to provide answers to this class of questions.

Questions involving the use of policy simulation are more difficult to answer. Here one asks, "What would be the best estimate of job openings (by occupation) in a given target-year *if* policy X or event Y occurs"? Advance knowledge of the local employment impacts of a certain policy or event could, for example, give valuable lead time to employment planners to help mitigate any economic dislocations or to meet a sudden demand for certain labor skills. Policies involving tax changes, trade restrictions, environmental regulations, defense facility location, etc., can in general have large local employment impacts. The ability to provide timely job-retraining programs, to initiate a plan for worker ownership in the case of an imminent plant closing or to plan other short-term relief responses could be improved in situations where the size and sectoral distribution of the employment impact could be known with advance warning.

If the policymaker wishes to build a capacity to address this second class of questions *in addition* to the first class, then the potential sensitivity of the alternative techniques to policy variables becomes the key consideration. This was discussed in the opening section of the second chapter: econometric models and, to a somewhat lesser extent, input-output models offer a considerably greater capacity here than the other approaches. Yet even with the most policy-sensitive and detailed econometric model, policy simulation has remained a highly imperfect art with frequently disappointing results. Because of this imperfection and the high cost of undertaking such an effort at the local level, policy simulation has not yet been widely adopted in local public agencies. It has been used in the policy analysis process more often at the State and National government levels where data is more complete and where projections are made at a higher level of spatial aggregation.

The discussion throughout this report has focused on alternative techniques for projecting occupational employment in the medium and long term (at least 1½-2 years). For developing information on current job openings by occupation or skill requirements, or for very short-term employment projections, other criteria become more important, and the relative appropriateness of the techniques may shift.

Prior Calibration and Development of Models for the Area

In the last few years the use of econometric models (and, to a lesser extent, of input-output models) in State and Federal Government policymaking has significantly increased. Concern over the fiscal crisis, declining school enrollments, and growing demand for public services has led policymakers in various public agencies to employ econometric models for estimating such variables as annual tax revenues, the number of school-age children, unemployment rates, welfare loads, etc. In some cases the models have been developed and operated "in-house." In other cases they have been developed at State universities or by private economic forecasters under contract to public agencies. If an econometric model (or input-output model) has been calibrated for a given local economy, it possibly may be used to develop detailed area industry employment forecasts even it it was originally developed for other purposes. Because other agencies would already be paying the maintenance and operating costs of the model, there would be little or no costs to the SESA or other employment and training-related agencies. Such characteristics of the model as degree of industry detail, definition of industry categories, and the length of the forecasting period should be checked carefully, however, for their suitability for *occupational employment projection* purposes.

In addition, the general structure of the model should reflect the industry structure of the local economy (e.g., if the local economy is built around durable goods manufacturing, the model should reflect that importance). If any incompatibilities were to exist between the model and the other elements of the projections system, it may be possible to correct for these by making appropriate adjustments to the model. In fact, however, many models which exist are not capable of providing sufficiently detailed industry employment forecasts; they would require revisions so major as to be unfeasible.

RECOMMENDATIONS FOR DEVELOPMENT OF LOCAL OCCUPATIONAL EMPLOYMENT PROJECTION SYSTEMS

The adequacy of an occupational projection system turns on the extent to which the output from that system meets users' legitimate information needs. These needs are based upon a given set of program responsibilities for delivering a variety of training, job creation, and educational services. Depending upon the specific public policy context (as discussed in the first chapter), there may be additional demands placed upon the occupational information system. Recommendations for improving the system must take into account not only the level of development of the individual elements of the system, but also many of the contextual elements of the public policy and program delivery arenas as well as local economic structure. The general occupational employment projection system outlined at the outset of Chapter 2 should be used as a reference point.

The following recommendations are based on the conclusion that the basic OES approach offers a reliable and cost-efficient *methodological framework* for meeting users' needs for medium- and long-term area occupational employment projections. Certain modifications or additions to the current OES approach are suggested, based in part on the assessment of its relative weaknesses and some particular strengths of the alternative approaches.

1. *In general, neither local econometric models nor input-output models should be developed to replace single-equation regression models for producing industry employment forecasts.* There is no clear and unambiguous empirical evidence to support the widely held view that fully specified econometric models and/or input-output models generate significantly more accurate forecasts than single-equation regression models. At the same time, econometric models and input-output models cost considerably more to develop and require more effort to maintain than single-equation regression models. They are also much less comprehensible to most users; building greater transparency into the forecasting system can result in great acceptance of the outputs of that system.

2. There are, however, some special circumstances in which econometric models should be considered for inclusion in the occupational employment projection system:

a. *If policy simulation and testing and/or employment impact analysis are to be incorporated into the ongoing local employment planning effort, then a fully specified econometric model should be developed* (or shared with another agency). Single-equation regression models are inadequate for these purposes. One must be sure, however, that the econometric model is capable of providing sufficiently *detailed* industry employment forecasts and whose industry categories are compatible with those in the OES industry-occupation matrix.

b. *In cases where a fully specified local econometric or input-output model has already been developed by, or for, another public agency (e.g., OMB, tax revenue department, economic development agency) then the model's forecasts of area industry employment should be regularly obtained.* The forecasts from the econometric model could be used either as supplementary information for making final adjustments in the industry employment projections developed using the BLS recommended models, or as a basis for an independent set of occupational employment projections. This assumes that the costs to the SESA, CETA prime sponsor, or other agencies developing occupational projections would be relatively small. If so, the benefits of having a second set of target-year estimates will likely outweigh the additional staffing costs.

c. *There are some types of labor market areas where the use of econometric models may lead to* *significantly higher accuracy in target-year estimates of industry employment over those obtained with single-equation regression models.* These areas include those which exhibit chronic unstable industry employment patterns, have particularly strong local interindustry linkages (agglomeration), or experience very high rates of growth (see Chapter 3). On the other hand, improvements in the specification of single-equation regression models can lead to improvements in accuracy over current efforts. There is no general answer to the question of whether a "satellite model" or an "endogenous model" strategy is the best econometric approach. The selection should depend upon the particular characteristics of the labor market area.

3. *The use of employer surveys for the direct development of medium- and long-term occupational employment projections is not recommended.* This approach lacks theoretical validity and has been demonstrated to be unreliable and inaccurate in several evaluations. Employer surveys do have potential value as a means of obtaining *other types* of area labor market information, but only when standard survey research procedures are followed.

4. *The accuracy of the BLS-recommended single-regression models can be improved through more careful and discriminating specification of the individual equations for particular industry sectors in a given labor market area.* The variable choices should be based upon industry-by-industry analyses of how employment levels in the local economy have changed in relation to fluctuations in the national economy and in similar labor market areas. It should not be expected, for instance, that the variables which are the best predictors of change in employment in one industry (e.g., total national industry employment) are those which will be the best predictors in other industries. Moreover, the best set of independent, or predictor, variables in a given industry sector will not necessarily be the best set for other labor market areas. Analyses leading to improved specifications of single-equation models should be performed at the State and local levels with guidelines and recommended procedures developed and provided by BLS. In all cases the variable choices should take into account ease of data availability.

5. *Significantly greater emphasis should be given at the State and local levels to developing and implementing a process of careful and insightful review, assessment, and adjustment of industry employment projections which emerge from any statistically based models.* This represents one of the best opportunities for improving an area's occupational employment projection system. Support for improving local labor market analysis should be given by BLS, NOICC, and ETA. A guidebook prepared by relevant Federal agencies, with SESA's, describing alternative processes and exemplary cases should be distributed widely to both providers and users of projections. The review, assessment, and adjustment process should include discussion and evaluation of the validity of alternative assumptions about future conditions which will underlie area projections. Means to take maximal advantage of the insights and knowledge of the local labor market developed by local businessmen, union officials, academics, and other public agency staff in the review, assessment, and adjustment process should continue to be encouraged.

6. *Cost-efficient methods for generating or simulating area-specific industry-occupation matrices should be further developed and tested by the SESA's with the technical support of BLS.* Tests of area matrices simulated from the State matrices in Oregon and Colorado are currently being performed. The development and testing should be expanded to a wider variety of States and labor market areas. Analyses to discover if there are other good stratifying variables besides size of establishment and industry sector should be performed.

7. *Improved procedures for estimating future job openings due to replacement needs should be developed.* Currently the SESA's in the OES system estimate job openings due to separations from the labor force due only to deaths and retirements, using the working-life table method. Other job separation components, including those which vary significantly across areas or across occupations—quits due to out-migration and separation due to occupational mobility, respectively—are not taken into account, although many analysts consider these two labor force separation components to be particularly important. Since the analytic constraints here have been primarily due to data unavailability, new sources of data need to be considered.

8. *The relative strengths and weaknesses of each of the various elements of the OES system should be evaluated empirically.* Proposals for making large investments to improve particular elements of an area's projection system (e.g., the industry employment projections, or the industry-occupation matrix) should be made with the knowledge of their likely improvement of the system as a whole (i.e., its final product). It is possible, for instance, to decrease the error in the industry-occupation matrix significantly without any significant increases in the accuracy of target-year total job openings if, say, job openings due to labor force separation for a particular occupation are 10 times as large as job openings due to economic expansion. As a basic principle, investments in improvement should be directed at those elements of the system which offer the greatest likely improvements to the system as a whole.

9. *Proposals to increase the level of occupational detail, or the spatial disaggregation of the projections in efforts to better meet users' needs for labor market information should be carefully assessed to avoid compromising the theoretical or statistical validity of the*

projections themselves. The potential benefits of increasing the level of occupational detail must be considered in view of the capacity of the local program/service delivery components of the employment and training/vocational education system to effectively utilize the greater detail. The loss in reliability of the data at greater levels of detail must also be considered, based upon assessments of misclassification of employers' job titles into OES occupational categories. Under no circumstances should projections be generated for spatial units smaller than labor market areas.

The development of industry or occupational projections for sublabor market areas is not recommended. Occupational projections as used in the planning process should reflect the entire labor market area, otherwise serious planning inadequacies may occur through the failure to recognize commuting of workers between jurisdictions within the labor market area. Sublabor market area projections may (1) miss possible job opportunities in other areas within the labor market area, and (2) may lead to occupational supply/demand imbalances by ignoring the fact that employers in the subarea may be hiring workers from other parts of the labor market area.

Appendix A
A Partial Inventory of Local Econometric Models

State	Project/Reference	Brief Description
Arizona	Economic Forecasting Model Division of Economic and Business Research University of Arizona Tucson, Arizona Carol Taylor, Project Director	Phoenix SMSA: Up to 2-year forecasting period, annual estimates; projects industry employment at the 2- and 3-digit SIC level (59 sectors) Tucson SMSA: Up to 2-year forecasting period, quarterly estimates; projects industry employment at the 2-digit SIC level (43 sectors)
California	Economic Forecasting Model Division of Economic and Business Research University of Arizona Tucson, Arizona Carol Taylor, Project Director	San Francisco: (Same as for Phoenix, except 63 sectors)
	"Building Small Region Econometric Models: Extension of Glickman's Structure to Los Angeles," *Journal of Regional Science*, Vol. 14, No. 3. Owen P. Hall and Joseph A. Licari, Authors	Los Angeles SMSA: Annual estimates; projects industry employment for manufacturing, wholesale and retail, government, and other (services, F.I.R.)
	The Santa Clara County Model County of Santa Clara Planning Department R. Goldman	Santa Clara: Documentation unavailable
Colorado	Labor Market Information System Institute of Labor and Industrial Relations University of Michigan—Wayne State University Malcolm S. Cohen, Author	Denver SMSA: Forecasting period up to 9 quarters, quarterly estimates; projects industry employment at the 1- and 2-digit SIC level
Florida	Bureau of Economic and Business Research University of Florida Gainesville, Florida 32611 Henry Fishkind, Project Director	Jacksonville, Tampa Bay LMA's: Forecasting period up to 5 years, quarterly estimates; projects industry employment at 1-digit and 2-digit SIC level (20 sectors)
Georgia	Economic Forecasting Project College of Business Administration Georgia State University Atlanta, Georgia Donald Ratajczak, Project Director	Atlanta SMSA: Forecasting period up to 5 years, quarterly estimates; projects industry employment at 1-digit and 2-digit SIC level (23 sectors)

Appendix A (Con't.)

State	Project/Reference	Brief Description
Massachusetts	Economic Forecasting Model Division of Economic and Business Research University of Arizona Tucson, Arizona Carol Taylor, Project Director	Springfield-Holyoke-Chicopee: Forecasting period up to 2 years, annual estimates; projects industry employment at the 2-digit SIC level (46 sectors)
Michigan	Labor Market Information System Institute of Labor and Industrial Relations University of Michigan—Wayne State University Malcolm S. Cohen	Detroit SMSA: Up to a 9 quarter forecasting period, quarterly estimates; projects industry employment at the 1-digit and 2-digit SIC level
New York	An Econometric Model of the Buffalo SMSA School of Management State University of New York at Buffalo Robert T. Crow, Director	Buffalo SMSA: (Documentation unavailable)
	The New York Region Econometric Model Wharton Econometric Forecasting Associates 369 Lexington Avenue New York, N.Y. 10017 Dr. Nancy Mantell	New York SMSA and New York City: Up to 10 year forecast period, annual estimates; projects industry employment for 23 sectors
Ohio	Quarterly Econometric Forecasting Model for Dayton SMSA Department of Economics Wright State University Dayton, Ohio Mark Fabrycy, Project Director	Dayton: Forecasting period: up to 2 quarters, quarterly estimates; projects industry employment for manufacturing and four 2-digit manufacturing sectors
	An Econometric Forecasting Model of the Cleveland Metropolitan Area Case Western Reserve University Research Program in Industrial Economics C. Loxley and M.D. McCarthy	Cleveland: (Documentation unavailable)
Pennsylvania	Econometric Model of the Philadelphia Region Department of Economics University of Pennsylvania Philadelphia, Pa. 19174 Norman J. Glickman, Project Director	Philadelphia: Annual estimates; projects industry employment at the 1-digit and 2-digit SIC level (23 sectors)
Tennessee	Economic Forecasting Model Division of Economic and Business Research University of Arizona Tucson, Arizona Carol Taylor, Project Director	Mid-Cumberland EDD: Forecasting period up to 2 years, annual estimates; projects industry employment at the 2-digit SIC level (52 sectors)

Appendix A (Con't.)

State	Project/Reference	Brief Description
	The Tennessee Econometric Model (TEM II) Center for Business and Economic Research College of Business Administration University of Tennessee Neil Alper	Chattanooga, Knoxville, Memphis, Nashville: Annual forecasts, tested up to 4 to 7-year forecasting period; project industry employment at the 1-digit SIC level (9 sectors). But including two manufacturing sectors. Comment: Metropolitan industry employment derived indirectly, from estimates of State industry employment and metropolitan industry output
Utah	Economic Forecasting Model Division of Economic and Business Research University of Arizona Tucson, Arizona Carol Taylor, Project Director	Southeast Utah EDD: Forecasting period up to 2 years, annual estimates; projects industry employment at the 1- and 2-digit SIC levels (12 sectors)

Appendix B
Mathematical Descriptions of Projection Techniques/Models

1. Single-equation Regression Models

$$E_i^{t+1} = a_i + b_{i1}x_{i1}^{t+1} + b_{i2}x_{i2} + \ldots + b_{in}x_{in} + e_i$$

where E_i^{t+1} (dependent variable) denotes the estimated target-year area employment level for industry sector i

x_{i1}^{t+1} (independent variable) denotes target-year estimates of national employment, industry i

x_{i2} denotes the time variable, frequently expressed as the lag of the dependent variable

Other independent variables as appropriate

a_i, $b_{i1} \ldots b_{in}$ denote the regression coefficients estimated in the calibration process

e_i denotes the residual or error term

2. Classical Shift-Share Model

$$E_i^{t+1} = E_i^t + E_i^t[US^{t+1}/US^t - 1] + E_i^t[US_i^{t+1}/US_i^t - US^{t+1}/US^t] + E_i^t[E_i^t/E_i^{t-1} - US_i^t/US_i^{t-1}]$$

where E_i^{t+1} = target-year estimate of local employment in industry i

E_i^t = base-year local employment, industry i

US_i^{t+1} = target-year estimate of national employment, industry i

US_i^t = base-year national employment, industry i

US^{t+1} = target-year estimate of total national employment

US^t = base-year total national employment

3. Input-Output Model

$$X_i = a_{i1}x_1 + a_{i2}x_2 + \ldots a_{in}x_n + Y_i$$

or

$$X = (I - A)^{-1}Y$$

where x_i is the target-year output of local industry i,

a_{ij} are the ratios of: purchases by industry j from industry i to total production of industry j,

Y_i is the final demand for goods and services of local industry i.

In matrix form,

X is an nxl vector of local industry output,

A is an nxn matrix of technical coefficients,

Y is an nxl vector of final demand by industry

I is an nxn identity matrix, and $[I-A]^{-1}$ is the inverse of $[I-A]$

4. Fully-Specified Regional Econometric Models

$$Y_i^{t+1} = f(Y_j^{t+1}, Z_k^{t+1}, e^{t+1})$$

or

$$BY^{t+1} + CZ^{t+1} + \quad = e^{t+1}$$

where Y_i^{t+1} is the i^{th} endogenous variable in the target-year

Z_k^{t+1} is the k^{th} exogenous variable in the target-year (but includes lagged endogenous variables)

e is the error in the target-year estimate of Y_i.

In matrix form, for a system of n equations,

B is an nxn matrix of regression coefficients at the endogenous variables

Y^{t+1} is an nxl vector of endogenous variables

C is an nxm matrix of coefficients of the exogenous variables,

Z^{t+1} is an nxl vector of endogenous variables (including lagged endogenous variables),

e is a vector of n error terms.

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