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Forecasting the local economic impacts of energy resource development: a methodological approach

Regional Studies Program

MASTER

Energy/environmental assessments

Argonne National Laboratory

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REGIONAL STUDIES PROGRAM

FORECASTING THE LOCAL ECONOMIC IMPACTS
OF ENERGY RESOURCE DEVELOPMENT:
A METHODOLOGICAL APPROACH

by

Erik J. Stenehjem

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EXECUTIVE SUMMARY

The precipitous rise in world energy prices and the United States' goal of energy self-sufficiency have stimulated commercial interest in the nation's fossil-fuel resources, which until very recently were viewed as economically noncompetitive. While energy self-sufficiency clearly is economically in the country's best interests, social and environmental concerns call for efforts to moderate or eliminate the deleterious side effects that can accompany construction and operation of energy facilities.

Most of the areas being considered for fossil-fuel development are primarily rural and sparsely populated, and massive infusions of capital and labor could completely transform their socioeconomic and cultural character. In order to mitigate the effects of energy-related development in such regions, the ability to accurately forecast both the nature and magnitude of socioeconomic impacts is needed.

Argonne National Laboratory has designed a comprehensive model that identifies and estimates the magnitude of the economic impacts of anticipated energy resource development in site-specific areas (local) and geographically contiguous areas of unspecified size (regional). In preparing this methodology, the following sequential tasks were undertaken:

1. The primary economic impacts actually experienced by an area subjected to intensive energy-related industrial development were identified and their causes explained.
2. A number of empirical studies purporting to forecast the impacts of new industry were reviewed and evaluated with respect to whether the forecasted impacts conformed to those actually experienced by an area subjected to such development.
3. The analytical techniques and procedures employed by these empirical studies to forecast the magnitude and timing of the primary socioeconomic impacts were critically evaluated.
4. A number of alternative and supplementary analytical and informational techniques for forecasting the magnitude of the primary economic impacts from energy-related development were examined.
5. Finally, the techniques and procedures judged capable of consistently estimating the timing and magnitude of the primary economic impacts of energy resource development in any area of the country were integrated into a comprehensive impact model.

This modeling project is part of Argonne's role in the Regional Studies Program being conducted by the national laboratories of the Energy Research and Development Administration (ERDA). The economic impact model represents one of three socioeconomic impact assessments being carried out by Argonne; a subsequent report will deal with sociocultural and institutional effects of energy development and present an integrated approach to socioeconomic impact assessments. These studies reflect the Regional Studies Program's goal of devising and applying techniques for analyzing regional health, environmental, and socioeconomic impacts of energy supply/demand options.

Argonne's method of developing region-sensitive impact assessment consists of analyzing critical localized or subregional energy and environmental problems, i.e., taking a case study approach. A regional or national assessment therefore is a buildup from these well-understood components with a proposed national or multiregional overview. In line with the case study philosophy, the economic impact model soon will be used to forecast effects of a coal gasification plant proposed for the Williston Basin region of Mercer County, North Dakota.

Generally applicable to a wide range of nuclear and fossil-fuel energy technologies, the modeling methodology also was designed to assist industries and government agencies complying with recent federal and state legislation requiring subregional impact analyses for individual facilities. The model could be used for the economic components of analyses such as those required by the National Environmental Policy Act (NEPA) of 1969 or the North Dakota Regional Environmental Assessment program, which calls for statewide impact analysis of alternate energy development options.

A critical review of the limitations of past models and empirical impact studies, with respect to their applicability to more than one technology or more than one region, underscored the importance of the technical components of a comprehensive impact assessment methodology and suggested criteria for developing such a model. First, choices of analytical techniques and the extent of informational content must be very carefully considered because they influence the accuracy with which impacts can be measured. Second, while accuracy must be stressed in selecting techniques, the analytical procedures and the data for their operation also must be expandable and

exportable if consistent estimates of economic impacts from various energy-related development projects throughout the country are required. That is, the methodology must be flexible enough to permit analysts to examine the effects of energy resource development within any local community, surrounding area, or multicounty region, without requiring major new data collection or computational efforts.

The model described in this report was designed in light of the requirements for accuracy, expandability, and exportability. A comprehensive methodology, it represents a modification and refinement of existing techniques and procedures that were brought together specifically for the purpose of consistently estimating regional impacts of energy-related development in any area of the country, and, within each area, in regions and localities of varying types and sizes.

The economic effects usually associated with local energy-related development have to do with growth in population, employment, and business activity. However, simply forecasting these parameters provides rather sterile analysis. What is more important is to identify and measure the local and regional socioeconomic impacts that these increases can be expected to precipitate. A recent study of an area subjected to intensive energy resource development revealed that growth-induced demands for local services directly affect both local productivity and the general quality of life. As population increases, demand for public services grows correspondingly. However, as the study demonstrates, if local capacities to provide these services fail to grow at an adequate rate, the per-capita decrease in services leads to a lower quality of life in the area, a general emmigration of labor from both the primary and service sectors of the economy, and a further decline in the provision of services and quality of life. This self-perpetuating cycle of socioeconomic deterioration identifies the primary socioeconomic impacts associated with energy resource development.

The methodology presented in this report forecasts absolute increments in local and regional growth on an annual or biennial basis and transforms these parameters into estimates of the affected area's ability to accommodate growth-induced demands, especially demands for public services. The model uses the following approach to accomplish these objectives.

First, the new energy-related industry is surveyed to determine expected annual increments in direct output, investment, and employment within the region. However, the addition of the energy facility will stimulate further growth: other regional businesses and industries will expand, hiring more workers. This increase in regional employment, which is indirectly related to the presence of the new plant, will itself lead to higher regional income and hence greater consumer demand. This increased income will induce still more growth in regional employment. Therefore, the second step involves forecasting the total -- direct, indirect, and income-induced -- periodic increases in regional employment. To accomplish this, a special estimating procedure based on central-place and economic-base theory has been adapted for use.

Given the expected employment increase for a particular period, regional population estimates are derived, using a demographic survey of construction and operation/maintenance workers and a review of the existing labor pool in the region. New jobs not filled by resident labor will, by assumption, go to workers migrating into the area. By using the demographic survey to indicate the average family size of such immigrants, a new regional population total is derived. However, because the impacts of the new population will be most severely felt in specific localities within the region, the new residents must be "allocated" to these communities. A variant of a general gravity model is employed for this purpose to permit area officials to use their "best judgment" to determine where new families are most likely to locate.

Having determined the population estimates for individual localities and school districts, the effects of the new residents on local fiscal resources are derived. A baseline profile is prepared, describing the physical and financial capacities of the public service institutions (schools, police and fire, water and sewer, local government, hospitals, etc.) in each jurisdiction within the region. The need to expand these facilities in response to the increased population is translated into an estimate of future required expenditures. Given housing and expenditure preferences of the new residents (obtained from the demographic survey), the period-by-period increases in local property tax revenue, and where applicable, sales and use tax revenue, also are computed. Thus, for each period in the life of the energy facility, incremental local public expenditures and revenues are estimated and compared.

By examining the net fiscal resources of the localities and the region for each period, analysts can easily determine whether or not the communities affected by the facility will face a cycle of deterioration such as that described earlier.

Finally, the incidence of the increased revenues and expenditures is examined; that is, the relative burdens of new services and taxes are evaluated with respect to which segments of the society are most seriously affected. For example, as the new energy facility is being built and hundreds (perhaps thousands) of construction workers descend on the region, the shortages in public facilities likely will affect local residents most severely. This incidence analysis determines whether, over the life of the development, local residents -- particularly those not directly involved in the energy project -- will see their quality of life improve or decline.

Appendix I, an annotated bibliography, summarizes 25 impact studies, including all those cited in the report plus others that are less directly related to forecasting regional impacts but that contribute to an understanding of the regional impacts of energy resource development.

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1. INTRODUCTION

Marginal sources of commercial energy, largely in outlying areas, are becoming economically competitive because of the expanding need for domestically-supplied energy and the advancing new technologies of liquefaction, gasification, strip mining, and land reclamation. Many areas that are currently rural and sparsely populated will be subject to increased pressure for the development of natural resources. Hence, a logical concomitant of energy-related industrialization in such regions is that major social and economic changes will be experienced. To mitigate the more deleterious of these socioeconomic impacts, the ability to identify and forecast both the nature and magnitude of the effects of development on a particular area emerges as an important goal of energy-related research.

Given a comprehensive procedure for consistently estimating the most pervasive of these impacts, national energy resource planners would be better prepared to evaluate the relative effects of alternative energy development projects as well as the effectiveness of alternative policies designed to moderate the most serious of these potential changes in particular areas.

Evaluations of these impacts would benefit local and regional planning officials as well. Obviously, the impacts associated with a new energy facility will be most severely felt in the adjacent community. However, the impacts from construction and operation of the facility can be expected to extend beyond the borders of this local community. As used in this study, therefore, the term "region" refers to that contiguous area in which predicted and measurable socioeconomic changes will occur.

Advance knowledge, through the aid of a simulative methodology, of what these changes might portend for the future viability of their economies would place these local and regional areas in a far better position to assess whether, or under what conditions, energy development would be allowed to take place.

This report recommends a comprehensive methodological framework for consistently forecasting the economic impacts on local and regional areas of energy resource development. The model, a synthesis of analytical procedures suggested in the empirical and theoretical literature of impact assessment, is designed to evaluate the economic impacts experienced by quite diverse

regions, with a minimum of time-consuming data preparation and analysis. (While the analytical procedures, per se, require a minimum of data, the comprehensive nature of this methodology dictates that a complete socioeconomic profile of each region be prepared before an impact analysis is attempted.) Furthermore, the model is intended to enable the analyst to expand the size of the region under study with a minimum of effort. The method of analysis outlined in this report will be applied in the near future to an empirical assessment of the economic impacts of a coal gasification plant in the Williston Basin region of Mercer County, North Dakota.

The primary economic impacts of regional energy-related growth are identified in Chapter 2 of this report and used as criteria for evaluating a wide variety of empirical impact studies. While some of the studies reviewed refer to impacts accompanying general forms of industrialization, the distinction is not important analytically.

To facilitate the transition from discussing previous empirical impact studies of specific projects to describing the development of a comprehensive model that could be used to forecast the fiscal impacts of any energy-related development project in any area of the country, an early theoretical model for the estimation of future fiscal impacts is presented in detail. This model, developed by Hirsch¹⁰ in 1961, was conceptually similar to, and was assumed to have provided the framework for, the empirical studies referred to above. A careful examination of the limited applicability of this model, and of the empirical impact studies, to more than one area or more than one technology, emphasized the importance of the technical components chosen to be part of a truly comprehensive impact assessment model. Specifically, the analytical components of the Hirsch model are evaluated with respect to their data requirements, ease of application, and general informative nature.

Alternative and supplementary procedures are discussed later in the report and evaluated with respect to the same standards. In the final chapter, the Argonne model that incorporates procedures to satisfy these requirements is presented and its operation described.

2. A REVIEW OF RECENT IMPACT STUDIES

In this section, a number of empirical studies purporting to measure the future impacts of energy resource and/or industrial development activities on various regions of the country are critically reviewed. The criteria upon which these studies are evaluated are taken from a recent study by Gilmore and Duff.⁵ Their study, which looks back at the boom conditions in Sweetwater County, Wyoming during the early years of development, explains the critical factors that contributed to the deterioration in the quality of life. The relevancy of the factors considered and the methodologies employed by each of the studies reviewed in this section are gauged by the criteria derived from the Sweetwater study.

The studies reviewed fall into two general categories: 1) those that attempt to measure only the magnitude of future expected growth (as defined by the expected increases in population, employment, and/or income) associated with the development; and 2) those that estimate these parameters and use them to predict the ability of the region's institutions to accommodate this increased growth. While the studies in both categories are evaluated by the criteria derived from the Sweetwater study, a critical analysis is also made of the strengths and weaknesses of the various techniques that the studies use to generate their ex ante measurements. A brief evaluation of the relative merits of these techniques is made in the concluding portion of this section.

2.1 THE ECONOMIC IMPACTS FROM NEW DEVELOPMENT

A recent study by Gilmore and Duff⁵ looks back at the boom conditions that existed in Sweetwater County, Wyoming during the years 1971 to 1974. This study is important because it identifies the confluence of events that contributed to the significant problems that Sweetwater experienced as a result of rapid industrialization. Because this study focuses on identifying and explaining the impacts that a regional area (i.e., Sweetwater County) actually experienced following industrialization, it provides a framework within which to evaluate the relevance of the impacts considered by the studies to be reviewed in this section.

In their analysis of the problems experienced in Sweetwater, Gilmore and Duff⁵ found that:

... the financial stability of municipalities and schools has been threatened; both capital and operating funds are inadequate. Not only has local government (the public side of the local services sector) suffered, but the private side, e.g., housing, retailing, has also fallen behind booming demand based on a doubling of population between 1971 and 1974. The entire local service sector is underserving the community with goods and services. In addition, the intangible people-supporting activities are no longer adequate ... The overall quality of life has declined in Sweetwater County with the boom.

The authors observed that the impacts outlined above are both interrelated and self-perpetuating. They concluded that in situations of rapidly occurring economic growth, large increments in regional employment and population could be accommodated only if additional capital was invested in the expansion of local services in a timely fashion. If this capital is not forthcoming, the local service sector cannot expand sufficiently to meet the increased demand for local goods and services with the result that there is less for everyone. This degrades the quality of life in the area and encourages people to leave. As out-migration takes place, the local supply of labor falls relative to demand and productivity in both the basic as well as the service sectors of the local economy declines. As Gilmore and Duff pointed out, this cycle of events was precipitated by the failure of the local service sector of the impacted community to keep pace with growth-induced demand. Under conditions of less rapid growth or in areas characterized by a diversified and mature economy, the normal operations of the competitive market system can be relied upon to automatically provide for the necessary productive inputs to accommodate the growing demand for local services. However, in areas that lack skilled workers or industrial diversity, new industrial development is likely to exceed the capacity of the local economy to provide the increased service needs of a growing population.

As the Sweetwater County study stresses, the cycle of deterioration that was experienced there was directly attributable to the failure of the supply of local services to keep pace with the increased demand. In order to avoid the problems experienced in Sweetwater, public officials in areas expecting rapid development must be made aware of, and assume the responsibility

of providing for, the future demands for services before actual development is allowed to begin. Therefore, impact studies, in order to be effective, must make these officials aware of, and help them prepare for, the required future additions to their service institutions. Thus, not only must the timing and magnitude of growth be forecast to indicate resulting demands for services, but an estimate must also be made of the future financial capacities of these jurisdictions so that they can determine whether the required services can be provided when needed.

Based on the observations made in Sweetwater County, the criteria for effective analysis of future impacts from development can be simply stated:

1. The future increases in the growth of individual communities within a planning region must be estimated on an annual or periodic basis. These estimates serve as a basis for forecasting the periodic increases in demand for local public services.
2. Given these estimates of growth, the ability of the local community to meet its expected future needs must be examined. The costs of expanding services, when demand is estimated to exceed current capacities, must be calculated.
3. The estimates of growth in population, employment, and commercial activity must be used to estimate the increased public revenues available to provide these expanded services. Given this information on a period-by-period basis, local officials can effectively budget for the required addition to local public services, thereby mitigating or avoiding the cycle of deterioration that Sweetwater County experienced.

Future impact studies of this type that satisfy these criteria prepare local and regional planning officials to assess, before submitting to the proposed project, whether it would lead to a decline in the availability of local services and, hence, to a general decline in the quality of life. Further, such ex ante analysis enables communities to identify potential shortfalls in future services and to evaluate the effectiveness of alternative plans for meeting future needs. This type of analysis could also be used to advantage by national energy planning officials to evaluate the relative impacts of alternative energy development proposals among various regions.

In the remainder of Chapter 2, a number of economic impact studies are reviewed. These studies are broadly classified on the basis of which, if any, of the above criteria they fulfill. Those studies that attempt only to predict local and regional growth in population, employment, and/or business activity are discussed first, followed by a number of studies that generally attempt to satisfy all three criteria. Within each section the level of detail and the methods of prediction and analysis employed by the various studies are contrasted and discussed.

2.2 FORECASTING GROWTH ASSOCIATED WITH LOCAL DEVELOPMENT PROJECTS

The introduction of a new industry within a particular region will have "direct," "indirect," and "income-induced" effects upon its future growth in employment and business activity. For example, the new plant will provide "direct" employment to a number of new workers. However, the addition of this new plant to the regional economy will mean that other regional businesses and industries will be stimulated and as a consequence will hire additional workers. This new increase in employment is "indirectly" related to the presence of the new plant. Finally, these additions to employment in the region will, in turn, lead to increased regional income and hence to an increase in consumer demand. This increased income will "induce" still further increases in regional employment. Thus, the "total" effect of the presence of new industry within a region will result in direct, indirect, and income-induced increases in regional employment. In this section, three studies are reviewed that have attempted to forecast the total effects of new local development projects on the growth of employment, population, and business activity.

Helgeson and Zink⁶ conducted a case study of rural industrialization in Jamestown, North Dakota. Four new firms (representing the food processing, aerospace, farm machinery, and mobile homes industries), which were recently attracted to this area, were polled to determine the amount of money they spent locally within thirteen specific economic sectors. Using an input-output model, and treating these locally spent sums as exogenous increases in final demand, the total effect on the gross business volume of the thirteen economic sectors was estimated for Jamestown and its surrounding nine-county planning region. On the basis of these estimates, the authors concluded

that future impacts on the region from the existence of these four new firms would be negligible. However, these conclusions about future growth in Jamestown depend crucially on the use of input-output analysis.

Input-output models attempt to simulate, in matrix form, the interrelationships among the industries and economic sectors in the area being analyzed. The original matrix (referred to as the "transactions matrix") shows the output sold by each industry or sector listed on the left-hand side of the table to each industry or sector listed at the top. Each column shows the purchases made by that industry or sector from the industries or sectors listed in each row. The processing segment of this table is a square matrix containing only the region's producing industries in its rows and columns. By dividing each entry in each column by the gross output of the industry represented by that column, a table of "technical coefficients" is obtained. This table illustrates the amount of inputs required by each industry from all other industries in order to produce one unit of output. Thus, this table displays the linearized production functions for each industry. And, because these coefficients are scalars, the assumption is tacitly made that these industries are characterized by fixed-proportions production functions; that is, no change in the input proportions is assumed to occur in any industry. Obviously, if the relative prices of inputs change, new technologies are discovered, or new industries enter the region, the assumption of fixed-proportion production functions is made increasingly unrealistic. And, as Miernyk¹⁷ points out, the longer the forecast period for which these tables are used, the more likely these changes are to occur. Therefore, input-output (I/O) tables become less reliable as the length of the forecast period is extended over time. By taking the difference between the identity matrix and this matrix of technical coefficients and inverting, a matrix of "direct and indirect coefficients" is obtained. This final matrix shows the manner in which an increase in the final demand for a particular industry stimulates production in all other regional industries.*

Unfortunately, the authors failed to discuss either the source or timeliness of the data used to construct the matrix of technical coefficients.

*For a more complete discussion of input-output models generally, and these three matrices in particular, see Miernyk.¹⁷ A more detailed description of the use of I/O tables in constructing regional multipliers is presented in Section 4.1 of this report.

As is well known, the technical coefficients reflect the intersectoral expenditure patterns for a particular geographic region at a particular point in time. The practitioner must then assume that the fixed-proportion production relationships (an extremely restrictive assumption) that this table reflects will remain constant and invariant, at least for the period covered by his analysis. Obviously either the use of technical coefficients that no longer accurately reflect the intersectoral relationships of a given region or the use of technical coefficients not specifically derived for the region under study will badly distort the analysis.

In a study of the impacts of alternative levels of coal-related energy development on population, employment, and gross business volume in an eighteen-county area of Southwestern North Dakota, Leistritz et al.¹⁴ found that major coal development could cause drastic changes in the regional economy. Estimates of the local expenditures made by the basic industry for each alternative level of development were assigned to the sectors from which the inputs were purchased. Using a thirteen-sector I/O model constructed in 1965, direct and indirect coefficients were applied to these direct expenditures to obtain estimates of the total effects on the gross business volume of the region for the years 1980, 1985, and 2000 for each level of development. By using an input-output model consisting of technical coefficients, which reflect the extant intersectoral expenditure patterns in 1965, the authors are assuming that no essential change has been made in the regional economy to date, and, further, that no essential changes will be made until at least the year 2000.

Given the estimates of total gross business volume for 1980, 1985, and 2000, a ratio of gross business volume per worker was used to predict the level of employment in the region during each of these periods. Finally, the changes in population for these periods were estimated by applying projected participation rates to the total employment estimates. Both the ratio of business volume per worker and the labor force participation rates were constructed by extrapolating from historic data.

In a similar study conducted by Leistritz and Hertsgaard,¹⁵ the authors estimate the effects of alternative levels of local energy-related industrial development on population, employment, and gross business volume for an eight-county region in Southwestern North Dakota. Given estimates of the direct employment and local expenditures anticipated for each level of development,

the total gross business volume was estimated in a manner similar to that used in the preceding study. However, total employment was derived using an employment multiplier. The level of total regional population accounted for by the direct and indirect effects of energy-related development was computed by multiplying the total employment figure by the population-to-employment ratio.

Each of these studies satisfies the first of the set of criteria outlined above; i.e., each measures the total increase in regional growth associated with the development of new industry. However, the level of analytical detail varies considerably among these studies. For example, only one of these studies attempts to introduce time into the analysis. In Leistritz et al.¹⁴ the levels of business volume, employment, and population were estimated for the years 1980, 1985, and 2000. Secondly, none of these studies attempted to measure the total increases in these parameters within individual communities. Even the study by Helgeson and Zink⁶ of the Jamestown area developed growth parameters only for a nine-county planning region. However, the major impacts of industrial development will be most severely felt at the community level. That is, an addition of 1000 new employees (and their families) have far greater implications for a community of 1000 people than for a region containing 30,000 residents. If a new development project is estimated to require a total of 1000 new employees, it is essential that they be assigned to the smallest possible jurisdictional levels in order to gauge specifically their potential impacts on the socioeconomic structure of these communities.

With respect to the methodologies employed by these studies, each chose to rely on input-output (I/O) analysis to generate estimates of future regional growth. In fact, the I/O models for these studies came from the same general source.* However, as the discussion indicates, the use of an essentially static technique to predict long-run economic growth in areas undergoing dynamic change can lead to errors in estimation. This point is be developed more fully in Section 4.1.

In the following section, a number of studies are reviewed that purport to forecast the effects of industrialization on the future capabilities

*The studies each referenced the input-output model prepared by North Dakota State University during the mid-1960s.

of localities and regions to provide adequate services to their growing populations.

2.3 REGIONAL GROWTH AND FUTURE FISCAL IMPACTS

Many recent socioeconomic impact studies have attempted to forecast the effects of local industrial development on the community's fiscal capacity to meet the need for increased public service expenditures and on the expected increase in local public revenues to meet these expenditures. The studies reviewed in this section, therefore, at least conceptually, satisfy the three criteria mentioned above. However, these studies differ markedly with respect to the level of analytic detail that they contain. The most obvious difference among these studies of the future fiscal impacts of industrialization is the manner in which the initial forecast of regional growth is made. As indicated above, the introduction of a new industry (e.g., a coal gasification plant or an electronics firm) will have direct, indirect, and income-induced effects upon the future growth of an area. While each of the studies discussed in this section attempts to forecast the effects of industrial growth on the fiscal capacities of regions to respond to increasing service needs, a number of them consider only the direct increases in employment, population, and business activity. In terms of the criteria outlined above, such studies satisfy the second and third, but are deficient with respect to the first. In these studies, the direct employment of the new industry is used to indicate the total number of new workers required in a particular area. Also, the wages paid solely by the new firm are used as the measure of the total increase in personal income accruing to the region. Thus, in these studies, the indirect and income-induced stimulus to regional growth from the new industry is ignored. Therefore, the total growth of the region is understated, and, as a consequence, the future demand for public services and the future availability of public revenues are also understated.

For expository purposes, the studies of the future fiscal impacts from industrialization are segregated on the basis of whether they consider only these direct effects or whether they attempt to analyze the total impacts of new industry on the provision of public services. In the following subsection, those studies relating to direct industry-induced effects on the fiscal resources of a region are presented.

2.3.1 The Direct Impacts

In these studies an attempt is made to determine whether a community or region will possess adequate future public revenues to provide the services required by the families of the new employees directly hired by the new industry. That is, an attempt is made to determine the direct contributions made to local public revenues by the firm and its employees and to match these against projections of the future public expenditures required by these new employees and their families.

Lowenstein¹⁶ questions the general belief that industrial expansion benefits local communities by increasing their tax bases. In order to determine whether, and in what instances, this is true, Lowenstein studied three suburban communities that had recently attracted various types of industries. By examining the actual revenues contributed to the communities by the individual firms and comparing these figures to the increased costs of local public services attributable to the firm's new employees and their families, the author concludes that industry does not always contribute in direct public revenue what it causes to be expended for additional public services. While this study examines what has actually happened following local industrialization, Lowenstein uses the results of his study to forecast the outcome of industrialization in communities not yet impacted. He found that those industries that have high values of assessment per employee and tend to hire local employees rather than importing workers from outside the region will generally contribute positively to the fiscal resource base of the community.* Thus, the attraction of labor-intensive industries by rural areas having a limited labor pool would mean, ceteris paribus, that the community would be unable to finance the required increases in public services from direct tax revenues contributed by the plant.

Using the same analytical procedure, Garrison⁴ found that a negative fiscal impact was most likely when the new firm was granted property tax concessions or when its physical plant was city-owned and not subject to local taxes. In addition, the author found that the fiscal impact was not uniform among the several units of local government. That is, revenues may fall far short of the required expenditures at the school district level while they

*Similar conclusions were drawn by Kee¹¹ and Garrison.⁴

may exceed expenditures required by the county. In fact, Garrison found that county governments were least affected by local development. This is an important observation since it illustrates the need to examine the impacts of local development at the community and school district level in order to gauge specific impacts of local industrialization.

Both Hill⁷ and Callahan and Callahan² attempted to measure the direct impacts of coal development on counties that are currently being strip-mined by comparing them to adjacent counties that are not being mined. Both studies assumed that the differences in economic conditions between the adjacent counties were attributable to the presence of the coal industry in the strip-mined counties. Furthermore, each study assumed that these observable differences (i.e., the net effect of the presence of the coal industry) would be felt in other counties that were to be mined at some future date. Neither study, however, reported significant differences in the economic conditions of the adjacent counties. For example, Callahan and Callahan indicated only that unemployment was somewhat higher and assessed evaluation somewhat lower in the coal county.*

For purposes of assessing and projecting the impacts of local industrial development, the intercounty comparison technique employed by these studies is somewhat deficient. As Callahan and Callahan point out, differences in the economies of individual counties may be solely a function of the differences in the preferences of the residents for varying levels of public and private services. Because counties are independent governmental units, the burden of local taxation and the provision of public and private services are influenced by the political process, quite independently of the level of industrialization. In addition, as previously observed, the level of aggregation implicit in intercounty comparisons fails to obviate the true impacts of local development on local communities. In summary, comparing two counties, differing only with respect to their degrees of industrialization at a point in time, is of only limited value in estimating the future regional impacts of industrialization.

*Seitz,²⁴ in a study of the decline in local revenues experienced by Illinois counties currently being strip mined, found that assessment practices appeared to have been "designed" to reduce public revenues as strip mining became more intensive.

In a study prepared for the Western Gasification Company (WESCO),²⁵ the future economic impacts from major economic development are given greater emphasis. WESCO has proposed to build four gasification plants in San Juan County, New Mexico. Using estimates of the future construction and operating personnel required to build and maintain these facilities, the total annual increase in regional employment is projected into the future. The existing regional population and its labor force participation is analyzed and estimates are made of the number of new immigrants required to support these new facilities by subtracting the number of local employees from the total number of new jobs. These data are used to indicate, in a general way, the severity of the impact of local development on the demand for local services.* In addition, WESCO provides estimates of its future tax and royalty payments within the region. However, no attempt is made to determine whether the increase in direct public revenues would be sufficient to cover the increased costs of providing community services for the new employees and their families. Still, the annually projected increments in population and revenues directly occurring from the development provide a basis for such revenue -- expenditure analysis.

From the standpoint of providing communities with the kind of timely information required to mitigate the economic impacts of proposed development, the method of analysis employed in the WESCO study seems most valuable. While both Garison and Lowenstein were able to isolate and quantify the increases in local revenues and expenditures attributable to the presence of new local industries, their methodologies did not permit them to adequately forecast such effects in communities for which industrialization is only proposed. Obviously, the studies by Hill and Callahan suffer from a similar deficiency. With the exception of the WESCO report, conclusions as to the future economic impacts of local industrial development were based on extrapolations and generalizations from past or current observations of previously impacted areas. While the estimation of the future effects of new industry on local revenues and expenditures is vital for effective planning, the analysis must proceed from an examination of the community's current fiscal resources and estimates of the actual manpower requirements associated with the new facility.

*A simple employment multiplier was also used to indicate the magnitude of the indirect effects of the development.

While the WESCO study assessed the economic and demographic characteristics of the county prior to development and proceeded to overlay these conditions with the increases in employment and population associated with the gasification facilities, no attempt was made to evaluate the net fiscal impact of the regional development. That is, the increased revenues contributed by the facility in the form of taxes and royalties were not weighed against the increased costs of providing public services to the new employees and their families. In the following section, the concept of net fiscal impacts is more precisely defined and demonstrated by focusing on several recent studies that have attempted to measure both the direct as well as the indirect effects of local development.

2.3.2 The Total Impacts

The studies in this subsection attempt to examine the local fiscal impacts of industry-induced growth -- direct, indirect, and income-induced. That is, the increased services required to accommodate the new families of workers hired directly by the new plant, those hired by other local support firms, and those employed in retail trades that expanded as a result of the increased regional income are projected and contrasted with the estimates of the increase in local public revenues contributed by each of these groups. The concept of the "net fiscal impact" referred to in many of these studies is simply the balance, either annually or over the entire expected life of the new industry, of these projected increases in public revenues and public expenditures. It is used, therefore, to indicate whether the communities (and regions) will have sufficient resources to provide the necessary future public services. That is, it enables local and national planning officials to determine whether the cycle of deterioration experienced by Sweetwater County, Wyoming is likely to be repeated in any area currently under consideration for either new energy-related development or any other form of commercial or industrial expansion.

In this subsection, a number of studies are presented that generally examine the fiscal resources of a region following development. However, the methods employed and the levels of detail included in these studies vary considerably. As in the previous sections, the analytical procedures underlying the general approaches used in the various studies are critically compared and evaluated.

In what is best described as a theoretical analysis, Kee¹¹ challenges the cursory nature of studies that compare the contributions to public revenues made by new industries to the increased public expenditures that are directly attributable to them. The author contends that local planning based on such evidence is clearly unsatisfactory. In a test of this hypothesis, Kee evaluates the marginal impacts of five new firms on the town of Brooklyn, New York. Unfortunately, his methodology is similar to, albeit more sophisticated than, that employed by Garrison⁴ and Lowenstein.¹⁶ While he finds that the total effect of industrial development on the community is positive for only three of the five industries examined, his methodology is inappropriate for use in assessing the future impacts of local development on the fiscal resources of a particular area. That is, the analysis conducted by Kee is essentially ex post. He examines the community after the effects of industrialization have been felt and then proceeds to analyze whether the new industries have caused per capita public revenues to rise or fall while per capita services are allowed to grow at an appropriate rate. Thus, to evaluate the future effects of a new development project on a given region, the analyst, using Kee's approach, would be forced to draw comparisons among the area and industries studied by Kee and those expecting the impact. In the remaining studies, the analysis is essentially ex ante. That is, methods are developed and used to predict future impacts rather than explain previous effects.

In his study of the economic implications of coal development in Southeastern Montana, Polzin²⁰ focuses on two concentric regions. The primary impacts are assumed to occur in the three-county region surrounding the development. However, Polzin also examines the effect of the development in a larger, seven-county region that includes the smaller primary impact area. Given estimates of the personal income contributed by the industry to both regions during 1980 and 1985, the total increase in regional income is calculated with the use of income multipliers. That is, secondary income is made a function of primary (industry-related) income in both regions. The income multiplier for the seven-county region is found to be greater than that for the primary region; a result that is at least intuitively correct. Given total regional income indirectly and directly contributed by the new development for the years 1980 and 1985, Polzin attempts to anticipate the level of total regional employment during these periods. Dividing secondary

(i.e., derivative) income by the average earnings of derivative workers, the level of secondary employment is obtained. However, Polzin recognizes that the average earnings of derivative workers will be influenced by the availability of such workers in the resident population. By establishing estimates of the future regional population and their labor force participation without major regional development, he determines the size of the resident work force during the years 1980 and 1985. Then, using an iterative procedure, he simultaneously solves for the expected population the number of derivative employees and their average wage during 1980 and 1985. Finally, given the expected population of the concentric regions following development, Polzin estimates their impact on the fiscal resources of both regions. Unfortunately, the new families attracted to the regions as a result of the coal industry are not allocated to particular geographic areas for the purpose of analysis. This lack of specificity in the geographic distribution of the incoming population prevents Polzin from accurately assessing the impact of development on local revenues and expenditures. Thus, while he is led to conclude that industrial development will contribute positively to the net fiscal resources of the entire region, Polzin must caution that his conclusions are only rough approximations.

In his Master's thesis, Prestgard²¹ conducted a more detailed analysis of the impact of coal development on a regional economy. Given estimates of the future annual expenditures made by four proposed gasification plants and mines to the retail and household sectors of the Mercer County, North Dakota economy, Prestgard computed, using a regional input-output model, the direct, indirect, and induced gross dollar volume accruing to the household, retail, and "all other business" sectors of the local economy. These estimates represent the annual increases in household income and local business volume. By applying various state tax rates (e.g., sales tax, income tax, etc.) to these estimates, the annually recurring increments in state revenues were derived. The nonrecurring increases in state revenues were calculated by assigning the capital costs of constructing the new plants, new retail and commercial establishments, new public facilities, and new residential housing to the appropriate sectors in the final demand vector and applying the procedure discussed above. County and local revenues were assumed to come exclusively from the property tax. Appropriate rates were applied to the value of the plants and mines, the new local business structures, and estimates of

residential housing in place. As mentioned earlier, the allocation of the new primary and secondary employees and their families within the region, and the assumptions made concerning their choices of residence (simple family homes, trailers, apartments), will alter the anticipated increases in property tax revenues. In this study, two extreme settlement patterns were considered. The effects on property tax revenues under each scenario were found to differ dramatically. Concomitantly, the impacts of the new population on such publicly provided services as education, roads, police and fire protection, and social services varied considerably under the alternative settlement scenarios. In fact, the estimated increases in recurring local public expenditures ranged from \$.7 to \$5.7 million, while the estimates of increased local revenues varied from \$4.2 to \$7.7 million. Prestgard's results neither confirm nor deny the hypothesis that coal development in Mercer County will contribute positively to the region's net fiscal resources.* These disparities underscore the importance of being able to forecast accurately the approximate settlement patterns, housing preferences, and family characteristics of the incoming population.

In a study prepared for the Old West Regional Commission,³ special consideration was given to estimating the spatial distribution of the incoming population. This study also introduces the use of an employment multiplier as an alternative to the input-output tables and income multipliers used in the preceding studies. The report attempts to measure the net fiscal impacts of coal-related development on the State of North Dakota, Mercer County, and several individual communities and school districts. The impacts on these various jurisdictions were further stratified with respect to whether they were expected to occur during construction of the facilities or during their operation. The study concludes that the net fiscal impact on local public revenues and expenditures will be negative during the construction phase and positive by the mid-1980s when the facilities are in operation.

Given estimates of the number of operation employees required to staff the facilities in the mid-1980s, the size of the secondary work force was estimated with the aid of a rather simple employment multiplier. The

*The analysis conducted by Prestgard is similar to, and in fact was made a part of, a study conducted by Leholm et al.¹² of the economic impacts of one coal gasification plant in Mercer County, North Dakota.

multiplier was constructed by examining the recent historical ratios between primary and derivative (i.e., secondary) employment. The ratio indicates the number of local secondary employees required to support an additional primary worker. The multiplier for Mercer County was determined to be 1.5. This means that for every primary (i.e., basic) employee, one and one-half local secondary workers will be hired in service-related occupations. While rather crude, the employment multiplier provides a more direct linkage to the estimation of population, the most important parameter for determination of net fiscal impacts. Use of I/O tables or income multipliers requires that the estimates of gross business volume or aggregate personal income be translated into estimates of increased employment and then into estimates of total increased population. Obviously, the use of an employment multiplier eliminates the necessity of specifying an arbitrary relationship between business volume and/or income and employment. In addition, the employment multiplier is preferable to the input-output model because it can be computed both easily and inexpensively. Therefore, it is easily updated. Input-output tables that are badly out of date are often used simply because the process of updating them is both time-consuming and very costly.

Having determined the employment multiplier, total additional employment (primary and secondary) was derived for Mercer County as of the mid-1980s. By estimating the number of new employment opportunities that would have to be filled by workers from outside the region and multiplying by average family size, the total increase in Mercer County population during the mid-1980s was derived. Recognizing that this influx of people would have greater impacts on some communities within the county than on others, an attempt was made to anticipate the manner in which the new population would distribute itself among several small communities within commuting distance of the plants and mines. A simple gravity model was used for this purpose. It was assumed that choice of location would be a function of the community's size and its distance to the development. Once the new population was apportioned among the several small towns, the impact on local public services was examined. This study analyzed extensively the current capacities of the local services and their per capita expansion costs. Thus, the estimates of required increased public expenditures reflect actual conditions in real communities and school districts. These estimates of increased public expenditures were compared to equally reliable estimates of the increased public revenues that

the new population, new retail businesses, and the plants and mines would contribute to the various jurisdictions. Beyond a simple determination of the net fiscal impacts, which each jurisdiction might expect during a single year in the mid-1980s, this study presents the soon-to-be impacted communities with a remarkably clear picture of their economic environments ten years hence. However, the study would have been improved if the impacts from development had been estimated for each year of the expected life of the development. By placing the impacts into a temporal framework, the communities would have had a better picture of how to adjust to the short-run negative fiscal impacts by "borrowing" against the positive impacts that are expected in the more distant future.

Leholm et al.,¹² have attempted to estimate the year-by-year net fiscal impacts of a single coal gasification facility on Mercer County, North Dakota. While such an approach represents an advance in the state of the art, the analysis is less precise than that conducted in the preceding study. The authors find that the net fiscal impact for the State of North Dakota will be positive throughout the expected life of the gasification facility. However, at the local level, the net fiscal impact is estimated to be severely negative during the early years. By analyzing these impacts annually for thirty years, the authors are able to indicate that the cumulative local net fiscal impact will not be positive until approximately the twentieth year of operation.

Although the study is confined to an examination of the local impacts at the county level (i.e., no multicounty region is designated), they use an input-output model to generate their estimates of the direct, indirect, and income-induced effects on gross business volume. Given that the "region" of analysis is confined to a single county, the input-output table must be specifically constructed to reflect only the intersectoral relationships of the sectors and firms of that county. Constructing a usable I/O table for a small, essentially rural county is not an easy task. And, it is one that must be replicated whenever the region of analysis changes to another county. Assuming fixed relationships between business volume and employment and population, the authors must rely on these estimates of gross business volume to derive the more critical parameters of expected future employment and population for each year in the life of the development. In addition, the fact that

exogenous annual changes in the final demand for regional factors of production will eventually give rise to indirect and induced stimulation within the local economy does not imply that these iterative effects will be realized within a single year. In fact, it may take as many as three or four years for the full effect of each new annual stimulus to be felt. Estimating these lags with the essentially static input-output technique is quite difficult. Therefore, the annual effects of the gasification plant may be overstated, particularly in the early years of construction and operation. Finally, while the net fiscal impacts were computed on an annual basis for both the state and the county, no attempt was made to examine the impacts on individual towns or school districts.

The studies examined in this subsection demonstrate the feasibility of satisfying the criteria for economic impact analyses outlined in Section 2.1. The majority of these studies attempted, by various means, to project the total effects of industrial development into future periods and to estimate the net fiscal impacts on jurisdictions as small as local communities and school districts. In the final section of Chapter 2, a brief overview of the various empirical methods used to predict these future impacts is presented.

2.4 AN OVERVIEW OF EMPIRICAL METHODS

Obviously, from the standpoint of identifying the potential economic impacts of the types that contributed to the problems experienced in Sweetwater County, the kinds of studies reviewed in the previous subsection provide the most complete and useful information. By quantifying the future expected increases in regional population, employment, and business activity resulting from both the new industry directly and the stimulus to the secondary or local services sector indirectly, these studies attempt to approximate actual future conditions in the region. While this type of information is similar to that provided by the studies reviewed in the first section of this chapter, these latter studies demonstrate that such projections can be put to more informative use; that of indicating the precise nature and expense of expanding publicly provided services to accommodate these increases. Further, if given a temporal framework, these latter studies demonstrate a capability to balance the required expenditures of public funds to the availability of increases in public revenues.

Beyond revealing the conceptual feasibility of satisfying the three criteria taken from the Sweetwater County experience, the empirical studies reviewed here have demonstrated the use of a wide variety of analytical and informational procedures and techniques. A number of these are summarized below.

Among the studies that attempted to forecast the net fiscal impacts of local development projects, extensive data gathering activities were required. The analysts had to have information on the capacities of local service institutions and organizations, the costs of providing these services, and the taxing institutions available to the local communities. In fact, before the projections of future impacts could be made, a profile of the community and the region had to be constructed. The number of current residents, their demographic characteristics, their availability for employment, and their consumption patterns had to be determined in advance of the empirical analysis. As alluded to in the review of the various studies, there were considerable variations in the extensiveness of the profile information collected.

However, even if considerable effort is devoted to the collection and interpretation of such data, the estimates of future net fiscal impacts can be no better than the analytical techniques used to generate the projections of future growth. These studies made use of a variety of techniques to estimate future regional employment opportunities and the size of the immigrating population required to fill them. The analysis of the individual impact studies indicated that these estimates of secondary or indirect effects influence the entire analysis of future impacts. Therefore, a great deal of care is required in the construction and use of multipliers. The multipliers used in the studies reviewed, with few exceptions, were taken from input-output models of the regions being studied. As mentioned repeatedly, a number of problems are associated with the use of I/O tables, especially in sparsely populated rural areas. In almost all of the studies, multipliers, however derived, were used to provide estimates of the increased demand for local services; that is, they were used to indicate the expected size of the future population. Thus, in studies that relied on the use of input-output models, the expected increase in gross business volume (estimated by the table of direct and indirect coefficients) had to be transformed into estimates of

the number of new jobs available in the area. This was generally accomplished by determining the ratio of business activity to employment. Finally, these new jobs had to be transformed into estimates of the increase in area population. Again, a simple ratio of population to employment was most often used to provide these estimates. Unfortunately, a number of extremely restrictive assumptions tacitly underly this rather complex estimating procedure. While income and employment multipliers were calculated directly in two separate studies, they were constructed as simple linear extrapolations of historic trends between exogenous and endogenous employment or income. Thus, they were unable to anticipate the extreme changes in regional character following industrialization. None of these procedures for constructing regional multipliers appear adequate to the task of accurately estimating the future demands for public services confronting local communities.

Finally, given the estimates of the regional population as of some future, arbitrarily specified data, in almost all of the studies reviewed here, no attempt was made to allocate this new population to individual towns and villages. As mentioned before, it is clearly at the smallest jurisdictional level that most of the impacts are felt. It is, for example, the local school district that must build new classrooms and hire new teachers, not the multicounty region. While several studies attempted to circumvent this problem by exploring different scenarios of possible settlement patterns, the wide variation in net fiscal impacts among alternative scenarios (from positive to negative in several cases) indicates that analysts must be far more precise if their results are to be of any use to planning officials. That is, it is insufficient, from a planner's point of view, to offer the comment that if people settle in this fashion the impacts will be modest, but if they settle in that fashion they will be totally unable to receive the required services. Rather, far more careful study of the locational alternatives available to an incoming population must be undertaken. From such analysis, a realistic settlement pattern must be developed so that local impacts can be accurately forecasted.

While the state of the art of socioeconomic impact analysis has surely been advanced in recent years, the comments made in this overview of empirical methods indicate that there is both room for, and a need to, improve upon the analytic and methodological procedures if future impacted communities are to avoid the problems experienced by Sweetwater County, Wyoming.

In the following chapter, an early theoretical model that appears to have provided the conceptual foundation for many of the empirical studies reviewed is outlined and critically reviewed. By focusing attention on this single theoretical model, the strengths and weaknesses inherent in the many empirical studies just examined are more effectively obviated.

3. THE HIRSCH APPROACH: A GENERAL FRAMEWORK FOR ANALYSIS

As early as 1961, Hirsch¹⁰ questioned the implicit assumption that economic expansion through local industrialization means net fiscal benefits to the jurisdiction in which the proposed development is to take place. In order to facilitate future empirical tests of the validity of this implicit assumption, Hirsch attempted to outline a systematic set of procedures that would both predict and quantify the impact of local economic development on a region's fiscal conditions. An abbreviated overview of Hirsch's model is presented in Fig. 3.1.

The model that Hirsch developed has two main elements: 1) regional input-output analysis and 2) a number of fiscal side calculations. The input-output analysis is recommended by Hirsch to provide estimates of the indirect and induced increases in employment, output, and income, given exogenously determined direct increases in employment, output, and income contributed to the regional economy by the new industry. Given the total (direct, indirect, and income-induced) increments in regional employment, output, and income, Hirsch uses a series of fiscal side calculations to translate these projections into estimates of the incremental regional tax payments and public service costs.

On the revenue side, the model that Hirsch proposes requires a number of simplifying assumptions. First, he suggests that there is a reliable and discoverable relationship between the increase in total output and the assessed value of new industrial and commercial establishments. However, if there is substantial excess physical capacity in the private sector, such a relationship may grossly overstate the increased value of new industrial and commercial facilities. A similar assumption is made concerning the relationship between personal income and the assessed value of residential property. Again, the simplistic nature of this assumption may result in seriously misleading estimates of new residential construction in the local community. If, as seems likely, large segments of the new labor force regard their tenure in the area as temporary, they may choose to live in trailers and boarding houses. Hence, the assumption that previously established relationships between personal income and residential housing will be continued during a period of rapid growth is likely to overstate estimates of the increased value of new residential housing.

Fig. 3.1. The Hirsch Model for Determining Future Local Fiscal Resources

Given these estimates of the increases in the assessed valuation of residential, commercial, and industrial properties, Hirsch applies the appropriate local property tax rates to these figures to arrive at an estimate of the increase in local property tax revenues. While the property tax is clearly the primary revenue source for local governments, Hirsch includes estimates of associated increases in total government charges, local government gross-receipt tax payments, and the local governmental sales tax. Certainly, different jurisdictions will have different sources of revenue and the analysis, which Hirsch presents as an example of how such computations might be made, would have to be changed to fit the particular circumstances.

On the cost side, similar simplifying assumptions are required. Given estimates of the total increase in regional employment associated directly and indirectly with the new industry, a labor force participation rate is implicitly used to generate estimates of the total new population. However, if the demographic characteristics of the new employee population differs substantially from that of the resident population, this estimate may lead to an over- or under-statement of the total increase in population. Further, by applying the current number of school-aged children per resident family to the estimate of the new population, the total number of new school children is predicted. The problem associated with the estimation of the new population may very possibly be exacerbated by this procedure. That is, there is no a priori reason to suspect that the incoming employees will either bring their families or, if they do, that these new families will have demographic characteristics similar to those of the permanent residents.

Once these estimates of the total increases in regional population and regional school-aged children are made, Hirsch simply extrapolates the associated increases in local public non-school and school costs from extant per capita figures. Such a procedure ignores the presence or absence of excess capacity in local public services. Thus, if local schools are operating at full capacity, the construction of new classrooms and the hiring of new staff will place a tremendous capital burden on the local district. Further, by applying current average, rather than marginal, per capita costs to the new population, Hirsch is assuming that constant costs prevail in the provision of public services. Given today's economic climate, this assumption is dangerously misleading. Even more serious is the fact that the estimates of

total new employment and population obtained with the aid of a regional input-output model are not spatially distributed. Regional I/O models are generally constructed to encompass relatively large geographic areas. The increased population derived from this analysis may be assumed to settle anywhere within this region. If the local net fiscal impacts are to be seriously studied, the precise location of the new families must be accurately determined.

The problems associated with the lack of spatial specificity apply with equal force to the determination of local revenues. However, the comparison of local public revenues with expenditures, and the estimation of the local net fiscal impacts, face a still more serious problem: the "timelessness" of the analysis. The input-output model, which Hirsch uses to derive the estimates of the additions to regional employment, output, and income following local industrialization, assumes that the iterative process of growth, represented by the various multipliers, is instantaneously achieved. That is, input-output analysis is essentially one of comparative statistics. Thus, given exogenous increases in the final demand for the output by sectors affected by the new industry, the I/O table simply shows the end result after all of the "feedback effects" have worked themselves out. That is, a period-by-period adjustment to the new equilibrium levels of growth is precluded. While attempts have been made to introduce dynamics into I/O analysis, these techniques are not yet fully developed.*

Hirsch¹⁰ points out that, "A region's net fiscal resource status makes possible an understanding of the fiscal position of a region (following industrialization) without reference to who are the individuals who carry the ultimate money burden of taxes and who are the recipients of services." While he suggests that the distribution of service costs and benefits be given separate treatment in any analysis of the economic impacts of local industrialization, he does not make such analysis a part of his general model. Because communities need to know both the level and incidence of the provision of public services following the introduction of new industry, a prognosis of their future fiscal resource status should be supplemented by an analysis of the degree to which an equitable distribution of these resources will be achieved.

*For a further discussion of the workings of the I/O table of direct and indirect requirements, see Miernyk.¹⁷ There are additional problems associated with the use of input-output tables that will be discussed in more detail in the following section.

Conceptually, the model outlined by Hirsch clearly satisfies the set of criteria listed in Section 2.1. In fact, Hirsch's suggestion that the relative incidence of services and taxes be studied adds a fourth criterion with which to evaluate the effectiveness of socioeconomic impact studies. However, this critique of the theoretical model developed by Hirsch indicates that the analytical and informational content of a methodology that satisfies these criteria is extremely important. First, both the choice of techniques and the extensiveness of the information gathered on the area being studied influence the accuracy with which the future fiscal impacts are measured. Second, in order to provide consistent estimates of the socioeconomic impacts attributable to local development projects throughout the country, the analytical procedures and the data required for their effective operation must be both "exportable" and "expandable." That is, none of the techniques in a general methodology should be limited in their applicability to specific regions. Further, these techniques must be capable of use in regions of varying size. For example, the methodology should be flexible enough to permit the analyst to examine the effects of new energy-related development projects on the future growth of the local community, the surrounding county, or a multicounty region without extensive new data requirements.

In the review of the general theoretical model proposed by Hirsch,¹⁰ the following analytical and informational components were singled out for criticism:

1. Multiplier analysis for growth parameters.
2. Demographic analysis of the new population.
3. Locational or spatial analysis of this population.
4. Temporal analysis of future growth.
5. Public service resources information.
6. Public revenue resources information.

In the following chapter, a variety of alternative and/or supplemental procedures are suggested for use in the estimation of these effects. Each recommended technique or procedure is evaluated with respect to: 1) the accuracy of estimates that it provides, 2) the ease with which it can be used in a multitude of distinct regions, and 3) the flexibility of its use in the same area but in regions of different sizes.

4. ANALYTIC PROCEDURES AND TECHNIQUES

In this chapter, a number of alternative, supplemental, or additional components are evaluated for their accuracy, exportability, and expandability. These procedures and techniques are then recommended for inclusion in a comprehensive model for the ex ante determination of the impacts from any energy-related development project on the fiscal resources of a region.

4.1 REGIONAL MULTIPLIER ANALYSIS

4.1.1 Input-Output Analysis

The model that Hirsch developed made use of regional input-output analysis in the determination of the total increase in employment, output, and income following local industrial development. As indicated in Fig. 3.1, the estimation of the direct and indirect increases in these parameters provides the foundation upon which all of the succeeding analyses are predicated. From a methodological standpoint, therefore, the technique used to provide regional multipliers must be both easily applied and consistently accurate regardless of either the socioeconomic or geographic character of the region being studied. Unfortunately, input-output models require major expenditures of both time and effort in their construction. In addition, no two separate regions can make use of the same I/O table, which means that the effort expended in the tailoring and construction of an input-output model for a specific region must be duplicated in order to study another area. In fact, the use of I/O analysis is effectively prohibited in certain very small regions that depend solely on a specific industry (e.g., agriculture) for their economic survival. All too frequently such descriptions characterize regions that expect major energy resource industrialization. Finally, due to the restrictive assumptions underlying input-output analysis and the poor quality of most extant regional data, the long-range forecasts derived from regional I/O tables are, in Miernyk's¹⁷ words, "... likely to provide only rough and broad guidelines."

Input-output models require vast quantities of current information about the interrelationships that exist among the various producing and non-producing sectors of the economy. However, the construction of regional tables, as opposed to models constructed for the United States' economy, involve special data problems. Miernyk has observed that most regional tables

have been based, until very recently, on the input coefficients taken from national I/O models. The reason for this is simple: Secondary data sources on regional economic activity are not well developed. However, if regional industrial interrelationships are extrapolated from national tables, there is an implicit assumption that regional trade patterns are identical to national patterns. Of course, this implicit assumption may seriously distort the predictive usefulness of regional tables derived in this manner. Moore and Peterson¹⁸ recognized this problem and attempted to construct an interindustry model of the Utah economy by modifying the national coefficients with all available information on individual industries and technical data gathered on the Utah economy. According to Moore and Peterson,¹⁸ "In cases where appreciable differences existed between Utah and national productive processes, an intensive examination of the industry would usually turn up the dissimilarity, and some change in the input structure would be suggested." This approach led to general improvement in the construction of regional models. However, its application required additional effort and expense, making regional I/O tables more difficult to construct.

Regional input-output tables were further improved by Hirsch⁹ in a study of the St. Louis SMSA. Using the Moore-Peterson model as a point of departure, Hirsch attempted "... to estimate [the] coefficients with the help of data obtained directly from a sample of private and public bodies, which together, constitute the St. Louis metropolitan area economy." Thus, the model constructed by Hirsch contained primary data on the St. Louis economy. While the reliability of the estimates derived from this type of model are clearly superior to those obtained by Moore and Peterson, the survey methods employed to obtain these data involved even greater expenditures of time and money.

This abbreviated history of the developmental evolution of regional input-output models makes the point that the increase in their predictive reliability is directly related to the time and effort expended in their construction. When this observation is juxtaposed with the fact that the production processes described in regional I/O tables are not geographically invariant (requiring that they be recomputed in every area), the usefulness of input-output models as the cornerstone of a general methodological approach to the assessment of the fiscal impacts of industrialization must be seriously questioned.

In addition, the regional input-output forecast is limited to the case of relatively short-term projections because the model upon which it is based is static. That is, once constructed, the regional I/O table assumes that there will be no change in the technical coefficients! Because the technical coefficients that comprise the cells of the transactions matrix describe the production functions of regional industries, this assumption requires that the production processes of all regional industries remain fixed throughout the forecast period. As Miernyk points out, this in effect means that no changes in the relative prices of inputs, no new industries, and no technological changes are permitted within the region during this period. Clearly, the longer the forecast period, the more likely such changes are to occur. Hence, the accuracy of the forecasts of the effects of local industrialization on the parameters of employment, output, and income must diminish as the forecast period is extended over time.

In Hirsch's¹⁰ general model, input-output analysis is used to derive regional output, income, and employment multipliers. While the computation of income and employment multipliers by I/O analysis is not a novel idea, it is also not the usual way in which input-output tables are used. In fact, constructing such multipliers from I/O tables is a rather complicated task, requiring several additional restrictive assumptions and a number of extra processing steps. For example, computing the employment multiplier, which is the most vital of these parameters, requires an I/O table of indirect and direct coefficients, employment-production functions, and a set of consumption functions. In their analysis of the impacts of a change in demand for employment in Utah, Moore and Peterson¹⁸ began by postulating the existence of a linear relationship between total employment and gross output for each industry.* Having derived the simple slope parameters of these relationships for each major industrial sector, the authors multiplied each of the cells in the matrix of direct and indirect coefficients by the appropriate industrial employment-production ratio to obtain the direct and indirect effects of a change in the final demand for a given industry on total employment.

*Specifically, the author specified that $E_i = a + bx_i$, where E_i is the total employment in the i^{th} industry and x_i is total gross output of that industry. Separate time-series regressions were run for each of the major industrial sectors in Utah and the coefficients (b) were interpreted as revealing the required increase in employment for a given increment in output in each industrial sector.

These simple employment multipliers show how much Utah employment is affected by a variation in each industry's employment. Finally, these simple employment multipliers were expanded in scope to include the changes in total employment that occur as a result of a drop in income and consumption.* Such multipliers that explicitly measure the income-induced effects on regional employment are generally referred to as "Type II" multipliers. As this brief analysis indicates, the process involved in computing employment multipliers from input-output analysis involves considerable effort and requires simplifying assumptions about the form and specification of both employment and consumption functions; i.e., linear in both cases.

This brief critique of the usefulness of regional input output analysis indicates that as a general tool for regional impact analysis, it has serious deficiencies. The primary problems associated with the use of input-output analysis are:

1. the computational effort required to construct the transactions table;
2. the fact that once constructed, I/O tables cannot be "exported" for use in other regions;
3. the computational difficulty and restrictive assumptions required to derive regional multipliers; and
4. the necessity of assuming that the productive processes of all regional industries must remain invariant over the planning horizon in order to be confident of its predictive accuracy.

4.1.2 Economic Base Analysis

Given these problems and the need to develop a general methodology that can be easily applied in a variety of different regions, an alternative computational tool capable of accurately estimating regional multipliers (specifically employment multipliers) with a minimum expenditure of time and

*In order to transform the simple employment multiplier from a measure of direct and indirect effects of a change in final demand to one that also included the income-induced effects, Moore and Peterson had to estimate a set of consumption functions and utilize them in a complex iterative procedure.

effort must be found. Economic base analysis, according to Richardson²² is capable of providing a simplified framework for the calculation of regional multipliers that are mathematically identical to the "type II" multipliers derived from input-output analysis. Both the I/O and economic base multipliers reflect the direct, indirect, and induced-income effects of exogenous changes in output.

Reduced to its essence, economic base theory suggests that the growth of a region depends upon the growth of its export sector. The implication being that expansion of demand external to the region is the driving force behind growth within the region. Thus, as Richardson²³ points out, an increase in the economic base of the region (i.e., all the exportable goods and services produced therein) sets off a multiplier process of growth within the local or secondary sectors of the regional economy. Using this theory as a foundation, economists and regional analysts have attempted to measure the relationship between exogenously determined growth in a region's basic (i.e., export) sector and the indirect and income-induced effects that this growth makes possible within the local (i.e., secondary) sectors. As mentioned above, the multiplier derived from this type of analysis is mathematically identical to that obtained with the use of input-output models. However, the process of analysis required to derive economic-base multipliers, even at levels of extreme sophistication, is relatively simple when compared to the effort required to prepare I/O tables and derive similar multipliers.

The specification of multipliers derived from economic base theory has taken many forms. In its most crude form, the employment multiplier for a given region is derived, using least-squares estimation, from the following equation:

$$E_s = a + bE_p \quad (1)$$

That is, secondary employment is postulated to be a linear function of primary (i.e., basic) employment. In practice, this relationship is fitted by first segmenting the industries of a particular region on the basis of whether their employment is, or is not, sustained by an inflow of external receipts. Employment in industries that are sustained by local receipts is considered an exogenous variable for the purpose of model specification; that is, its level

affects local employment but is not influenced by it. While the separation of regional industries on the basis of this criterion can range from easy to extremely difficult, there is evidence that whenever the analyst is in doubt of which category to assign a certain industry, no bias will result if he assigns its employment to the endogenous (i.e., secondary employment) category.*

Equation 1, which reveals the increase in secondary employment given a unit increase in primary (i.e., exogenous) employment, is greatly oversimplified. Implicit in this specification is the assumption that an increase in employment in any primary industry will have an identical impact on local secondary employment. Thus, a unit increase in manufacturing employment will have the same effect, "b," on secondary employment as a unit increase in transportation employment. Further, the relationship between primary and secondary employment is assumed to be constant, regardless of the size of the exogenous employment increase. This assumption ignores the existence of scale economies in the endogenous sector. Realistically, it can be expected that as larger exogenous increases in primary employment occur, regional support employment will increase at a decreasing rate. Finally, the character of the community receiving the exogenous employment will have a marked influence on the multiplier. That is, if the community is located close to a regional trade center, secondary employment increases may be much smaller than if the increase in primary employment should occur in relatively isolated localities. Such localities would have to provide support activities without relying on regional trade centers to absorb the increased demand. These are among the most difficult problems associated with the simple specification of Equation 1. And, to lesser degrees, these problems apply also to employment multipliers derived by input-output models. However, they are more easily remedied in economic base analysis.

²⁶
*Thompson²⁶ has argued that the separation of endogenous and exogenous employment is critical to the derivation of appropriate multipliers. He has developed a complex scheme, involving location quotients and specialization ratios, to accomplish this separation. However, Polzin¹⁹ proves, with a simple variance--covariance analysis--that the inclusion of some exogenous employment in the endogenous sector will not bias the estimate of the multiplier.

In a recent article, Bender and Coltrane¹ outlined a statistical model for the estimation of regional employment multipliers that explicitly dealt with all of the problems enumerated above. And, using cross-sectional data on 181 counties in the Northern Plains Province (Montana, Wyoming, North and South Dakotas, and Nebraska), they tested their model's performance. Using a single equation model, employment multipliers were constructed to measure the association between four separate exogenous sectors (agriculture, mining, manufacturing, and transportation) and local secondary employment. In addition, each sectoral multiplier is specified to vary with the scale of industry and the distance between the localities and the nearest regional trade center. In abbreviated form, the multiplier for each basic sector is expressed within the full equation as

$$E_X = b_1 X + b_2 DX + b_3 D^2 X + b_4 X^2, \quad (2)$$

where E_X is secondary employment associated with X , X is the employment in the basic sector, D is distance to the regional trade center, and the b_i are the estimated coefficients. Since the relationships are additive, the multiplier at the margin for each X is

$$\partial EX / \partial X = b_1 + b_2 D + b_3 D^2 + 2b_4 X, \quad (3)$$

which indicates that the change in secondary employment induced by a unit increase in each type of basic employment will vary with distance to the trade center and scale of industry employment.

Apart from the obvious advantages inherent in this specification, the fact that this model can be used to compare the effects of similar types of industrialization among various counties within a five-state region (without requiring one additional piece of information), makes this an ideal model for regional impact analysis.*

However, there remain problems associated with its use. For example, although the authors did not mention it, it appears necessary to assume that

*Bender and Coltrane include additional variables in their model specification for control purposes. Among these are measures of the institutional population in each county, college students, motel employees, and median family income.

each of the counties comprising the universe of observations are in a state of equilibrium with respect to their primary-secondary employment situation; i.e., that they have not recently experienced unreconciled increases in primary employment. Additionally, in order to apply the variable multipliers to a given county for a given infusion of primary employment, it is necessary to assume that the growth patterns of the subject county will be similar to those experienced by the universe of counties in the data base. Fortunately, the economic and geopolitical similarities among the counties in the Plains States are sufficiently strong to permit this assumption.

A particular difficulty inherent in this approach is that the amount of time required to adjust secondary employment to an instantaneous change in primary employment is not readily measured. Obviously, the lag in adjustment is of definite importance in assessing annual changes in indirect and induced employment and population. Thus, some method must be found to estimate the extent of the increase in secondary employment, which will occur in the first, second, and third years following the initial increase in primary employment. Lagged terms are precluded from inclusion in Equation 2 due to the necessity of assuming that the observations on each county represent fully adjusted employment situations; i.e., that the multipliers of Equation 3 reflect the total effect of primary employment. An obviously simple procedure would be to isolate a single county that has experienced recent growth and examine the increase in secondary employment in each of the three (or more) annual periods following the initial perturbation in primary employment. Because it is assumed that counties will grow in similar manners due to their homogeneity, the application of this trend to the subject county is not unwarranted. However, a promising, albeit untested, procedure may be substituted. This procedure would combine time-series and cross-sectional observations on fifteen counties that are currently undergoing growth in their primary sectors. Thus,

$$\begin{aligned} Ex_{72} &= a + b_1X_{72} + b_2X_{71} + b_3X_{70} \\ Ex_{71} &= a + b_1X_{71} + b_2X_{70} + b_3X_{69} \\ Ex_{70} &= a + b_1X_{70} + b_2X_{69} + b_3X_{68} \end{aligned} \tag{4}$$

In this case, each equation would have fifteen observations that would be treated as independent. However, data limitations and specification problems may preclude the use of this approach.

Regardless of the ultimate form of the lag procedure, the comprehensive methodology suggested by this study for appropriate regional impact analysis will make use of the modified economic base formulation just discussed. The critical nature of the estimates of regional multipliers requires that as much precision as possible be built into these estimates with a minimum of data gathering and computational effort. The procedure first outlined by Bender and Coltrane represents a significant contribution to the relatively easy estimation of consistent and accurate multipliers. With some modification, their technique will be made a part of the comprehensive methodology.

4.2 DEMOGRAPHIC ANALYSIS

Given accurate estimates of the total increases in employment opportunities following major industrialization, the increase in regional population must be obtained. In his model, Hirsch simply applied an average labor force participation ratio to the number of new jobs indicated by the employment multiplier to generate estimates of the increase in regional population. Two assumptions are implicit in this procedure:

1. All new jobs will be filled by people moving into the region, and
2. The family characteristics of this incoming population are identical to some regional average.

Neither of these assumptions is valid. First, unless there are no unemployed or underemployed individuals in the region, it must be expected that a share of these new jobs will go to the indigenous work force. Further, the new employees who move into the region in response to the employment opportunities will almost certainly not have family characteristics similar to the resident population. Thus a more complete analysis will be required if the employment multiplier is to be used to reveal accurate estimates of the increased regional population and its demographic characteristics.

First, a comprehensive survey of the population and employment of the region must be undertaken to obtain information on the current employment opportunities and the size and skill levels of the available labor pool. Because it is in the best interests of the new industry to hire local workers first (when possible), the total employment opportunities generated by the new industry can be reduced by the number of local employees with the requisite

skills who are looking for work. Only the remaining jobs will be filled by in-migrants. Next, from information obtained by surveys of construction and operation workers, the expected increase in total population can be obtained. It must also be recognized that the spouses of these primary workers may choose to accept employment in local secondary sectors. To the extent that this is done, the increase in total population will be further reduced. Given the demographic data obtained by the surveys mentioned above, the total increase in the regional population can be broken down by age and sex categories.* Given these data, accurate estimates of the uncreased demands for a variety of local services can be provided.

4.3 LOCATIONAL ANALYSIS

Using these procedures, a more accurate picture of the new regional population will emerge. However, simply knowing the size and demography of the new regional population is inadequate. The real stresses of the externalities produced by this new population will be felt on very localized geographic areas. It is these impacts that must be measured. Using the employment multiplier and the demographic studies outlined above, estimates of the new population expected by a given region are obtained. This new population must be assigned to particular towns and school districts within the region in order to truly assess future impacts. Therefore, a procedure is required that will enable the analyst to predict the settlement patterns of the new population. For this purpose, several variants of the standard gravity model were considered.

$$P_A = f(S_A, T_1, T_2) \quad (5)$$

It is assumed that the population choosing to settle in a particular community (P_A) will be influenced by both the size of the community (S_A), the time required to commute from that area to the work site (T_1) and the time required to commute to the nearest trade center (T_2). Depending upon the number and diversity of local communities in the region under study, the weight to be

*It should be pointed out that these surveys need not be repeated in each new case study. Because the migrating labor force is drawn from a national pool, it can be assumed that their characteristics will be similar in various regional locations.

applied to these variables will be obtained either by regression or by observation and a priori reasoning. The variables T_1 and T_2 are used as surrogates for the standard distance measures, since, in many areas, the lack of paved roads and climatological barriers such as mountainous terrain and heavy snow make simple mileage an inappropriate variable. This technique, while requiring separate analysis in each area under study, is easily computed. And, it provides sufficient flexibility to allow the opinions of local officials to actually determine by setting the weights, based on familiarity with local conditions, the most likely settlement patterns of new immigrants.

4.4 PUBLIC RESOURCES INFORMATION

Having determined the expected settlement patterns of the anticipated increase on county population, the impacts on local revenues and expenditures can be examined. However, much more detail is required for this analysis than was made part of the model outlined by Hirsch. First, a complete analysis of the current utilization, financing, and capacities of publicly provided services in each community must be undertaken. Specifically, both the ability of local jurisdictions to raise capital for future expansion as well as the excess capacities in existing facilities must be measured. From this profile of the localities, the ability of each to meet the anticipated needs of the future population can be derived. However, it is not sufficient to simply multiply the current per capita costs of these services by the incoming population. As the population increases, the profile reveals which facilities will have to be expanded first. It also indicates whether debt financing is available to provide these additions. Further, as facilities are expanded, and services increase, it is not likely that constant operating costs will be observed. Therefore, it seems more realistic to examine the operating costs of similar services being offered in larger communities as a measure of future costs.*

*For example, as a community grows it must increase its fire-fighting equipment. However, there is also a legally prescribed level of population at which a permanent staff of professional firemen must be hired. Obviously, the per capita costs of providing fire protection can be expected to jump significantly when this plateau is reached. Accurate forecasts of future expenditures require that these new operating costs be estimated.

In addition, it is not sufficient to merely assume that the property tax base of school districts, local communities, and the county will increase in some proportional manner with aggregate income or output. Instead, the survey of construction and operation workers should be used to indicate residential housing preferences. Of course, if a number of these new employees intend to live in trailers, the impact on new revenues to the various jurisdictions will be altered significantly. By obtaining information on the capacities and needs of the local private sector, estimates of required expansions in commercial and retail establishments can be more accurately obtained. Finally, attention must be paid to the transfers that each of these jurisdictions will receive from the state and federal governments as well as the increased royalty payments paid for the use of the region's natural resources. Information on the disbursements of these funds can usually be obtained from the office of the State Tax Commissioner.

4.5 TEMPORAL ANALYSIS

Once all of these pieces of information have been accumulated, the forecasts of revenues and expenditures must be put on an annual or biennial basis. One of the two alternative techniques for estimating the lags in the employment multiplier will be used to provide period-by-period increases in total employment, given the initial exogenous stimulus. Using the new industry's forecasts of its total future employment needs, this type of analysis will be conducted over the entire expected life of the development. In this manner, increments in expected public revenues and expenditures will be forecast by jurisdiction (school district, town, and county) for each period. If, as expected, the early years of development will produce negative fiscal impacts, with positive fiscal impacts occurring only much later, the failure to consider the annual or biennial changes in net impacts will yield results that will be of limited value to decision-makers.

While a period-by-period analysis of the net fiscal impacts permits a dynamic appraisal of local industrialization at the school district, town, and county jurisdictional levels, it omits consideration of the impacts on individuals. As industrialization proceeds, the effects of the changes in public revenues and expenditures imply changes in both the quality and quantity of locally available public services. However, even if revenues are

expected to keep pace with demand-induced expenditures, the burden of providing these revenues and the distribution of services may be altered. In particular, some local residents may find that they must bear an increasing proportion of the burden of paying for public services while their per capita share of services fails to rise commensurately. This maladjustment in the distribution of public costs and services involves the issue of equity. The final segment of this comprehensive methodology will be concerned with examining this issue. By cross-classifying the population with respect to age, occupation, and geographic location, the level of services provided to, and the average burden demanded from, each category will be systematically analyzed. Given the age distribution, occupations, and residential locations of the indigenous population and calculating similar data on the new population (by the methods outlined above), the property tax burdens of the various segments of the population can be computed. By examining the mix of services provided at the local level and assigning their dollar values to these various segments, a net service burden will be derived for each category of the population.

This chapter has presented, in considerable detail, a list of supplementary techniques and procedures required to transform the general framework presented by Hirsch¹⁰ into a comprehensive methodology for the assessment of the local impacts from energy-related industrialization. In the following chapter, a general outline of this methodology will be presented in logical sequence. While a detailed description of the various portions will not be repeated, an attempt will be made to demonstrate how the various pieces can be integrated.

5. A COMPREHENSIVE MODEL OF REGIONAL IMPACTS

The set of informational and analytical procedures discussed in detail in the preceding chapter are now presented in the context of a comprehensive methodology for the ex ante evaluation of the future fiscal impacts of proposed development projects. This comprehensive methodology focuses on the estimation of net fiscal impacts, a concept first espoused by Hirsch. Some of the techniques and procedures employed by this comprehensive model were taken from a review of extant estimation techniques and algorithms found in the economic literature, while others represent innovations on and expansions of the procedures employed in the empirical impact studies reviewed in the first part of this paper. Thus, the comprehensive model presented in Fig. 5.1 represents a codification and refinement of existing techniques and procedures brought together specifically for the purpose of providing consistent estimates of the future regional impacts of energy-related development in any area of the country and within each area among regions and localities of any size or description.

A comparison of the general model prepared by Hirsch (and summarized in Fig. 3.1) and the comprehensive model presented in Fig. 5.1 reveals several significant differences. In this latter model, the number of employees required annually by the new facility is treated as a parameter to be input by the analyst and, presumably, is supplied by the firm. Using the employment multiplier discussed in the preceding chapter, these annual increments in direct employment are used to obtain the total increases in direct, indirect, and income-induced employment opportunities accruing to the region. With the aid of either the simultaneous equation model of employment lags or the simple extrapolation method, the availability of new job opportunities following an initial stimulus to direct employment is forecast on an annual or biennial basis. As Fig. 5.1 indicates, the employment multiplier is the only parameter that has to be derived in order to gauge the future regional growth in demand for local services. This contrasts sharply with the requirement of the Hirsch model that separate employment, income, and output multipliers, each be calculated.

Fig. 5.1. The Comprehensive Methodology for Economic Impact Assessment

Given the increments in total regional employment opportunities for a particular period, the survey of the local population is used to determine the number of these jobs that the local labor pool can be expected to fill. Deducting these estimates from the total number of new jobs and assuming that these jobs will all be filled, the number of in-migrating workers for the period is derived. Surveys of in-migrants in related fields of employment are used to determine their demographic characteristics. Applying this information on age, sex, and family size to the estimated number of relocating workers, the increment in total regional population is derived for the period. This survey method, as explained above, is used to estimate family size, because it is felt that many in-migrating workers do not bring their families or do so only after they perceive of their jobs as being permanent. Obviously, using statistics on average family size for the region or, for that matter, for the nation as a whole would overstate the size of the new population if this assumption is correct.

Given the size and age distribution of the new regional population expected during this period, a gravity model is employed to estimate the manner in which these individuals will distribute themselves throughout the country. With this task accomplished, the impacts that this increase in population will have on the demand for and finance of public services can be computed for various jurisdictional levels. For example, given information on the size and age distribution of the new population within a particular school district, the analyst can begin to forecast both the increased costs of providing additional public education as well as the increased availability of funds with which to pay for these educational services. From the baseline profile of the region, data on the financial and physical capacities of the schools within each district are used to indicate, given the number of new school-aged children, the need for and the feasibility of expanding educational facilities. If expansion is required, and the debt ceiling permits, the amortized cost of adding to these facilities is counted as an expense for the period. However, it is recognized that the marginal cost of operating schools of larger size may also change. By using the per capita operating costs of comparably sized schools, the increasing or decreasing components of these costs are automatically accounted for in the additional operating expenses for the period.

On the revenue side of the ledger, both the increased school tax bill and the increase in state and federal aid are computed. Using the housing preferences revealed in the survey of transient workers, the increase in the property tax base within the district is computed. Applying the appropriate school district rates to this increased base yields the estimate of the new tax bill. Given information on state and federal participation in financing school construction and operation, the period additions to district revenues from these sources are obtained.

For each period, these increased revenues and expenditures are totaled and the net fiscal impact for each jurisdiction is examined. Finally, having repeated this process for each jurisdictional level, the net fiscal impact for the region is estimated. This process, as indicated in Fig. 5.1, is repeated for each period throughout the expected life of the development. At this stage, the distribution among various categories of individuals of the net burdens associated with the increased expenditures for publicly provided services will be analyzed. And, following this, a final analytical statement will be prepared that will attempt to answer two important questions first raised by Hirsch:⁶

1. Will local energy-related development add to or subtract from the net fiscal resources of a region?
2. Will this industrial development increase or decrease the ultimate money burden of taxes among various categories of individuals as local services are expanded?

The answers to these questions will, in large measure, enable local citizens to critically analyze the desirability of industrial development for their regions. In addition, the results of these studies will enable national energy planners to choose among alternative regional development plans on the basis of the severity of their relative economic impacts.

APPENDIX - ANNOTATED BIBLIOGRAPHY

Anticipated Effects of Major Coal Development on Public Services, Costs, and Revenues in Six Selected Counties, prepared for the Northern Great Plains Research Program by the Bureau of Reclamation and the Institute of Applied Research, Montana State University, Bozeman, Montana, January 1975.

This report, which was funded in part by the Northern Great Plains Research Program (NGPRP), is a summary version of a much longer research document on the impact of coal-related development in the six counties of the Northern Plains states. The study begins by examining the public services currently available in six counties from three Great Plains states. Once these services and their present excess capacities are described, the current (1974) per capita costs of providing these services are derived for each of the six counties. Using alternative development scenarios established by the NGPRP, the increased costs of providing public services are estimated from population projections under each scenario for the years 1980, 1985, and 2000. While the population forecasts include secondary employees and estimates of family size, no description of the analysis used to arrive at these figures is provided in the text.

The public revenue institutions that are available within each of the states and counties are carefully analyzed. The increase in public revenues are evaluated for the six counties for 1980, 1985, and 2000. However, only the taxes and royalties paid directly by the anticipated new residences and business firms are included. The study finds that five of the six counties will have insufficient revenues to meet their public service needs during the early years of operation. However, after this initial adjustment period, the net fiscal impact appears to be positive in all of the counties.

Brock, Samuel M., Benefit-Cost Analysis of Surface Coal Mining, Mining Engineering, 21:75-77, 1969.

This study reports that substantial costs resulting from surface coal mining are being borne by the public rather than the mining firms. This article urges that regulations should be made flexible enough to ensure that the social or external costs associated with surface mining are minimized in all cases. While the profit maximizing motives of individual firms assures that

private costs will be minimized, if such firms are not required to absorb the social costs associated with their activities, inefficient resource utilization may result. The social welfare, in such cases, is not necessarily optimized by legislation that imposes inflexible standards with respect to the health, environmental, and esthetic conditions required at all surface mine installations.

Brock, Samuel M., and David B. Brooks, The Myles Job Mine - A Study of Benefits and Costs of Surface Mining for Coal in Northern West Virginia, Research Series 1, Appalachian Center, West Virginia University, Morgantown, W.V., 1968, 61 pp.

This study recognizes the need for government regulation in the mining activities of private industry when the presence of social costs associated with coal mining leads to a divergence between private and social goals. In cases where the use or exploitation of a resource by private industry gives rise to social costs that are not directly borne by the surface mining industry, unregulated profit maximization may produce inefficiencies in resource use. In these cases, public policy must be directed toward resolving the differences between social and private objectives. However, this study makes clear that laws and regulations imposed by the public sector should be based on economic considerations designed to maximize social welfare. The authors demonstrate how economic solutions to the problems associated with the existence of technical externalities may be attained through the use of benefit-cost analysis. They find that legislative requirements that set forth inflexible standards for surface mining fail to give proper consideration to differences in social costs of mining under various physiographical and sociological conditions. They therefore conclude that regulatory decisions must be based on the total social costs of mining under varying conditions and provide for varying degrees of control according to the net social gain, which the judicious use of benefit-cost analysis indicates may be expected.

Brooks, D. R., Strip Mine Reclamation and Economic Analysis, Natural Resources Journal, 6:13-44.

This article reviews the principles of welfare economics and the possibility of their application to strip mining. It concludes that government should take an active role in ensuring that all costs -- including social costs -- are considered in the operation and reclamation of strip mines.

Brooks suggests that benefit-cost analysis represents a powerful tool that can be used to assist in the determination of just how much regulation is required to attain a socially optimal solution to the remission of social costs at various strip mining sites. He also illustrates the need for better collection of information concerning the socially undesirable side-effects of strip mining and the exact technology that can be used to alleviate them.

Callahan, John C., and Jacquelin G. Callahan, Effects of Strip Mining and Technological Change on Communities and Natural Resources in Indiana's Coal Mining Region, Research Bulletin No. 871, Agricultural Experiment Station, Purdue University, Lafayette, Indiana, 1971, 43 pp.

One of the primary objectives of this study was to examine the effects of local strip mining operations on counties and townships in Indiana. Two counties that have been subjected to considerable strip mining were selected for intensive examination. In addition, two counties adjacent to each strip-mined county, which are relatively free of mining activities, were selected for control purposes. A comparison of the local economic conditions within each county currently being mined with the adjacent control counties revealed little conclusive evidence that strip mining leads to either economic growth or deterioration.

The comparison of local economic conditions was undertaken by case studies at two levels: the county level and the township level. The case studies of the individual counties indicated that all were experiencing population declines. However, the unemployment rate was found to be higher in the coal counties than in their adjacent control counties, and assessed valuation in these coal counties was shown to be declining relative to the control group. However, the comparison of economic effects among these counties was judged unfair due to the fact that both the level of service and the extent of taxation could vary considerably among counties simply because of the differences in preferences among the inhabitants. Case studies of individual townships within counties were considered to be more representative of the impacts of coal strip mining. These case studies, however, confirmed no significant trends between coal mining activities and population declines, welfare expenditures, or relative tax rate changes.

Economic and Social Impacts of Coal Development in the 1970s for Mercer County, North Dakota, prepared for Old West Regional Commission by Thomas E. Carroll Associates, 1974.

This report examines the socioeconomic impacts of lignite mining, electrical generation, and coal-gasification facilities being introduced in Mercer County, North Dakota. In particular, the study is oriented to estimating the net fiscal impacts of such coal-related development on the state of North Dakota, Mercer County, and several individual communities and school districts. The impacts on these various jurisdictions were further stratified with respect to those that were expected during the construction of these facilities and those of a more permanent nature that were expected during the operation phase. The findings suggest that the net fiscal impacts on public revenues and expenditures will be positive during the operation of the facilities and negative during the temporary construction phase.

Using an employment multiplier for the Mercer County area, the secondary employment impacts were derived from estimates of the primary employment associated with the operation of each facility during the mid-1980s. From the estimates of total (secondary and primary) employment, the additional population expected in Mercer County was prepared. This additional population expected in Mercer County was assumed to distribute itself among the communities of Beulah, Hazen, Stanton, and the remainder of the county according to community size and the distance to the coal-development facilities. Given the increased population in each of these communities and measures of the current capacities of publicly provided services and institutions, the increased costs to each community and school district were estimated. The estimates of increased expenditures confronting each community and school district were compared to the additional revenues that the new population would generate in each jurisdiction. This comparison revealed that the development of coal resources in Mercer County would result in positive net fiscal impacts accruing to the jurisdictions from the operation of the coal energy facilities.

Garrison, C. B., The Impact of New Industry on Local Government Finances in Five Small Towns in Kentucky, Agricultural Economic Report No. 191, USDA, Economic Research Service, Washington, D.C., 1970, 27 pp.

This study analyzes the effects on local governmental revenues and expenditures of small-scale industrial development in five communities in

Kentucky. The author feels that too often local governments simply assume that new industry of any sort will add to the local tax base of the community. He attempts to measure the net fiscal impacts experienced by five separate communities that attracted industry during the period 1958 to 1963. Essentially, Garrison examines the direct increases in public revenues and expenditures attributable to the new local industry during this period. In addition, he attempts to provide some quantitative measure of the secondary impacts that local industrialization has had upon the regional economy. By comparing the service and revenue increases in the impacted communities to "control" counties that received no exogenous stimulus, Garrison attributes the observable differences to the secondary impacts of development.

The study supports the hypothesis that attracting local industry is no guarantee that a local community will experience positive net fiscal impacts.

Gilmore, John S., and Mark K. Duff, The Process for Policy and Objectives for Growth Management in Sweetwater County, Wyoming, University of Denver Research Institute, January 1975.

The authors look back at the mining and construction boom conditions that existed in Sweetwater County, Wyoming during the years 1971 to 1974. Their study has led them to conclude that there are three essential problems associated with rapid industrialization that are interrelated and therefore self-perpetuating. Firstly, as growth in the basic industry outran the local sector's ability to provide public and private services, the quality of life deteriorated for all inhabitants. Secondly, the deteriorating quality of life in Sweetwater was responsible for high labor turnover and concomitant declines in productivity. Finally, the reduction in productivity exacerbated the short-fall of public and private capital investment in the local services sector that led to a reduction in the availability of important goods and services. The lack of local services in the community naturally contributed to the deterioration of the quality of life. The authors observe that the primary reason for the existence of the problems outlined above is the failure of the market to provide for the requisite factors of production needed to adequately expand local services. They suggest that major growth of the type experienced by Sweetwater County must be better managed and recommended programs that can be designed and carried out to meet the consensus objectives of growth management.

Helgeson, Delmar L., and Maurice J. Zink, A Case Study of Rural Industrialization in Jamestown, North Dakota, Agricultural Economics Report No. 95, Department of Agricultural Economics, North Dakota State University, Fargo, N.D., 1973, 42 pp.

A portion of this report was devoted to assessing the economic impact of industrial growth in Jamestown, North Dakota and its surrounding nine-county planning region. The authors examined the local spending patterns of four firms that were recently attracted to Jamestown. They found that the direct economic stimulus provided by these firms had very little impact on either the level of public services provided at the local level or the secondary (indirect) employment effects within the nine-county rural region. They reasoned that excess capacity in both the business and service sectors as well as the relatively large number of underemployed people in this area were responsible for these observations. As a result, they concluded that in rural areas considerable excess capacity in both the public and private sectors serves to dampen the multiplier effects of economic expansion.

The new firms in the Jamestown area were polled to determine the amount of money that they spent locally within thirteen economic sectors. Treating these sums as exogenous increases in final demand, the direct, indirect, and induced impacts on the gross business volume of the region were derived through the use of a thirteen-sector, input-output table. Dividing the total increase in business volume attributable to the new firms by the number of new employees hired by the four firms, it was found that little additional expansion would be realized in the Jamestown region.

Hill, Jack K., Social and Economic Implications of Strip Mining in Harrison County, unpublished Master's thesis, Ohio State University, 1965.

In this study, the author examined two counties in southeastern Ohio with respect to their economic and social conditions. Harrison County is currently being extensively strip mined while Carroll County is not. Hill postulates that the differences in the current economic and social conditions between these two counties can be attributed to strip mining and the presence of the coal industry in Harrison County. The author uses the conclusions arrived at from this intercounty comparison to deduce the types of impacts that other counties can expect from the presence of strip coal mining.

Approximately eighty social, cultural, and economic dimensions in Harrison and Carroll counties are compared at a point in time. These eighty dimensions were grouped into ten major categories to facilitate the comparison. These categories include population characteristics, industry attributes, local governmental service provision, social problems, agricultural dimensions, medical facilities, personal wealth, labor force characteristics, and educational achievements. The comparison of Harrison and Carroll counties on these sets of criteria, while largely inconclusive, indicate that Carroll County is at least as well off without strip mining as Harrison is with it.

In addition, the economic strengths of the counties were compared, and Hill found no evidence to suggest that either the coal or strip mining industries were supporting Harrison County with strong complementing industries. In fact, leakages from local expenditures were found to be quite high, indicating that secondary employment and income from mining activities were almost nonexistent.

Hirsch, Werner Z., Fiscal Impact of Industrialization on Local Schools, Review of Economics and Statistics, 46:191-199, 1964.

Citing as inadequate and incomplete the studies that have made comparisons of local public revenues and expenditures that accrue directly from industrial development, Hirsch constructs an empirical model that he uses to examine the direct, indirect, and induced effects of industrial development on the net fiscal resources of public schools. The author finds that under conditions of full employment and full plant utilization, stimulating local industrialization tends to generate more property tax revenue through the residential sector (through the indirect and induced effects on population expansion) than is generated from the industry directly.

The study is conducted in the St. Louis SMSA region for which a regional input-output table was available. The author examined the indirect and induced effects on output, employment, and population of a one-million-dollar increase in the final demand of specific industries. Given the total effects on regional employment, output, and population, fiscal side calculations were used to estimate changes in the industrial, commercial, and residential property tax base. Using the prevailing school tax rates, the increase

in locally raised school tax revenues were obtained. Using a predetermined ratio of employment to public school enrollment, increases in public school enrollment were derived. With the aid of two sets of figures (per pupil operating and construction costs), the increase in total school district costs were estimated.

Hirsch repeated this process for each of sixteen industrial sectors. He found that without including state aid to schools, thirteen of the sixteen industrial sectors given a one-million-dollar stimulus would cause the school district to experience negative net fiscal resource change. With state aid included in school district revenues, expansion of no fewer than five industrial sectors would continue to cause school expenditures to exceed school revenues.

Hirsch, Werner Z., Regional Fiscal Impact of Local Industrial Development, Papers and Proceedings of the Regional Science Association, 7:119-130, 1961.

This seminal article represents a point of divergence with the traditional approach to measuring regional economic impacts from industrial development. The author seeks to develop a methodological framework capable of determining whether a given local industrial development will add to or subtract from the net fiscal resources of a region. In addition, he recognizes the importance of the equity consideration and examines the question of whether the industrial development will increase or decrease the ultimate money burden of taxes for people in the region while their level of publicly provided services remains constant.

The model that Hirsch constructs has two main elements: regional input-output analysis and a variety of fiscal side calculations. The I/O model, given estimates of direct income, employment, and/or output from the proposed development, measures the iterative effects of these impacts on the regional economy through the multiplier process. Given the total employment, output, and income resulting from development, the fiscal side calculations are used to translate these impacts into tax payments and public service costs. Hirsch suggests that these two steps be repeated independently for each level of government (local, state, and federal) to gain information on the two sides of the region's fiscal account. However, he emphasizes the local governmental

level in his model and suggests that unless the region in which the development takes place is large in relation to the entire state, both state and federal implications of local development may be negligible. However, Hirsch does not spell out the procedures under which the equity issue might be examined. Instead, he reviews several studies that have addressed this issue and suggests that similar types of analyses be performed.

Howard, Herbert A., *A Measurement of the External Dis-economies Associated with Bituminous Coal Surface Mining, Eastern Kentucky, 1962-1967*, Natural Resources Journal, 11:76-101, 1971.

Howard outlines a methodological approach for measuring the social (external) and private (internal) costs of strip and auger mining. He examines a number of external costs that surface mining imposes on society. Given estimates of the magnitude of these costs that are expected to continue into the future, he discounts them to the present time. Howard then estimates the costs to the mining firms of meeting the 1966 Kentucky land reclamation statute plus the costs associated with enforcing the statute.

The internal and external costs are compared. The authors find that the internal costs of control exceed the social benefits associated with the reduction of the externalities from surface mining. Howard then suggests that the Kentucky General Assembly should carefully evaluate the present as well as any proposed additional land reclamation requirements in a similar manner.

Impact Analysis and Development Patterns Related to an Oil Shale Industry, prepared for the Colorado West Area Council of Governments, THK Associates, Inc., Denver, CO, Feb. 1974.

The study begins by assessing the current socioeconomic conditions of three counties in Colorado that anticipate some degree of oil-shale development. Three growth scenarios are constructed for this region and the impacts on the fiscal resources of the counties are projected for each level of growth. The results of this analysis indicate that potential local revenues from oil-shale development will not meet the potential costs of constructing and maintaining public service facilities.

In this study, the public revenues and expenditures were calculated on the basis of successive increments in population of 1000 people. Given

the population projections associated with each level of growth implied by the three scenarios, costs and revenues were estimated as strict multiples of each 1000 increments in the projected population. This approach was used because it was impossible, according to the authors, to predict precisely where the people and plants would locate or even how many of each there would be.

Kee, Woo Sik, Industrial Development and Its Impact on Local Finance, Quarterly Review of Economics and Business, 8(3):19-24, 1968.

Kee challenges the cursory studies that compare direct increases in local public revenues and expenditures arising from new industry. The author contends that local planning based on such evidence is unsatisfactory for two reasons: (1) the limitation of considering only direct public costs and revenues contributed by the new industry and (2) the use of average rather than marginal cost and revenue measures. Kee develops a conceptual framework for measuring the marginal costs and revenues associated with the labor force employed by new industry. Using this model, Kee evaluates the revenue-expenditure impact of selected firms in the town of Brookhaven, New York. He finds that only three of the five firms in the Brookhaven area evaluated by his model contribute positively to the net fiscal impact within the community. A closer look at these three industries leads Kee to conclude that industries that have a high value of assessment per worker and tend to hire both second family wage earners and employees who will not move to the new plant site are most desirable from the community's point of view.

Kee gathers information of the nature of the new population attracted by industry (particularly wages, average number of dependents, and the choices of residences), the capital-labor ratio of the firm, and the incremental (i.e., marginal) cost of school and town services required by the new employees and their families. With this information and a set of assumptions concerning the local economy, the author constructs three functional relationships that represent his basic model. Essentially, he compares the total estimated full-value tax rate to the hypothetical tax rate with a given new industry excluded from the community. The computation of this hypothetical rate involves estimating the expected marginal changes in public revenues and expenditures associated with the decline in population. If the hypothetical rate is greater than the full-value rate, the industry is judged to be an asset to the community.

Leholm, A. F., F. L. Leistritz, and T. A. Hertsgaard,
Fiscal Impact of a New Industry in a Rural Area: A
Coal Gasification Plant in Western North Dakota, paper
 for presentation at Seventh Annual Meeting, Mid-continent
 Section, Regional Science Association, Duluth, Minn.,
 June 13-14, 1975.

In this paper the authors examine the effects of constructing and operating a coal gasification plant and mine in Mercer County, North Dakota with respect to the anticipated changes in state and county revenues and expenditures. The annual impacts on these public revenues and expenditures during both the construction and operating phases are evaluated over the entire expected life of the development. The authors find the net fiscal impact for the state of North Dakota to be positive during both the construction and operation of the plant and mine. However, at the local level, the net impact is expected to be severely negative during construction and to become positive only after many years of operation.

Given estimates of the local annual direct expenditures by the gasification facility, the total (direct, indirect, and induced) effects on the gross business volume of the household (personal income), retail, and contract construction sectors are derived using the relevant coefficients from an input-output table. Assuming fixed relationships between business volume and employment and employment and population, the total increases in employment and population are computed for Mercer County. Additions to state and local revenues are derived from the estimates of increased business volume and population. The increased state and local expenditures are arrived at by finding the current per capita costs of publicly provided services and multiplying them by the increase in population. Finally, these state and local revenues and expenditures are compared over the expected life of the project and measures of the net fiscal impacts accruing to both the state and county levels of government are derived.

Leholm, A., F. L. Leistritz, and T. A. Hertsgaard,
Local Impacts of Energy Resources Development in the
Northern Great Plains, Department of Agricultural
 Economics, North Dakota State University, Fargo, North
 Dakota, Sept. 1974, 209 pp.

The authors have attempted to forecast the impacts of coal-related energy development in Mercer County, North Dakota. The authors focused their

analysis on the estimation of anticipated changes in state and local revenues and expenditures expected from the operation of one coal-gasification plant and its associated mine and a single electric-generating plant and mine in Mercer County. Based on this development scenario, annually recurring and nonrecurring increases in North Dakota state tax revenues are estimated on the assumption that the initial development will lead to multiple rounds of regional economic growth. With total regional growth projections, they analyzed the annually recurring local (city, county, and school district) tax revenues and expenditures. No comparison of revenues and expenditures was attempted since state expenditures were not estimated and local public costs of capital construction were not amortized or annualized.

Given estimates of the direct operating personnel required at each installation and the annual expenditures by each plant to the retail and household sectors of the local economy, the direct, indirect, and induced impacts on the household, retail, and "all-business" sectors were computed using unexplained multipliers from an input-output table. By applying appropriate state tax rates to the estimated increase in the volume of each sector, annual state tax revenues from coal development were derived. Nonrecurring state revenues were estimated by assuming that each additional dollar of business revenues results in \$.22 of capital expenditure. By adding this figure to final demand in the construction sector, the impacts on the three local sectors are determined and taxed at appropriate state rates. A similar procedure was followed with respect to the estimated dollar volume of new private residences to be constructed.

At the local level, all expected revenues and expenditures depend crucially on the allocation of the incoming population to particular towns within the country. Two scenarios were considered, representing the extremes in settlement patterns. In addition, alternative scenarios were chosen to represent the choice of housing selected by the immigrants (single-family homes, apartments, or house trailers). For each type of housing and settlement pattern, the total impacts on the increase in local property tax revenues were computed. Concomitantly, the impacts on education, water treatment facilities, public roads, safety, and county and social service functions were computed.

Leistritz, F. L., N. L. Dalsted, and T. A. Hertsgaard,
The Economic Impact of Coal-Based Energy Development
in Western North Dakota, North Dakota Farm Research,
31(6):12-16, 1973.

The purpose of this study is to examine the impact of alternative levels of coal-related energy development on population, employment, and gross business volume in an eighteen-county area of southwestern North Dakota. Given three separate scenarios for the growth of coal-energy development and the expected levels of local expenditures and employment directly associated with each level of development, the authors estimate the total (direct, indirect, and induced) impacts on population, employment, and business volume that the area can expect in 1980, 1985, and 2000. The authors conclude that while minor levels of coal development would serve to reverse the current trend of out-migration, major coal development could cause drastic changes in the regional economy.

An input-output model containing regional expenditure data for 1965 was used to project total gross business volume resulting from the three alternative levels of development for the years 1980, 1985, and 2000. The local expenditures for the alternative levels of development were assigned to the sectors from which inputs were purchased. The corresponding interdependence coefficients were used to provide estimates of the total effects on gross business volume. Given the estimates of projected business volume, ratios of gross business volume to employment by sector were used to predict the ancillary levels of employment in each of the three target years for each level of development. Finally, population projections were arrived at by applying projected participation rates to the total employment estimates.

Leistritz, F. L. and T. A. Hertsgaard, Coal Development
in North Dakota: Effects on Agriculture and Rural Com-
munities, North Dakota Farm Research, 31(1):3-9, 1973.

The authors consider the effects on eight contiguous counties in southwestern North Dakota of the following types of coal-related development: (1) coal mining for export, (2) mine-mouth electrical generation, and (3) mine-mouth gasification. After briefly discussing the character of this region with respect to its population, employment, and reliance on agriculture, the impacts of coal development are addressed. Estimates of local expenditures

and direct employment associated with the three types of development are presented. Using an employment multiplier, total direct and secondary employment figures for each level of development are derived. Estimates of the total increase in population associated with the development scenarios are computed with the aid of a population-to-employment ratio. Finally, the increase in gross business volume within the region is computed with the use of coefficients from an input-output table. Given these projections, the authors stress the fact that the short-run impact from development is likely to be severe in the small rural counties. Over the long-run, the authors predict that as coal development declines, considerable disruption may be experienced in communities that have grown dependent on the coal industry. They point out that these problems may be compounded because the transition back to an agriculturally based economy could be hindered by the extent of stripped and unreclaimed land.

Lowenstein, Louis K., The Impacts of New Industry on the Fiscal Revenues and Expenditures of Suburban Communities, National Tax Journal, XVI(2):113-136, June 1963.

The growing migration of industry to suburban communities is traditionally viewed as a source of increased tax revenue and therefore beneficial to these local communities. The author of this study seeks to determine whether such industrial growth contributes more to increased local public expenditures than it does to local tax revenues. Three townships in Philadelphia's suburbs that have recently experienced varying degrees of industrialization are studied to gauge the effect of these activities on local revenues and expenditures. In addition, the author attempts to indicate the types of industries that should be encouraged to develop in local communities as a matter of practical fiscal policy. He finds that recent industrialization in two of the three townships proved to be a net gain to the financial resources of the communities. Abstracting from these case studies, Lowenstein suggests that in order to improve their finances, suburban municipalities should seek to encourage expansion of industries having a high value of assessment per employee and also have employees who are not apt to immigrate to the community as a result of the relocation of their jobs.

In conducting this study, the author examined the direct contributions that the new industries made to each municipality's tax revenues. This figure

was compared to the direct costs incurred by the community as a result of having the new industries in their midst. In the case of Radnor Township, for example, the increase in municipal service expenditures and school district costs directly attributable to the new industries were found to be considerably less than the revenue contributed directly by the new firms.

Polzin, Paul, Water Use and Coal Development in Eastern Montana, Montana University Joint Water Resources Center, Bozeman, Montana, Nov. 1974.

Polzin examines the economic implications of two alternative hypothetical levels of coal energy development in southeastern Montana. The major impacts are assumed to be confined to a three-county area. However, he also considers the impact of coal development on a larger seven-county region, which includes the primary regional trade centers. Using income multipliers tailored to the concentric regions, Polzin estimates the total population, income, and employment expected in 1980 and 1985 associated with the two levels of coal development. Those growth figures are compared with and added to the 1980 and 1985 projections of population, income, and employment conducted by OBERS under assumptions of normal growth. Finally, Polzin examines the net fiscal impact of coal-related development on state and county revenues and expenditures. The net fiscal impacts in both the three-county and seven-county areas are found to be quite favorable to regional energy development.

Direct earnings from the alternative levels of development in 1980 and 1985 are assumed to be exogenously determined. Using estimates of these figures, total derivative earnings were computed with the aid of separate income multipliers for the concentric regions. Derivative employment was estimated using average earnings per derivative worker, which was computed simultaneously with future population, migration, and labor force participation. Once estimated, the projected figures for population, employment, and income were used to analyze the net fiscal impacts at the regional and state levels. Because no attempt was made to identify the distribution of the population within each region, the author cautions that the estimates of revenues and expenditures at all levels are only reasonable approximations.

Prestgard, Per G., Effects of Coal Development on Public Costs and Revenues in North Dakota, unpublished Master's thesis, North Dakota State University, 1974, 130 pp.

This study examines the impacts associated with the hypothetical construction and operation of four coal gasification plants and their associated mines in Mercer County, North Dakota. Using an input-output table originally constructed for southwestern North Dakota, the exogenous increase in the business volume attributable to the coal-related development was transformed into total regional economic activity. Using appropriate fiscal calculations, the author estimated the increases in both state revenues and local revenues and expenditures that he categorized as either annually recurring or nonrecurring. State collectible taxes were estimated to be between \$90 and \$100 million in nonrecurring revenues and \$4.5 million in annual recurring revenues. The scenarios used to estimate the local revenue-expenditure impacts caused the estimates of annually recurring local tax revenues to range from \$4.2 to \$7.7 million. The estimated increases in recurring local public expenditures ranged from \$.7 to \$5.7 million, while capital public expenditure estimates varied from \$5.8 to \$50.5 million.

Given estimates of the direct expenditures made by the plants and mines to the retail and household sectors of the local economy, the direct, indirect, and induced dollar volume to the household, retail, and "all other business" sectors were computed using input-output coefficients. By applying appropriate state tax rates to these estimates, annually recurring increases in state tax revenues were derived. Nonrecurring state tax revenues were computed by adding the estimated capital expenditures for the plants, new businesses, new public facilities, and residential housing to the vector of final demand and applying the same methodology summarized above.

At the local level, only the real property tax was used to estimate increased public revenues. Appropriate rates were applied to the value of the plant and mine, the new local business structures, and estimates of residential housing in place. Obviously, the choice of both location and type of housing drastically affects the figure for local tax revenue from residences. The study considers two extreme scenarios of alternative settlement patterns. In addition, both settlement patterns are evaluated under conditions in which all new families live either in trailers, apartments, or single-family homes.

Local expenditures on publicly provided services are also affected by settlement patterns. The increased costs of schooling, waste disposal, and numerous other services were evaluated for both settlement alternatives.

Seitz, Wesley D., *An Analysis of Strip Mining and Local Taxation Practices*, Illinois Agricultural Economics, 12(1), 1972.

This study examines the effect of strip mining on the diminution of economic activity in eight Illinois counties as reflected by the changes in each county's taxable resources. The analysis focuses on the sources of future property tax revenue available to counties where strip coal mining represents a major economic activity. The author finds that a number of counties have assessment practices that are "designed" to reduce public revenues as mining continues. The article concludes by recommending that action be taken to offset the reduction in the tax base in those counties in which mining activities are concentrated.

In order to halt the erosion of the tax base due to mining activities in the impacted counties, Seitz suggests two alternative courses of action. First, he suggests that regulations requiring reclamation of strip-mined land may result in making this land economically productive. However, adherence to economic principles requires that such reclamation activity be undertaken only if the total of net private and social benefits expected from the reclaimed land exceeds the costs of reclamation. Secondly, Seitz suggests that the impact of mining activities on the tax base may be mitigated simply by altering tax laws and practices. Such changes in taxation procedures could be made either at the county level or the state level. The choice of alternative changes in the administration of the property tax must be made with respect to the kinds of effects each would have on providing incentives for the land and mineral rights owners to minimize current practices that are eroding county revenue sources.

Socioeconomic Characterization and Assessment of the North Dakota Coal Gasification Project Area, prepared for Michigan-Wisconsin Pipe Line Company by Woodward-Environ, Inc., Sept. 1974.

The coal-gasification project proposed by the Michigan-Wisconsin Pipe Line Company is to be a plant-mine complex located north of Beulah in

Mercer County, North Dakota. The primary purpose of this report is to provide a socioeconomic profile of the project area and to assess the impacts from this development on a three-county area surrounding the plant-mine site. The effects of industrial and residential growth are examined with respect to their impacts on local public revenues and expenditures. The study projects the effects of the proposed project on regional population, employment, and income. These projections, in conjunction with the profile of existing services available in the region, are used to predict the costs of expanding services to meet increased needs and the additional public revenues available to finance the expansion of community facilities. The study concludes that direct (plant-related) contributions to public revenues will exceed the identified direct costs during plant construction and operation. Furthermore, it is expected that the development should have a positive economic effect upon the baseline region by increasing the employment opportunities and income flows.

In computing the indirect (secondary) regional impacts, ratios relating the annual increase in direct employment to both the existing population and annual earnings in the three-county area were constructed to supplement the use of more traditional employment multipliers. Using these ratios, the number of new secondary employment opportunities were derived for each sector of the regional economy. It was assumed that a major portion of these new positions would be filled by the indigenous labor force and by spouses of the plant and mine employees. Given the number of direct employees required in the construction and operation of the project facilities, it was further assumed that 50% of the construction workers and 60% of the operational employees would be drawn from the local labor force living within 50 highway miles of the development. The workers hired from outside the region were assumed to distribute themselves among nine cities within the three counties. The increased population in each community was estimated as a function of city size and distance from the plant site. Given estimates of the number of incoming employees and the size of their families, the impact on local services was projected with the aid of the profile of the existing service capacities in the region. Using these same figures, the additions to state and local taxes from direct (plant and mine) and indirect sources were derived. Comparing these figures led the authors of this report to conclude that the net fiscal impact from the project would be positive.

Western Gasification Company (WESCO), Coal Gasification Project and Expansion of Navajo Mine by Utah International, Inc., a draft environmental statement prepared by the U.S. Department of the Interior and Bureau of Reclamation.

The portion of this report that addressed the economic impacts of WESCO's proposal to build four gasification plants in San Juan County, New Mexico is divided into two major categories: (1) an aspatial assessment of individual economic impacts and (2) an analysis of the economic impacts within the San Juan County region. The individual economic impacts of the proposed WESCO development program are confined to an assessment of the direct increases in employment and personal income contributed by the WESCO facility. While an effort was made to predict the extent of local labor participation (including local-hire rates for the Navajo population), no attempt was made to assess the extent of in-migration required to support the WESCO development. Similarly, the estimates of increased personal income derived from the proposed development are restricted to, and computed from, the anticipated wage bill of the WESCO plants.

The assessment of regional economic impacts resulting from the WESCO project are confined to estimates of future direct employment at the WESCO facilities, the accompanying population increases associated with this direct employment, and the derivative taxes and royalties contributed by WESCO to the Navajo Nation and federal, state, and county governments. The associated economic costs of the WESCO development are not measured.

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REFERENCES

1. Bender, L. D., and R. I. Coltrane, *Ancillary Employment Multipliers for the Northern Plains Province*, presented to Western Agricultural Economics Research Council, Reno, Nevada (Jan 7-9, 1975).
2. Callahan, J. C., and C. G. Callahan, *Effects of Strip Mining and Technological Change on Communities and Natural Resources in Indiana's Coal Mining Region*, Res. Bull. No. 871, Agricultural Experiment Station, Purdue University, Lafayette, Indiana (1971).
3. *Economic and Social Impacts of Coal Development in the 1970's for Mercer County, North Dakota*, prepared for Old West Regional Commission by Thomas E. Carroll Associates (1974).
4. Garrison, C. B., *The Impact of New Industry on Local Government Finances in Five Small Towns in Kentucky*, Agricultural Economic Report No. 191, USDA, Economic Research Service, Washington, D.C. (1970).
5. Gilmore, J. S., and M. K. Duff, *The Process for Policy and Objectives for Growth Management in Sweetwater County, Wyoming*, University of Denver Research Institute (Jan 1975).
6. Helgeson, D. L., and M. J. Zink, *A Case Study of Rural Industrialization in Jamestown, North Dakota*, Agricultural Economics, North Dakota State University, Fargo (1973).
7. Hill, J. K., *Social and Economic Implications of Strip Mining in Harrison County*, unpublished Master's thesis, Ohio State University (1975).
8. Hirsch, W. Z., *Fiscal Impacts of Industrialization on Local Schools*, Review of Economic and Statistics, 46, pp. 191-199 (1964).
9. _____, *Interindustry Relations of a Metropolitan Area*, Review of Economics and Statistics, 41, pp. 360-369 (1959).
10. _____, *Regional Fiscal Impact of Local Industrial Development*, Papers and Proceedings of the Regional Science Assn., 7, pp. 119-130 (1961).
11. Kee, W. S., *Industrial Development and its Impact on Local Finance*, Quarterly Review of Economics and Business, 8(3), pp. 19-24 (1968).
12. Leholm, A. G., F. L. Leistritz, and R. A. Hertogaard, *Fiscal Impact of a New Industry in a Rural Area: A Coal Gasification Plant in Western North Dakota*, paper presented at the Seventh Annual Meeting, Midcontinent Section, Regional Science Assn. (June 13-14, 1975).
13. _____, *Local Impacts of Energy Resources Development in the Northern Great Plains*, Dept. of Agricultural Economics, North Dakota State University, Fargo (Sept 1974).

REFERENCES (Contd.)

14. Leistritz, F. L., and T. A. Dalsted, *The Economic Impact of Coal-based Energy Development in Western North Dakota*, North Dakota Farm Research, 31(6), pp. 12-16 (1974).
15. Leistritz, E. F., and T. A. Hertsgaard, *Coal Development in North Dakota: Effects on Agriculture and Rural Communities*, North Dakota Farm Research, 31(1), pp. 3-9 (1973).
16. Lowenstein, L. K., *The Impacts of New Industry on the Fiscal Revenues and Expenditures of Suburban Communities*, National Tax Journal, XVI(2), pp. 113-136 (June 1963).
17. Miernyk, W. H., *The Elements of Input-Output Analysis*, Random House, New York (1967).
18. Moore, F. T., and J. W. Peterson, *Regional Analysis: An Interindustry Model of Utah*, Review of Economics and Statistics, 37, pp. 368-381 (1955).
19. Polzin, P. E., *Urban Employment Models: Estimation and Interpretation*, Land Economics, 49(2), pp. 226-235 (May 1973).
20. _____, *Water Use and Coal Development in Eastern Montana*, Montana University Joint Water Resources Center, Bozeman (Nov 1974).
21. Prestgard, P. G., *Effects of Coal Development on Public Costs and Revenues in North Dakota*, unpublished Master's thesis, North Dakota State University, Fargo (1974).
22. Richardson, H. W., *Input-Output and Regional Economics*, Weidenfeld and Nicholson, London (1974).
23. _____, *Regional Economics*, Praeger Publishers, New York (1969).
24. Seitz, W. D., *An Analysis of Strip Mining and Local Taxation Practices*, Illinois Agricultural Economics, 12(1) (1972).
25. *Socioeconomic Characterization and Assessment of the North Dakota Coal Gasification Project Area*, prepared for Michigan-Wisconsin Pipe Line Company by Woodward-Envicon, Inc. (Sept 1974).
26. Thompson, G. E., *An Investigation of the Local Employment Multiplier*, Review of Economics and Statistics, 41, pp. 61-67 (1959).

Regional Studies Program

The Regional Studies Program at Argonne National Laboratory is sponsored by the Division of Biomedical and Environmental Research in the U.S. Energy Research and Development Administration (ERDA). Its primary purpose is to assess the health, environmental, and socioeconomic impacts of energy development options in specific subregions of the country—the Midwest, the Southwest, and the Northern Great Plains states. In conjunction with this program, Argonne is preparing a national impact study of coal development options, based on the research of all the ERDA laboratories.