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Regional Economic Forecasting Models: Suitability for Use in the National Acid Precipitation Assessment Program

D. W. South, J. F. McDonald, and W. H. Oakland

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by

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PREFACE

In preparation for the Phase 1 test runs of the National Acid Precipitation Assessment Program Task Group B (TG-B) emissions model set, the need arose to provide regional economic data directly to the sector models in the model set and to the Argonne Regionalization Activity Module (ARAM). Candidate regional economic models were reviewed, and the Data Resources, Inc. (DRI), model was selected. This review of models, conducted during 1984-1985, is documented in this report. Even though considerable time has elapsed since then, the model descriptions and critique contained in this report are still fairly accurate and the recommendations should still be valid. There have been, however, some significant changes: (1) two of the economic consulting firms whose models were reviewed, Chase Econometrics and Wharton Econometric Forecasting Associates, have merged, (2) the DRI Regional Information System (DRI/RIS) now constructs a regional measure of industrial value of shipments, which will be used as the industrial activity variable (instead of employment) in the Phase 2 scenario analyses, and (3) based on recommendations from the third-party review of the TG-B model set, price-sensitive regional equations were developed to provide inputs, not already produced by the DRI/RIS model, directly to the sector models, thus eliminating the function served by ARAM.

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FOREWORD

Under the auspices of the National Acid Precipitation Assessment Program (NAPAP), activities supporting the preparation of future assessments have been planned and delegated to task groups. Task Group B (TG-B), "Man-Made Sources" (subsequently redesignated Task Group I, "Emissions and Controls"), of the Interagency Task Force on Acid Precipitation is responsible for developing and testing models that can be used to project fuel use and air pollutant emissions by energy use sector. Argonne National Laboratory has participated in the TG-B program since 1984.

The TG-B program is being carried out in two phases. Phase 1 includes development of the models for generation of baseline scenarios. Phase 2 will address the capabilities for modeling emission control scenarios. Under Phase 1, the sector models are being developed and tested. This testing is designed to aid in model development and help prepare the models for use by the task force. Upon completion, the sector models will be incorporated into the TG-B emissions model set and linked to a system of models that provide scenario-consistent input data.

The Argonne Energy-Economic Modeling Program is publishing a series of reports that document the steps undertaken to prepare national and regional projections of energy and economic activity required as input to the sector emissions models. This report is part of this series; it documents the review of various models to provide regional economic data to a preprocessor model and the sector models, and the recommendation of one model from those reviewed. Other reports in the series discuss the driver data needed by each sector model.

ACKNOWLEDGMENTS

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1 INTRODUCTION

In the National Acid Precipitation Assessment Program (NAPAP), Task Group B (TG-B) is responsible for developing and testing models that can be used to project fuel use and air pollutant emissions by energy use sector. An important component of these activities is the provision of regional (or state) input data to the sector models in the TG-B emissions model set. As discussed in the foreword, this work is being carried out in two phases. All activities described in this report have taken place under Phase 1 of the TG-B program.

Figure 1 illustrates the energy-economic driver module of the TG-B model set, together with the sector models that comprise the model set. The purpose of the energy-economic driver module is to systematically generate regional forecasts of energy and economic variables, called driver data, required by the sector models. This report addresses one aspect of the energy-economic driver module: the selection of an appropriate regional economic forecasting model.

1.1 INPUT REQUIREMENTS OF THE SECTOR MODELS

As shown in Table 1, the driver data required for the sector models are highly specific. We found, after an extensive review of regional economic forecasting models, that these data are not readily produced by such models. Most regional models produce a slate of general economic (and sometimes energy) data variables, but not the full set of driver data presented in Table 1. Consequently, an alternative method to supply these driver data to the sector models was devised.* The approach pursued involved the development of a generic regionalization procedure, called the Argonne Regionalization Activity Module (ARAM), which transforms control values (energy or economic) produced by national forecasting models into the required regional projections. In this way, the approach bridges the gap between national and regional modeling. ARAM is based on regional economic theory and implements a modified form of shift-share analysis.

*A twofold approach was actually devised, one for regional (or state) economic and energy quantity data and the other for regional (or state) fuel price data. This report considers the proposed approach for the quantity data. The fuel price data approach is covered by Marinelli, Hanson, and South (1987).

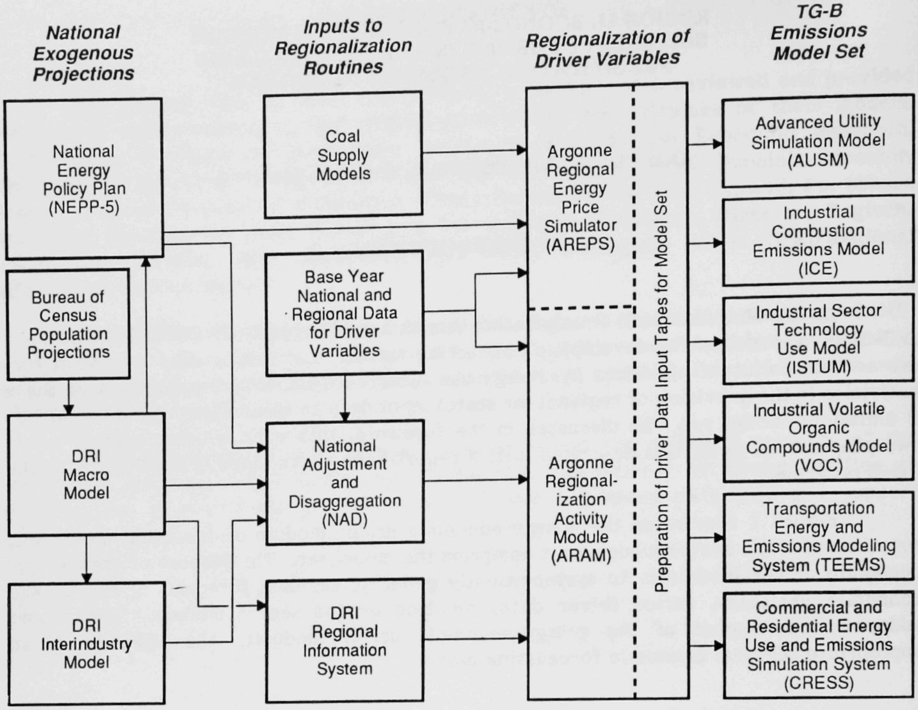

FIGURE 1 Block Diagram of the Energy/Economic Driver Module that Provides Inputs to the Sector Emissions Models

An important feature of this approach is that, although the configuration of the driver data for each model is different, a common regionalization algorithm is employed. The driver data projections (by region or state, depending on the spatial detail required by the model) are produced by systematically applying this generic regionalization algorithm in ARAM. The modified shift-share algorithm has three components: (1) base year (1980) values for the driver variable by region (or state), (2) national growth of the driver variable, and (3) shifts in regional (or state) shares, determined from a forecast of economic activity variables (related to the driver variable). The derivation of ARAM is described in Hanson, South, and Oakland (1985), and applications of ARAM to the driver data requirements of each sector model are described in a series of reports (South, Bragen, and Macal 1985; and South et al. 1985a, 1985b, and 1985c).

TABLE 1 Primary Driver Data Requirements for Sector Models in the TG-B Emissions Model Set[a]

	Driver Data Configuration			
Sector, Model	Data Set	Data Elements	Spatial Detail	Temporal Detail
Utility				
Advanced Utility Simulation Model (AUSM)	Endogenous demand model data	Personal income Population Manufacturing employment Total employment	48 states	1980-2000, 5-yr increments; and 2000-2030, 10-yr increments
	Fuel prices	Residual fuel oil Distillate fuel oil Natural gas Gasoline Nuclear	48 states	1980-2000, 5-yr increments; and 2000-2030, 10-yr increments
	Electricity demand	Annual growth rates for total electricity demand	48 states	Average annual growth rates for the periods of 1980-1990, 1990-1995, 1995-2000, 2000-2005, 2005-2010, 2010-2020, and 2020-2030
Industrial				
Industrial Combustion Emissions (ICE) Model	Boiler fuel demand	Projections of purchased fossil fuel for boiler use by industry group[b]	48 states and the District of Columbia	1980-2000, 5-yr increments; and 2000-2030, 10-yr increments
	Fuel prices[c]	Natural gas Distillate fuel oil Residual fuel oil Coal	10 federal regions	1980-2040, 5-yr increments
Industrial Sector Technology Use Model (ISTUM) and Process Model Projection Technique (PROMPT)	Industrial production indexes	Various measures of industrial production expressed in index form by industry group[d]	10 federal regions	1980-2000, 5-yr increments; and 2000-2030, 10-yr increments
	Fuel prices[c]	Natural gas Distillate Residual fuel oil Coal Electricity Liquefied petroleum gas (LPG)	10 federal regions	1980-2045, 5-yr increments
Industrial Volatile Organic Compounds (VOC) Model	Uncontrolled VOC emissions	Annual growth rates for uncontrolled VOC emissions by source category	National, plus a breakdown by 48 states and the District of Columbia	1980-2000, 5-yr increments; and 2000-2030, 10-yr increments

TABLE 1 (Cont'd)

Sector, Model	Driver Data Configuration: Data Set	Data Elements	Spatial Detail	Temporal Detail
Transportation				
Transportation Energy and Emissions Modeling System (TEEMS)	Economic inputs	Population Households Household demographics Gross national product (GNP) Industrial production (Federal Reserve Board indexes) Production indexes by commercial sector Agricultural exports Total employment Government employment Employment in service sector trade Wholesale, retail, and construction employment Disposable personal income Economic growth of major industrial countries	National for all data; plus a breakdown by 48 states for population and employment	1980-2030, 10-yr increments
	Fuel prices	Gasoline Diesel fuel Jet fuel	National	1980-2030, 10-yr increments
Residential/Commercial				
Commercial and Residential Energy Use and Emissions Simulation System (CRESS)	Economic inputs	Real disposable personal income Population Housing starts Mortgage interest rates (real) Employment, commercial sector	4 census regions and 48 states	1980-2030, 5-yr increments
	Fuel prices	Distillate fuel oil Residual fuel oil Natural gas Electricity LPG Kerosene Motor gasoline Coal	4 census regions and 48 states	1980-2030; 5-yr increments

[a] A more specific delineation of the driver data configuration for each sector model is contained in Hanson, Macal, and South (1984).

[b] Standard Industrial Classification (SIC) codes 20, 22, 26, 28, 29, and 33.

[c] Residual fuel oil and coal prices by sulfur category are required.

[d] SIC codes 1, 2, 10-14, 15, 20-32, 331, 3334, the rest of 33, and 34-39.

1.2 SCOPE AND ORGANIZATION OF THIS REPORT

The original purpose of this report was to review and evaluate regional economic forecasting models and recommend one model capable of supplying the requisite input data directly to the TG-B emissions model set, i.e., without the need for conversions or other manipulations of the data. As described above, a regional model capable of supplying all of the highly detailed input data could not be identified and an alternative approach for provisions of the economic and energy quantity data (ARAM) was pursued. Thus, the original focus of this report was reoriented to review and evaluate the capabilities of various regional models to supply a regional (or state) forecast of economic activity variables to ARAM* and selected driver data to the sector models. The specific activity variables and driver data required from such forecasting models are defined as part of the model evaluation criteria discussed in Sec. 2.

Section 2 presents the criteria used to evaluate the regional models and a survey of the regional models commercially available; three candidate models are identified for further examination. In Sec. 3, the structure and capabilities of each candidate model are thoroughly described and evaluated with respect to the selection criteria defined in Sec. 2, and one model from the three is recommended. Finally, a description and analysis of the projections produced by the recommended regional model are presented in Sec. 4.

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*In particular, the provision of regional (or state) economic activity forecasts required for the third component of the ARAM regionalization algorithm described in Sec. 1.1.

2 EVALUATION CRITERIA AND SCREENING OF REGIONAL MODELS

This section has three purposes. The first is to outline the criteria used to evaluate the capabilities of various regional models to supply economic activity forecasts to ARAM and the TG-B emissions model set. There are two general criteria: the extensiveness of the projection data (variable list and the length of the projected data series) and the attributes of the model. These criteria are discussed in Sec. 2.1. The second purpose of this section is to report on our survey of regional economic models and the initial screening of these models based on the evaluation criteria (Sec. 2.2). The final purpose is to identify a set of candidate models for thorough examination and evaluation (Sec. 2.3).

2.1 EVALUATION CRITERIA

2.1.1 Required Driver Data and Economic Activity Projections

As indicated in Table 1, the TG-B model set requires projections for an extensive set of data variables. Through ARAM, these regional (or state) projections can be generated with forecasts produced by regional economic models. Some activity or driver variables, required by the TG-B model set and ARAM, respectively, can be supplied by a regional economic forecasting model since they are demographic or economic in nature. These variables are listed below:

- Population (total),
- Real disposable personal income,
- Total employment, with breakdowns in the following categories: nonfarm (total), manufacturing (total and by two-digit Standard Industrial Classification [SIC] code), government, agricultural, mining, construction, and commercial, and
- Housing starts by type.

Regional (or state) data for the variables listed above are needed by 5- or 10-yr increments through 2030. Regional data are needed both at the federal region level (see Fig. 2) and the census region level (Fig. 3), depending on the application.

2.1.2 Model Attributes

For present purposes, the attributes of regional models can be segmented into two categories: one dealing with the general quality of the model and the other with its appropriateness for current requirements. First of all, does the model provide good

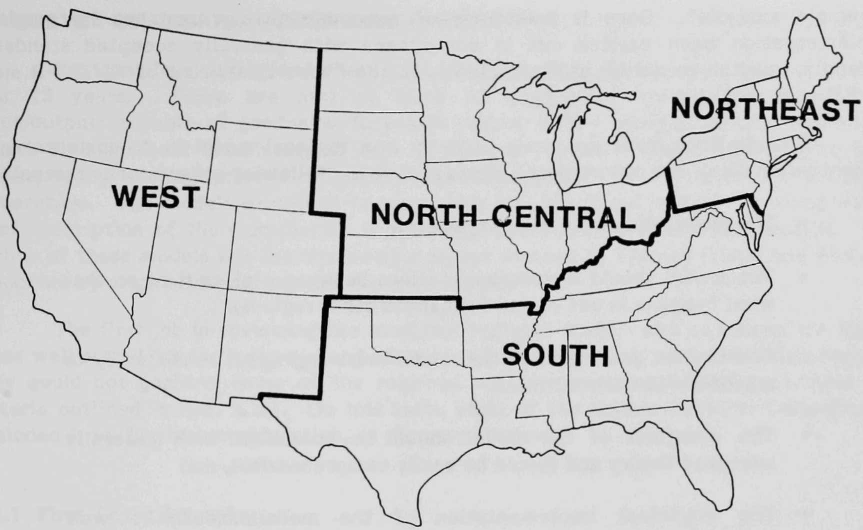

FIGURE 2 Census Regions of the United States

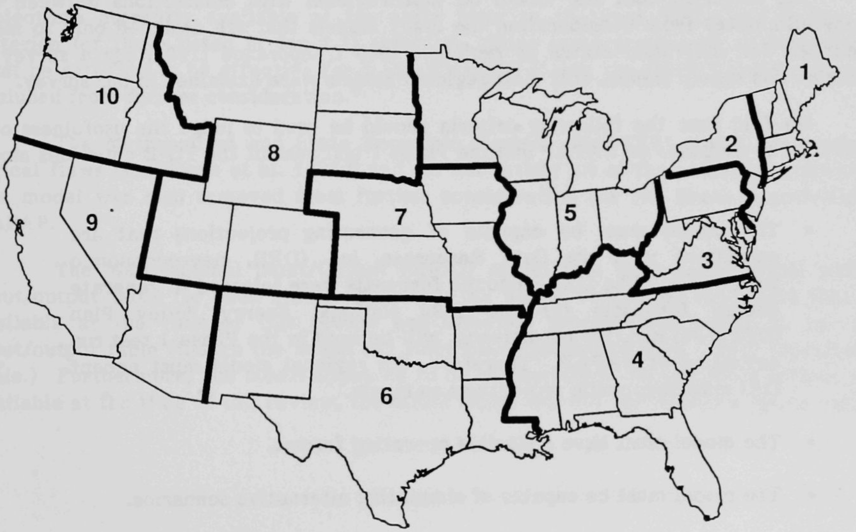

FIGURE 3 Federal Regions of the United States

economic analysis? Does it make use of economic theory, and has its empirical implementation been carried out in accordance with generally accepted standards? Secondly, can the model be used efficiently in the Phase 1 test runs of the TG-B model set?

The quality of the economic analysis in a regional model is, to some extent, a subjective matter. For our purposes, we feel that the following criteria are reasonable:

- The model should be multiregional,
- The model should include connections between regions (i.e., so that what happens in one region influences other regions),
- The regions and states in the model must aggregate consistently to a predefined national total,
- The equations of the model should be consistent with generally accepted theory and should be easily comprehensible, and
- The empirical implementation of the model should be well documented and tested, and the model should have a history of successful application.

The criterion that the model be multiregional with connections between the regions eliminates from consideration the many models that are designed only to make projections for individual states or regions. (See L'Esperance [1981] for a survey of models of this type.) Hence, only multiregional models were examined in our survey.

We feel that the following criteria should be used to judge the usefulness of a model for the purposes of NAPAP and the Phase 1 test runs of the TG-B emissions model set:

- The model must be capable of generating projections that are consistent with the Data Resources, Inc. (DRI), macroeconomic projections. The DRI economic forecasts were selected to generate energy forecasts for the 1985 National Energy Policy Plan (NEPP-85) and, for consistency, will be used in the Phase 1 test run activities of NAPAP. Therefore, the regional model must accept DRI macroeconomic projections as inputs.
- The model must have a flexible operating format.
- The model must be capable of simulating alternative scenarios.
- The model must be capable of providing projections to 2030, or it must be possible to extend the projections in a manner that is reasonably consistent with the methodology of the model and with other projection data.

2.2 SURVEY OF REGIONAL ECONOMIC MODELS

Regional forecasting and analysis methodology has developed rapidly during the past 15 years. There are now at least 12 large-scale models (econometric or input/output) capable of producing forecasts and/or policy analysis simulations at the census division level (consisting of nine regions) or below. These models have been developed by various private or public organizations and/or by individual academic researchers. The models examined in our survey are identified in Table 2, along with a brief description of their projection capabilities and other pertinent information. Our review of these models was facilitated by a report written by Tierney (1981) and was also supported by original documentation for each model.

The first job in reviewing the available regional models was to reduce the list to those well suited for the tasks at hand. Some models could quickly be eliminated because they could not perform some of the required tasks or because they did not meet the criteria outlined in Sec. 2.1.1. On this basis, eight of the models listed in Table 2 were excluded from further consideration, as discussed below.

2.2.1 First-Level Screening

• The OBERS regional projections are long-term projections (to the year 2030) prepared by regional economists at the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. While the OBERS regional projections are the only projections currently available at the state level to the year 2030, this is the only criterion (of those listed in Sec 2.1) satisfied. Since some portion of all five criteria must be satisfied to be effective for NAPAP and TG-B use, the OBERS projections were excluded from further consideration.*

The Metropolitan and State Economic Regions (MASTER) model has methodological flaws (see South et al. 1985d) and did not satisfy all of the screening criteria, so this model was also removed from further consideration for the Phase 1 activities of NAPAP.

The Multiregional Input/Output (MRIO) model is a large-scale model with an input/output table for each state. However, the public version of the model that was available at the time of this review and selection process was based on the 1963 input/output table (though the model has since been updated to have a 1977 input/output table.) Furthermore, the model appeared to be cumbersome. Since better options were available at the time of this review, the MRIO model was not considered a viable option.

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*A combination of OBERS and NRIES would satisfy most (three or four) of the screening criteria, but such a linkage is not presently available (though it has been discussed at the BEA [Knox 1984]) and operational difficulties may arise in scaling the output to match the DRI macroeconomic forecast.

TABLE 2 Available Regional Economic Models

Model Name	Developer	Projection Capability[a]	Comments	Documentation
OBERS[b] Regional Projections	BEA[c]	5-yr intervals to 2030; state level; most variables	Cannot run alternative scenarios	BEA (1981)
Metropolitan and State Economic Regions (MASTER) Model	Battelle Pacific Northwest Laboratory	Unknown projection length; state level; most variables	Weaknesses in model documented in South et al. (1985d)	Adams, Mue, and Scott (1983)
Multiregional Input/Output (MRIO) Model	K. Polenske et al.	Annual, up to 5-yr time horizon; state level; most variables	Based on 1963 input/output table	Tierney (1981)
Income Determination Input/Output Model (IDIOM)	S. Dresch	Limited capability for long-run projections; state level; population and housing starts not projected	Designed to study effects of substituting value-added tax for corporate income tax	Dresch and Updegrove (1978); Dresch and Goldberg (1973)
Regional Earnings Impact System (REIS)	DOE[c] and CONSAD Research Corp.	Best for 1- to 8-yr projections; state level; population and housing starts not projected	Relies on BEA estimates of state shares of industrial output	Tierney (1981)
REGSHARE	CONSAD Research Corp.	Used by EIA[c] to regionalize national projections to 1995; state level; population and housing starts not projected	Uses BEA population projections at the state level, DRI industrial production growth rates at the national level	CONSAD (1981)

TABLE 2 (Cont'd)

Model Name	Developer	Projection Capability[a]	Comments	Documentation
Environmental Trends Analysis Model (ETAM)	DOE	Used for long-run projections; federal region level; environmental indicators projected based on projections of economic variables obtained elsewhere	Relies on OBERS and Chase regional growth rate projections for economic activity and population	Tierney (1981)
National-Regional Impact Evaluation System (NREIS)	BEA	Annual, up to 15-yr time horizon; state level; all variables except housing starts	Does not check against national control totals	Kort, Cartwright, and Beemiller (1984); Kort and Beemiller (1984); Ballard, Gustely, and Wendling (1980)
Wharton Census Region Model	Wharton Econometric Forecasting Associates	Annual, 10-yr time horizon; census region level; not all variables projected	Lacks too many variables	Milne et al. (1980); Milne and Loxley (1980)
MULTIREGION	Oak Ridge National Laboratory	5-yr intervals; 173 BEA areas; all variables except housing starts	Focuses on labor market, geographic detail limits data for model estimation	Olsen et al. (1977); Tierney (1981)

TABLE 2 (Cont'd)

Model Name	Developer	Projection Capability[a]	Comments	Documentation
Regional Industrial Multiplier System (RIMS)	BEA	Long-run projection capability unknown; county level; population and housing starts not projected	Designed to provide regional impact multipliers for an industry	Tierney (1981); Cartwright, Beemiller, and Gustely (1981)
DRI[c] Regional Information Service (DRI/RIS) Model	DRI	Annual to 2009; census division[d] and state level; all variables		DRI (undated [a], [b]; 1984a, 1984b, 1985a, 1985b)
Chase State Metropolitan Area Forecasting System	Chase Econometrics	Quarterly, 10-yr time horizon; state level; all variables		Tierney (1981); Chase Econometrics (1985)
Multiregional Multi-industry (MRMI) Forecasting Model	C. Harris	Good for long-run projections; county level; all variables	Has been used for in-depth regional impact studies	Harris (1979, 1980); Fjeldsted and South (1979); Tierney (1981)

[a]Refers to the time frame projected, the spatial detail projected, and the variables from the list in Sec. 2.1.1 projected (the models reviewed may also project other variables not of concern in this report).

[b]The OBERS acronym reflects a cooperative effort of the Office of Business Economics (now BEA) and the Economic Research Service (now the Economics Statistics and Cooperative Services) in the U.S. Department of Agriculture. The regional projections are now prepared solely by BEA, but the OBERS name has been kept.

[c]Organizational abbreviations: BEA = Bureau of Economic Analysis, U.S. Department of Commerce; DOE = U.S. Department of Energy; EIA = DOE Energy Information Administration; and DRI = Data Resources, Inc.

[d]There are nine census divisions, distinct from the four census regions shown in Fig. 2.

The Income Determination Input/Output Model (IDIOM) is based on the 1970 input/output table and does not project population or housing starts. Again, better options were available; therefore, IDIOM was not considered as a candidate model.

The Regional Earnings Impact System (REIS) is a second-generation version of the Multiregional Earnings Impact Model (MEIM) built by the U.S. Department of Energy (DOE) during 1975-1976 to provide quick and detailed analyses of the spatial and industry-specific impacts of alternative energy futures. The system is best suited for comparative analysis of impacts of alternative economic scenarios; it is not, and was not, designed to be a sophisticated forecasting or simulation model. This is reflected in the fact that REIS does not project population or housing starts and that it relies on BEA estimates of state shares of industrial output. It is our judgment that such shares should be endogenously determined by the regional model, so REIS was deleted from the list of candidate models.

The regional sharing model developed by CONSAD Research Corp., REGSHARE, has been used by the DOE Energy Information Administration (EIA) to project regional and state industrial production and personal disposable income to 1995. It does not project population or housing starts; it uses BEA population projections at the state level (or other state-level population projections). The projections of state-level industrial production and personal disposable income are based on DRI projections at the national level. Changes in the state shares of industrial production are based on BEA projections. The state shares of personal disposable income are assumed to change with the OBERS projections through 1995. Essentially, REGSHARE is a very simple procedure for allocating the DRI macroeconomic forecasts to the state level. Since the DRI Regional Information Service (RIS) performs this procedure more rigorously and without significant resource requirements, REGSHARE was eliminated from further consideration.

The Environmental Trends Analysis Model (ETAM) is not a regional economic model, but rather uses regional economic and population projections (from the OBERS and Chase models) to make projections of environmental indicators. Furthermore, ETAM cannot perform the required tasks specified in Sec. 2.1.2.

The National-Regional Impact Evaluation System (NRIES) is principally a "bottom-up" model of the 50 states plus the District of Columbia that is both comprehensive and well documented. The current version, called NRIES II, consists of 51 individual state models, a set of indexes that measure trade flows among states, and a national model. The system is structured so that coefficients of equations pertaining to variables that differ little among states, such as federal fiscal and monetary variables, are estimated within the national model. Coefficients of equations pertaining to variables that differ appreciably across states, such as industry product and employment, are estimated within the individual state models. Variables projected within the national model are called "top-down;" those projected within the state models are called "bottom-up." When bottom-up variables are aggregated to national totals, the sums are the national projections of those variables. Thus, as currently structured, the NRIES II projections do not add to prespecified national control totals.

Since the modeling strategy governing the Phase 1 test runs of NAPAP and TG-B is principally a top-down method (i.e., matching national control totals is important), NRIES II was removed from current consideration for Phase 1 activities. In conversations with BEA economists, it has been determined that a method exists to use NRIES II projections and be consistent with DRI macroeconomic projections, i.e., compute state shares with NRIES projections and reapportion to the states based on the DRI macroeconomic forecast (Knox 1984). Further, this procedure could be employed for any number of scenarios. While we acknowledge that this approach is feasible, it could be subject to considerable technical and coordination problems. While excluded from current consideration, NRIES II could be a candidate in subsequent NAPAP assessments if some of these technical and procedural hurdles can be resolved.

The review of models to this point left six candidate models that appeared to meet the criteria outlined in Sec. 2.1. Further screening to reduce the list to three candidate models was then performed, as described in Sec. 2.2.2.

2.2.2 Second-Level Screening

The six candidate models remaining from the initial screening process (see Sec. 2.3) are the regional models constructed by DRI, Chase, and Wharton, together with MULTIREGION, the MRMI model, and RIMS (see Table 2). All six models appear to have the general model attributes listed as requirements in Sec. 2.1.2, and all meet professional standards both theoretically and empirically. The second-level screening resulted in elimination of three models, for the reasons given below.

The Wharton Census Region model was eliminated from the list of candidate models for three reasons:

- It projects only at the census-region level, so we would have to design a method to project at the state level and a method to aggregate to the federal region level when necessary.
- It only projects 10 years into the future, so an extension of the model to 2030 would be a major undertaking.
- It lacks some industrial detail.

The MULTIREGION model (developed by Oak Ridge National Laboratory) appears to be an acceptable choice. It projects all the required variables except for housing starts at the BEA economic area (173 areas) level. However, these areas would have to be combined (and, in some cases, disaggregated and recombined) to the state level. In addition, while reviews of the model have been quite favorable, Tierney (1981) has noted two disadvantages: (1) the level of geographic detail limits the amount of data available for model estimation and (2) the equations that project population migration and regional basic and service employment are somewhat weak in terms of statistical criteria. These factors led us to reject MULTIREGION for the Phase 1 test runs of NAPAP.

The Regional Industrial Multiplier System (RIMS) developed by BEA has three deficiencies. First, the accuracy of long-run projections with RIMS is unknown since its coefficients do not change over time. Second, it does not project population or housing starts and, third, it is outdated. The model operates at the county level and is based on the 1977 input/output table, so it is well designed to provide regional impact multipliers at the industry level. However, since the input/output table is somewhat outdated and its shares are static over time, RIMS was removed from consideration for the Phase 1 activities of NAPAP. Nevertheless, RIMS could become a candidate for future NAPAP activities if it is updated and made dynamic to account for shifts in industrial activity over time.

On the basis of these considerations, we reduced to three the number of candidate models: the DRI/RIS model, the State and Metropolitan Area Forecasting System developed by Chase Econometrics, and the MRMI model developed by C. Harris. Each is described and evaluated in greater detail in Sec. 3.

3 DESCRIPTION AND EVALUATION OF CANDIDATE REGIONAL FORECASTING MODELS

The analysis contained in Secs. 2.3 and 2.4 reduced the number of candidate regional economic models to three: the DRI/RIS model, the Chase Econometrics Regional Service (State and Metropolitan Area Forecasting System), and the MRMI model developed by C. Harris. Sections 3.1-3.3 discuss these three models in more detail to explain the final choice made regarding the model to supply regional activity projections for the Phase 1 test runs of the TG-B emissions model set. Section 3.4 summarizes the final recommendation.

3.1 THE DRI/RIS MODEL*

The DRI/RIS model projects all the variables needed at the regional and state levels for the Phase 1 test runs of the TG-B emissions model set. Every quarter, however, the model updates projections through 1995 using the DRI "trend" (i.e., middle) macroeconomic projection. The model can be run to 2009 using any DRI macroeconomic scenario covering the corresponding time period. The general structure of the model is outlined in Sec. 3.1.1, followed by a more technical description of each major component module (i.e., the manufacturing sector, nonmanufacturing sector, wage and income module, housing sector, and population model) in Secs. 3.1.2-3.1.6. A summary of the model's advantages and disadvantages is presented in Sec. 3.1.7.

3.1.1 General Structure

Generating a complete solution of the DRI/RIS model involves a two-step process. The model first projects levels of economic activity in nine regions, which are depicted in Fig. 4. In the second step, the model projects economic activity for individual states within each region.

The decision to model regional activity in a two-step process was the result of both theoretical and pragmatic considerations. Theoretical considerations are captured in the first step, i.e., the core model of the DRI/RIS system. The focus of the core model is to analyze the relative success of each geographic area in attracting and maintaining industries that serve national markets. As such, the theory of industrial location is an integral component of the core model. The industrial location algorithm in the core model differs from that incorporated in the state models, which comprise the second step of the DRI/RIS system. The algorithm differs because the factors influencing a business decision to move from one region to another are different from

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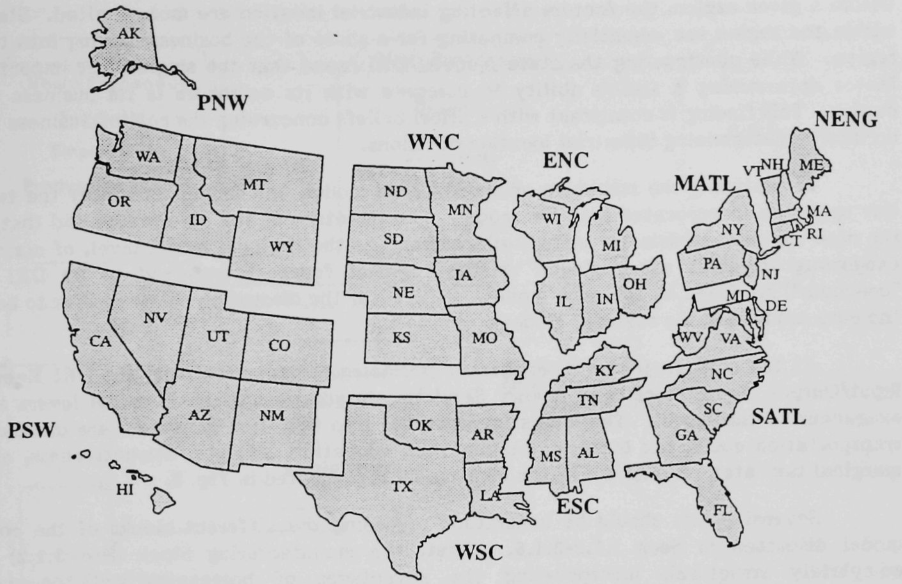
*This discussion is based extensively on documentation prepared by DRI (see DRI 1984a, 1984b, 1985a, 1985b, undated [a], and undated [b]).



Census Regions

Northeastern	Southern	Midwestern	Western
New England (NENG)	South Atlantic (SATL)	East North Central (ENC)	Pacific Northwest (PNW)
Middle Atlantic (MATL)	East South Central (ESC)	West North Central (WNC)	Pacific Southwest (PSW)
	West South Central (WSC)		

FIGURE 4 Regions Used in the DRI/RIS Model (Source: DRI 1989)

those affecting a firm's choice of a specific site within a region. The factors that a firm considers in the decision to move between regions are:

- Proximity to markets,
- Cost considerations such as wages, energy prices, and taxes,
- Degree of unionization,
- Housing prices,
- Climate, and
- Overall desirability or attractiveness of the region.

Within a given region, the factors affecting industrial location are more limited. States within the region are essentially competing for a share of the business moving into that region. While constructing the state models, DRI found that the single most important factor determining a state's ability to compete with its neighbors is its business tax burden. This finding is consistent with a priori beliefs concerning the role of business tax burdens in determining industrial location decisions.

In analyzing the structure of the DRI/RIS model, one should remember the two-tier approach incorporated into the model. The structure of the core model and that of the nine regional models are virtually identical. At the regional model level, of course, exogenous variables are replaced by the regional forecast (referred to by DRI as "concepts") produced by the core model. Otherwise, the discussion below applies to both the core model and the regional models.

At the core model level, exogenous variables are selected from the DRI Macro, Input/Output, Agriculture, and Energy Services. In addition, DRI/RIS model levers are exogenous to the model. The levers incorporated into this first-run model are distance, transportation costs, tax burdens, unionization, education, climate, attractiveness, and marginal tax rates. A diagram of the core model is presented in Fig. 5.

Several points should be understood regarding the different blocks of the core model discussed in Secs. 3.1.2-3.1.6. First, the manufacturing block (Sec. 3.1.2) is completely structural, incorporating the advantages of bottom-up and top-down techniques. Its pooled cross-sectional structure ensures that regional concepts sum to national figures without sacrificing the behavioral structure of bottom-up models. The specified structure of the model also makes possible the inclusion of a variety of cross-sectional concepts that could not be used in conventional time series regressions. These concepts include climate and attractiveness, which do not change over time, and other variables such as unionization, education, and personal and business taxes, which change only rarely or so gradually that they are not distinguishable from a time trend in the absence of cross-sectional methods. In addition, manufacturing employment relies on domestic-sector employment and on activity in the area's export-base industries. The relative impact of these factors will depend on the manufacturing sector in question. For example, concrete manufacturing is only marginally affected by export-base activity. Automobile production, on the other hand, is primarily a function of demand outside the state and is, therefore, largely independent of domestic-sector fluctuations.

The nonmanufacturing block (Sec. 3.1.3) also distinguishes among state, regional, and national end-market demand. Because state and regional boundaries are abstractions, a state's economic activity is a function of economic health in neighboring states as well as within its own borders. For example, a sharp decline in New Jersey's consumer spending will affect retail sales employment in New Jersey, New York, and Pennsylvania. Similarly, Florida's tourism-related employment can be expected to change in times of national economic malaise.

Most nonmanufacturing activity is a function of state, regional, and national income. Three nonmanufacturing sectors are exceptions to this rule. Construction employment is primarily a function of housing and nonresidential building activity, while

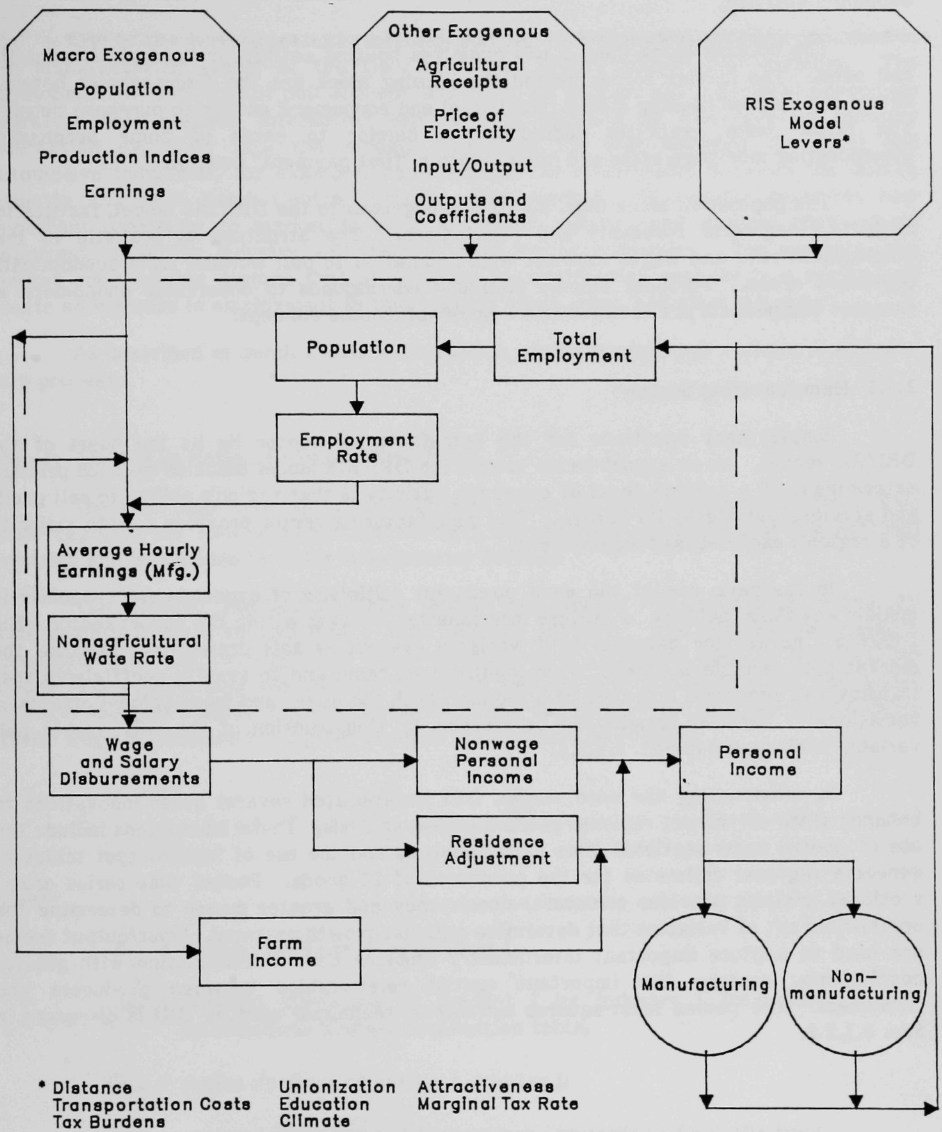


FIGURE 5 General Structure of the DRI/RIS Model (Source: DRI undated [a])

mining and federal government employment are principally dependent on national economic activity.

The housing block (Sec. 3.1.5) examines housing activity in light of affordability and need. The driving forces behind the housing block are the discrepancies between actual and desired housing stocks (stock gap) and consumers' ability to purchase housing. The latter term explicitly addresses the barrier to entry of home purchasing, incorporating mortgage rates and income into a "first payment" concept.

The population block (Sec. 3.1.6) is endogenous to the DRI/RIS model, facilitating realistic, long-term forecasts and simulations. The structure is realistic in that employment rate and wages interact with population to pull workers from economically depressed areas. Personal income similarly corresponds to observable phenomena as forecast components are summed into a personal income concept.

3.1.2 Manufacturing Sector*

Employment equations for the manufacturing sector lie at the heart of the DRI/RIS model. As an export-based model, the DRI/RIS model assumes that the primary determinant of a region's level of economic activity is that region's ability to sell goods and services outside of its borders. The manufacturing sector provides a large majority of a region's export-based employment.

In the past, one of the most persistent criticisms of export-based econometric models was their inability to capture interindustry linkages within the export sector. The DRI/RIS "market (or demand) pull" variable overcomes this drawback. Because the market pull variable is linked to an input/output table and to gravity coefficients that measure the economic bulkiness of a product, both the intra- and interregional effects of variations in regional growth can be measured. Construction of the DRI market pull variable is discussed in Sec. 3.1.2.1.

In constructing the core model, DRI incorporated several other innovations to enhance state-of-the-art regional economic base analysis. These innovations include the use of pooled cross-sectional time series analysis and the use of input/output tables to generate regional estimates for the purchases of 20 goods. Pooled time series cross-sectional analysis provides structural consistency and greater power to determine the appropriate set of variables that determine regional growth patterns. Input/output tables are used to capture important interindustry linkages and, in conjunction with gravity coefficients, capture the important spatial relationships between producers and consumers. The pooled least-squares estimation technique used by DRI is discussed in Sec. 3.1.2.2.

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*Historic shares and forecasted growth rates by DRI/RIS region are presented by SIC code in the appendix.

3.1.2.1 Market Pull Variable

One of the most important variables, and certainly the most complex one, used in the manufacturing sector of the DRI/RIS model is the market pull variable. The development of the market pull concept was based on suggestions in regional economics literature that regional interaction can be best modeled by incorporating industry interaction explicitly into the model. Including the link between the steel and automotive industries, for example, helps explain the relationship between the Middle Atlantic and East North Central regions. The market pull variable measures how important proximity to market is to a particular industry and ensures that, where important, a selling industry will develop near buying industries. For example, the market pull variable ensures that an increase in construction activity in a region will create an increase in employment in that region's stone, clay, and glass industry.

As described in detail below, construction of the market pull variable is a three-step process.

Step 1: Linking to National Input/Output Table

The first step is to link market demand to the national input/output table. This table captures the flow of goods and services between various sectors of the national economy and is provided by DRI's Interindustry Service.

The national input/output table is first compressed into a 29 × 36 matrix (29 intermediate demand sectors plus 7 final demand sectors). This construction permits examination of the two-digit SIC code manufacturing industries used in the DRI/RIS model. The coefficients necessary to calculate regional demand for 20 goods (SIC codes 20-39) in the nine DRI/RIS regions are derived from the compressed national input/output table. Regional demand for a given product is calculated as follows:

$$D_{ri} = \sum_{j=1}^{29} (a_{ij} \times SH_{rj}) + \sum_{f=1}^{7} (b_{if} \times SHF_{rf}) \qquad (1)$$

where:

D_{ri} = demand in region r for product i ,

a_{ij} = national purchases of product i by industry j from the intermediate demand transaction table,

SH_{rj} = region r's share of national industry j,

b_{if} = national final demand for product i by sector f from the final demand transaction table, and

SHF_{rf} = region r's share of final demand for good f.

This equation in essence says that the demand for a good (e.g., chemicals) in a particular region (e.g., the Pacific Northwest) is equal to the region's share of all intermediate consuming sectors times the amount each consumes, plus the region's share of all final consuming sectors times the amount each consumes. The regional shares that are most often used in the intermediate demand calculation are shares of employment in a particular buying industry. The exception is in agriculture, where farm cash receipts for crops and livestock are used in the sharing process. In the final demand sectors, the sharing factors vary more widely. Personal consumption is shared on the basis of personal income, residential investment by housing starts, government consumption by employment in government, and nonresidential investment on the basis of an investment proxy. These calculations provide estimates of the demand for 20 different goods in the 9 regions.

Step 2: Discounting by Distance

The second step involves discounting the demand by distance. Once the size of the market for a given good is determined in step 1, the next step is to determine if that good will be provided by industries within a region or if it will be imported from another region. Little information is available on the interregional flows of commodities, so it is impossible to generate a useful time series on a region's net import-export position with respect to all commodities.

An alternative to import-export calculations is the use of gravity coefficients. Gravity coefficients are often used in transportation modeling to discount market interaction over distance. In simple terms, a gravity coefficient says that the closer you are to a market, the more likely you are to trade with it. Gravity coefficients are specific to commodities and essentially represent the economic bulkiness of that product. Cement, for example, has a very high gravity coefficient. An average ton of cement only moves about 100 miles from the site of production to the site of consumption. Cement manufacturers are not very likely to sell to a potential buyer several hundred miles away. Computers, on the other hand, are not economically bulky. An average computer moves about 1100 miles; thus, computers have a low gravity coefficient. A computer buyer is likely to receive bids from firms around the world. Most commodities lie somewhere between these two extremes.

The demand for a given product in a given region is discounted using the following formula:

$$DA_{ki} = \sum_{r=1}^{9} \frac{D_{ri}}{(d_{kr})^{\lambda_i}} \qquad (2)$$

where:

DA_{ki} = discounted market for product i produced in region k,

D_{ri} = demand in region r for product i,

d_{kr} = distance in miles between producing region k and purchasing region r, and

λ_i = gravity coefficient for product i.

The distance between regions is expressed as the number of miles between the largest cities in each region. The calculation calls for the distance within a region to be used as well as the distance between it and all other regions.

Step 3: Normalizing

In the final step of this procedure, the raw numbers produced by steps 1 and 2 are normalized to yield the final market pull variable. This step involves dividing the discounted market for products produced in a particular region by the sum across all regions of the discounted markets. The market pull variable can be thought of as the share of the market for which a particular region has a transportation advantage over other regions. This step can be expressed as:

$$DPK_{ki} = \frac{DA_{ki}}{\sum_{k+1}^{9} DA_{ki}} \tag{3}$$

where:

DPK_{ki} = market (demand) pull for product i produced in region k, and

DA_{ki} = discounted market for product i produced in region k.

3.1.2.2 Pooled Least-Squares Estimation Technique*

The technique of pooled cross-sectional time series estimation, referred to as a pooled least-squares estimation technique (PLS) by DRI, was used to estimate manufacturing sector employment in the DRI/RIS model. The data set for a PLS estimation contains observations for the dependent and independent variables for every time period of the estimation interval, as well as for every section of the pool, i.e., states or regions. Running a PLS estimation across the original data yields a set of regression coefficients that are constant over time (as in ordinary least-squares estimation) and constant across sections.

The fundamental assumption involved in the PLS technique is that the dependent variable reacts to a unit change in an independent variable by a fixed amount across time as well as across sections. A unit change in an independent variable will alter the dependent variable by a fixed amount and in a fixed direction (i.e., the amount and direction of the regression coefficient). All other assumptions of the ordinary

*This discussion is based on DRI (1981).

least-squares estimation (Gauss-Markov Theorem) are supposed to be met in PLS estimations, allowing the use of standard hypothesis tests, including the t-statistic, the F-statistic, the R-squared, and others.

Running a PLS estimation on the original data set gives reasonable results only if the categorical means and variances (i.e., the means and variances computed in every section over time) are not very different. Many data transformations can be designed to ensure a better consistency within the original data set.

The deviation transformation technique is a three-step procedure:

1. Every observation in the original data set is replaced by its deviation from the corresponding categorical mean, i.e.:

$$x(s,t) = X(s,t) - X(s,.) \tag{4}$$

   where X(s,t) is the observation for section s and time period t in the original data set and X(s,.) is the categorical mean in section s.

2. The PLS estimation is run without a constant, using all the transformed data. This is possible because the average of the transformed data across all data sets is zero by definition.

3. Categorical constants are computed using categorical means (as follows for the one-variable case):

$$a(s) = Y(s,.) - b \times X(s,.) \tag{5}$$

   where Y(s,.) is the categorical mean of the dependent variable and b is the regression coefficient from step 2. The final equation for a section s is then structured as:

$$Y(s,t) = a(s) + b \times X(s,t) \tag{6}$$

   Here we see that impacts of explicit independent variables are the same across a section, but impacts of excluded variables (which are captured in the constant term) are allowed to be different across sections.

Because of the specific requirements of the DRI/RIS model (i.e., the dependent variables in the manufacturing model are shares of employment bounded by 0 and 1), other data transformations have to be undertaken. In a cross-sectional share model, the sum of the shares across sections is, by definition, 1 in every time period. So, a desirable feature would be for every independent variable to sum, across sections, to a constant in every time period and, for the sake of simplicity, to 0 or to 1. In the current specification of the DRI/RIS model, every independent variable sums to 0 across sections, except for the market (demand) pull variables (defined in Eq. 3), which sum to 1.

In algebraic form, this specification is written as

$$\sum_{s=1}^{n} X^{i}(s,t) = 0, \quad \sum_{s=1}^{n} X^{d}(s,t) = 1, \text{ and } \sum_{s=1}^{n} Y(s,t) = 1 \qquad (7)$$

where:

$X^{i}(s,t)$ = value of independent variable i for region s at time t,

$X^{d}(s,t)$ = last variable in the set of X's, or the market pull variable, and

$Y(s,t)$ = value of the dependent variable for region s at time t.

This implies that:

$$\sum_{i=1}^{d} \sum_{s=1}^{n} X^{i}(s,t) = 1 \qquad (8)$$

From the equation for the computation of the regional constants a(s),

$$\sum_{s=1}^{n} a(s) = \frac{1}{m} \sum_{s=1}^{n} \sum_{t=1}^{m} Y(s,t) - \frac{b^{i}}{m} \sum_{i=1}^{d} \sum_{s=1}^{n} \sum_{t=1}^{m} X^{i}(s,t)$$

$$= \sum_{s=1}^{n} Y(s,.) - \frac{b^{1}}{m} \sum_{i=1}^{d} \sum_{s=1}^{n} X^{i}(s,.) \qquad (9)$$

$$= 1 - b^{d}$$

where b^{i} is the coefficient of $x^{i}(s,t)$ and b^{d} is the coefficient of $X^{d}(s,t)$. This result implies that:

$$\sum_{s=1}^{n} \hat{Y}(s,t) = \sum_{s=1}^{n} a(s) + b \sum_{i=1}^{d} \sum_{s=1}^{n} X^{i}(s,t) = 1 \qquad (10)$$

or that the forecasted values for the dependent variable $\hat{Y}(s,t)$ sum to unity across regions.

The PLS estimation technique has two primary advantages. Most importantly, the PLS structure ensures a "zero-sum" game solution; regions can only gain employment at the expense of the rest of the nation. Any change in an area's explanatory variable is necessarily offset by an equal and opposite change in that variable in other regions because the variable value, across regions, is constrained to a constant.

This self-control mechanism guarantees a model forecast in which the sum of the parts equals the whole. The model is both bottom-up, since the share equations are structural, and top-down, since the shares are multiplied by exogenous national (or regional) totals to get regional (or state) levels.

The PLS technique also has two secondary advantages. First, the output of a PLS estimation relies on a larger data set (and subsequently more degrees of freedom) than the usual ordinary least squares (OLS) estimation on a single time series, thereby yielding more reliable coefficient estimates. Second, it is possible to use variables that are constant over time but that differ across sections (e.g., attractiveness and climate), allowing enhanced explanation of interregional discrepancies.

3.1.3 Nonmanufacturing Sector

The nonmanufacturing sector of the DRI/RIS model covers employment in the government, mining, and domestic sectors. For the purposes of the model, construction is considered a portion of the housing (construction) block. The industries that comprise the nonmanufacturing sector of the model are treated as domestic for the most part; see Sec. 3.1.3.3 for exceptions. In export-base theory, domestic industries are those that serve primarily local needs. Barber shops, fast-food outlets, real estate brokers, retail establishments, hospitals, local government, and utilities, for example, all derive most of their revenues from within the region. Business activity in each of the nonmanufacturing sectors is essentially driven by personal income in the region.

The following discussion describes the three components of the nonmanufacturing sector of the DRI/RIS model.

3.1.3.1 Government Employment

The government employment portion of the model is broken into two groups: (1) state and local government and (2) federal government. State and local government jobs are forecast on the basis of tax collections for state and local governments and on federal transfers to state and local governments. The level of state and local tax collections is a policy lever in the DRI/RIS model. It is manipulated by changing the business or nonbusiness tax burdens in the state or region. Federal transfers to state and local governments are determined in identity equations that allocate federal transfers to state and local governments on the basis of the portion of the population not working in the state or region, relative to the same ratio for the nation. This term is designed to capture the countercyclical nature of federal transfers.

Federal government employment, which is distributed largely on the basis of population, covers all nonmilitary federal employees. A regional forecast is produced by sharing out total federal government employment on the basis of a long-term moving average of the state or regional share of total employment.

3.1.3.2 Mining Employment

The mining industry is one portion of the nonmanufacturing sector that is clearly in the export base of a region's economy. That is, a substantial portion of mined materials are not consumed in the region that produced them; examples are oil and natural gas.

The DRI/RIS mining equations rely on several terms:

- A state- or region-specific, fixed-weight production index that captures the specific mix of mining industries in the area. The weights are derived from the *Census of Mining*, published every five years by the U.S. Department of Commerce.
- The ratio of the price of labor to the price of energy, which captures the labor/energy substitution that occurs in the mining industry.
- A time trend, included as a proxy for productivity trends.
- Dummy variables to capture the effects of strikes. These can also be used as policy variables to test the impact of possible future strikes.
- The ratio of energy prices to all prices, which captures the portion of energy development that is not well-reflected in a fixed weight index.

3.1.3.3 Domestic Employment

Domestic employment comprises employment in (1) services, (2) trade, (3) transportation, communication, and public utilities, and (4) finance, insurance, and real estate. This is typically the largest employment sector in the model in terms of the number of people employed. The domestic sector can be part export-based and part domestic. The banking industry in New York is a good example of an industry in the domestic sector that has a substantial export component. To calculate the export-oriented portion of employment in each domestic sector, the proportion of total employment is first calculated for every state and region. The lowest proportion is then used as an indicator of the amount of, for example, service employment that is "needed" by a region. Any employment above that proportion is treated as export-oriented and is tied in the model to demand in the rest of the region and the rest of the country.

Regional employment in the domestic sector is determined by the mix of personal income sources in the region and the nation. At the state level, it is determined by the mix of state, regional, and national personal income sources. At both the state and regional levels, the various types of income are combined into a weighted index of demand for domestic services. The index is deflated by wage rates to reflect the power of a dollar of personal income to purchase the services of a domestic sector employee.

To capture the cyclicality of the domestic sector, the weighted index of demand for domestic services is specified in the employment equations by using a variation of Friedman's permanent and transitory income hypothesis (Dornbusch and Fischer 1978). Friedman observed that consumers make consumption decisions on the basis of long-run expectations of income and that transitory changes in income are either saved or dissaved (i.e., the marginal propensity to consume a dollar of transitory income is less than the marginal propensity to consume a dollar of permanent income).

Permanent income is represented in the model as a long-run moving average of the weighted index of demand for domestic services. Transitory income is defined as the difference between the last period's value of the index and a long-run moving average of the index. Consistent with theoretical expectations, the coefficient of the transitory component is substantially smaller than the coefficient of the permanent component. The result of this specification is a short-run income multiplier that is smaller than the long-run income multiplier.

The final term included in the domestic-sector equations is the ratio of labor costs to capital costs. This term captures the labor/capital substitution effect. Because this substitution is dynamic, a long-run moving average of the ratio is used.

3.1.4 Wages and Income

Personal income provides the link between the export and domestic sectors of the export-based DRI/RIS model. The wage bill generated in a given region's export sector drives its domestic sector by a multiplier effect. In the DRI/RIS model, domestic economic activity is determined by total real personal income in a given region.* The ratio of personal income to export wages yields the export wage multiplier. The linkage occurs via the wage and salary disbursements term. This relationship between the export and domestic sectors is essentially simultaneous. The simultaneity works as follows:

- Wage and salary disbursements, as a major component of personal income, are a determinant of domestic sector employment.

- Domestic sector employment is a major component of total employment.

- Total employment is a major determinant of wage and salary disbursements.

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*A residence adjustment is applied to income earned in one state or region and spent in another (for example, a person employed in New York City with residence in a bedroom community in southwest Connecticut). For an explanation of residence adjustment, see DRI (1984a), p. 68.

The regional manufacturing wage rate, the main determinant of the wage bill in the region's export sector, is modeled in the DRI/RIS model as a function of the following variables:

- *National wages.* This is the driving variable in the equations. National wage trends are modified by regional labor market conditions and the regional cycle.

- *Ratio of the region's share of national employment to the region's share of national population.* This variable is designed to capture regional labor market tightness. To the extent that the percent of the national work force in a region exceeds the percent of the population living in the region, wage rates will be squeezed upward by a tighter-than-average labor market.

- *Current national industrial production relative to its long-run value.* This variable is cyclical and may appear in the wage equation with either a positive or negative sign. A positive coefficient implies the marginal employee is paid at a higher wage than the average, and a negative coefficient implies the reverse.

Farm income is determined primarily by cash receipts for crops and livestock at the state or regional level. Regional farm income is disaggregated from national farm income, and state farm income is similarly derived from regional farm income.

The balance of personal income is accounted for in the nonwage income term. Nonwage income is defined as the sum of nonfarm proprietors' income, transfer payments, residence adjustment, dividends, interest, rent, and other labor income, minus contributions for social insurance, and is divided into two aggregates: taxable and non-taxable.

Nonwage income is modeled using various sharing algorithms that disaggregate national income components to the regional or state level. The algorithms ensure the appropriate cyclical and countercyclical behavior. The sharing techniques are fairly straightforward with the exception of that for transfer payments. Because these payments are countercyclical, a simple sharing process would not suffice. It was necessary to derive a method to increase transfers as the economy slowed.

3.1.5 Housing Sector

The DRI/RIS model includes an expanded and enhanced housing sector. New concepts (i.e., variables) that are forecast in this sector of the model include the average price of new single-family homes and the level of construction employment. Enhancements include improving consistency across areas and using area-specific prices in determining affordability.

The foundation of the DRI/RIS single-family housing starts model is a modified form of the stock-adjustment model. In a stock-adjustment model, it is assumed that there is some underlying desired stock of housing that is a function of population and propensity to form households. Housing starts are then a function of this stock gap and financial supply and demand terms that reflect the affordability of purchasing housing and the profitability of constructing housing.

The DRI/RIS single-family housing starts equations contain the following four terms:

- *Desired vs. actual housing stock.* The desired stock of housing is a key component of the specification. Many attempts have been made to model this concept. Two divergent approaches are common. One successful approach has been to use microdata to predict each household's consumption of housing. Such an approach produces strong cross-section results, but has yet to be adapted for forecasting. The other common approach defines the desired stock per capita as a function of long-term affordability of housing and a time trend to reflect nonprice-related taste changes. This approach has been adopted by DRI, and state housing price, income, and population data are used to create state-specific desired stock series.

- *Real after-tax mortgage rate.* This variable reflects the equity effect of purchasing a home. The monthly payment on a mortgage is not equivalent to monthly expenditures for consumption of housing, because the underlying asset is appreciating in value. If appreciation exceeds the mortgage rate, the real interest lost is negative, as was the case from 1976 through 1979. In periods of high interest rates and slow price appreciation, such as in the early 1980s, the real interest rate becomes strongly positive, eliminating the investment motivation for buying housing.

- *Long-term affordability.* This term reflects both the buyer's consumption decisions and the lender's rule that housing payments not exceed 25-30% of gross income. Past modeling attempts have deflated per capita income with either national consumption deflators or national home prices. Neither captures differential price escalations and the perverse impact of high mortgage rates.

- *Transitory affordability.* This term captures short-run changes in affordability, which are crucial to consumer confidence.

Two new behavioral concepts in the DRI/RIS model housing sector are home prices and construction employment. Home prices are derived from the 1970 and 1980 censuses, data on value and number of permits, and home price data for the four census regions. According to DRI, these data have proven to be important determinants of manufacturing location decisions and have been crucial in the development of all terms in the single-family housing starts equations. They are modeled as a function of national home prices, relative per capita income, and relative housing market tightness. Market tightness is defined as the ratio of actual to desired housing stock.

Construction employment is driven by DRI-derived proxies for residential and nonresidential investment in construction. The residential construction term uses area housing starts and stock to allocate national investment. The sharing factors are derived from the national input/output table. National nonresidential construction is proportioned to areas on the bases of growth in employment and area share of employment. This is done with weights derived from an historical analysis of the replacement share of national construction investment. Both sharing algorithms force summation to national totals and ensure that replacement construction (that part proportioned by housing stock and level of employment) will be more important in times of slow growth than in times of high growth.

3.1.6 Population

The DRI projections of regional and state population use an equation that has been estimated by econometric methods in which the regional share of the national population (or the state share of the regional population) is a function of (1) the regional (or state) share of employment (3-year moving average), (2) the regional (or state) relative wage (3-year moving average), (3) the measure of attractiveness (share of tourism employment), (4) education level (percent college-educated), (5) rainfall, and (6) heating degree days. The employment variable is the most important term in the equation, followed by the relative wage. The coefficients of relative employment and wage rate growth capture the general tendency of people to move toward fast-growing regions rather than away from depressed ones. Hence, more movement occurs when the overall economy performs strongly.*

The estimation technique used is similar to the pooled time-series cross-sectional technique applied in the manufacturing sector. Consequently, this ensures that regional population forecasts will sum to the total reported by the DRI macroeconomic model (actually, the Bureau of the Census "middle" projection); all movements of population are therefore balanced.

3.1.7 Summary

The DRI/RIS model is, in our judgment, well designed and capable of performing the required tasks for the Phase 1 test runs of NAPAP. Its inclusion of comparative advantage indexes in the region for employment shares lends a strong microeconomic flavor to the DRI approach. Thus, the model makes it possible to take into account the influence of public policy on the regional location decision, making it suitable for policy simulation. The major drawbacks to the DRI/RIS model are its relatively short history of applications and its lack of documentation of the statistical results in the estimation of the model. For example, the model documentation provides no information on the statistical significance of the regional comparative advantage variables.

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*For a more complete discussion of the DRI/RIS population projection methodology and the recommended method to extend its forecast time horizon, see McDonald and South (1985).

3.2 CHASE STATE AND METROPOLITAN AREA FORECASTING SYSTEM*

3.2.1 General Structure

The State and Metropolitan Area Forecasting System developed by Chase Econometric Associates, Inc., is a series of state and metropolitan area econometric models. There are 51 state models (for the 50 states and the District of Columbia) and 300 metropolitan area models. These metropolitan area models are smaller, satellite models that forecast 5 to 20 variables, depending on the size of the metropolitan area and the availability of data.

The approach used by the Chase modeling system represents a significant departure from that of most multiregional models. Most other regional models are constructed as simple proportions of the United States. The Chase system, however, focuses on internal growth dynamics and differential business cycle responses. This structure contrasts sharply with the pure share (top-down) models and models that are not linked to a national macroeconomic model (bottom-up); it contains the best of both approaches. Through this approach, each area is modeled individually and then linked into a national system. In addition, the Chase modeling system is an interregional one, because the state models include interstate linkage variables that allow economic conditions in one state to influence activity in other states.

The Chase models also respond to changes in such items as tax rates, military spending, and utility costs. This "policy sensitivity" is due to the following factors. First, each state is modeled individually, with all the required variables -- income, employment, population, energy demand, housing starts, manufacturing activity, and consumer expenditures -- forecast at the state level. Second, national policy is explicitly captured in the Chase models, and third, the comparative advantage of one state over another is explicitly modeled using relative cost variables.

The Chase models have a quarterly periodicity (with the exception of the smaller metropolitan statistical areas). This enables the models to fully capture the business cycle. Currently, the modeling system has a 10-year forecast horizon, although 20- and 30-year forecasts can be made by special arrangement.

The state models each consist of three major components that are solved simultaneously: state export activity, state local output, and personal income. The resulting information is used to drive a series of optional satellite submodels that estimate consumer expenditures, banking and financial activity (including new passenger car registrations, time and demand deposits, business and personal loans, and retail sales), and energy demand in the transportation, residential/commercial, and industrial sectors. The satellite energy demand module estimates total energy demand (in Btu) but does not disaggregate this estimate into fuel-specific demand. These satellites are one-way models in that their outputs are not incorporated into feedback loops with the core state model.

*This discussion is based on two sources: Tierney (1981) and Chase Econometrics (1985).

The state models are structured on an economic base theory framework, in that local economic activity is assumed to depend on the magnitude of export-industry activity. However, the Chase modeling system is not an economic base multiplier type of model. It uses econometrically specified relationships to estimate export-industry output as a function of nationally determined variables and regional-attractiveness variables. Local output is estimated as a function of export activity and demographic variables. A valuable feature is that, unlike other regional models, this modeling system explicitly considers energy prices in estimating industrial activity.

The Chase modeling system also includes a population module. Many of the regional models surveyed for this report simply project population growth mechanically using information provided by the Bureau of the Census. The Chase model, however, estimates net migration as a function of economic variables and uses the results to calculate population growth.

3.2.2 State Model Components

The state models are driven by national variables, which are incorporated into econometric forecasting equations. These equations are specified so as to reflect the major features of the respective state or regional economy. The state models may be used together to simulate all the state components of the national economy simultaneously, they may be grouped to reflect specific regions, or they may be used individually to study specific states. If the whole system is solved simultaneously, the state economic and demographic forecasts are summed over all states and adjusted to equal macroeconomic totals as forecast by a macroeconomic model, usually the Chase Macro Model.

The state models all have three primary components: export activity, local activity/income, and population projections. These components are solved simultaneously. This reflects two major assumptions about how state or regional economies are organized. The first assumption, which comes from economic base theory, is that export activity in a state is a major determinant of total local economic activity. Economic activity both in the export and local industry sectors is estimated econometrically as a function of variables that capture national trends, state, or region-specific growth trends, and regional business-cycle behavior. (However, the Chase models do not calculate or use economic base multipliers.) The second major assumption concerns how export and local industries are grouped. Exporting industries are assumed to be manufacturing, mining, and agriculture. Financial services and insurance are also treated as export-oriented in those states where they are major industries, such as New York and Connecticut. Some of the state models do not explicitly distinguish between manufacturing industries that produce for local markets and those that produce for national markets. Otherwise, local industries are assumed to be construction, wholesale and retail trade, services, local government, utilities, and usually finance and insurance.

The export activity, local activity/income, and population components of the state models are further described below.

3.2.2.1 Export Activity

The major linkages among the models occur in the export sectors, which consist of agriculture, mining, the federal government, and most manufacturing industries. (The banking and insurance sectors are classified as export sectors in a few states.) Such export sectors generally serve national rather than local markets, or do not depend on the local market. The income generated from these sectors often provides the major economic stimulus to the local economy and therefore, the local growth (or decline) of these sectors is a major determinant of regional economic conditions.

Manufacturing is the predominant export activity for most states, so this sector is given special attention in the state models. The current version contains quarterly models of employment for the 20 manufacturing sectors that have a two-digit SIC code. Employment levels are estimated with national and state-specific explanatory variables, including the relative costs of energy, labor, and taxes.

The manufacturing employment equation for each two-digit SIC code industry in each state is specified as:

$$E,_{ij} = f(EMUS_i, RWJP_{ij}, RINTDM_{ij}, RCOST_j, LPRM_j, FINDEM_j) \quad (11)$$

where:

EM_{ij} = employment in industry i in state j,

$EMUS_i$ = employment in industry i in the United States,

$RWJIP_{ij}$ = industry mix within industry i in state j, relative to the corresponding national industry mix,

$RINTDM_{ij}$ = relative interindustry demand in industry i in state j,

$RCOST_j$ = costs of doing business in state j, relative to the national costs of doing business,

$LPRM_j$ = labor productivity in state j, relative to national labor productivity, and

$FINDEM_j$ = final demand factor in state j.

The first two terms are the key linkages to U.S. economic activity and may enter the equation in two ways: (1) when U.S. employment by two-digit SIC code industry is modified by that industry's mix in the state relative to the national mix, and (2) when state-weighted industrial production is modified by national productivity trends in each industry. The industry mix variable ($RWJIP_{ij}$) is a reweighting of the U.S. indexes of industrial production at the three-digit SIC code level according to the relative importance of these industries within the state's two-digit SIC code sectors. The interindustry demand variable ($RINTDM_{ij}$) measures both the interindustry and the interregional demand for the output of the two-digit SIC code industry based on input/output relationships, geographic location of potential markets, transportation costs (distances), and expected demand growth. The cost of doing business ($RCOST_j$) is a vector of variables that includes (1) labor costs (state wage relative to the national wage, weighted by the industry mix in the state), (2) capital costs (wage rate in the construction industry), (3) energy costs (natural gas and electricity costs), (4) tax cost (ratio of total state and local taxes to state personal income), and (5) transportation and distribution costs. The final demand factor ($FINDEM_j$) measures the demand for the output of the industry as a final product for consumption, investment, or government purchase.

The equations estimated for other export sectors, such as mining and agriculture, vary from state to state depending on the nature of the product and the market for it. No general form for these equations can be specified.

3.2.2.2 Local Activity

Local, or nonexport, industries in the Chase state models are those that generally provide support services and infrastructure to the export sectors and the local population. The primary dependent variables are local industry employment and personal income; these are determined simultaneously with export employment and population. The current version of the model estimates employment in six local industry sectors (wholesale/retail trade; services; state and local government; construction; finance, insurance and real estate; and transportation and utilities).

Sector employment in the local economy is estimated as a function of local economic activity, wage costs, national conditions, and business-cycle timing. Local economic activity represents factors that drive the local economy, including real income, population, and export sector activity. National conditions include factors that affect activity and employment in the construction industry and retail trade, such as credit availability and interest rates. The business-cycle variable attempts to capture the impact of state-specific economic cyclical movements on labor demand.

Personal income is the most frequently used variable, either alone or in combination with others. Since it captures wages, transfer payments, and nonwage income, it is the best measure of aggregate economic activity at the state level and a key determinant of the level of services. Moreover, through its effect on trade and tax revenues, it also has a significant influence on the wholesale/retail and government employment categories, which are major contributors to personal income (through wages). Figure 6 shows how personal income and local economy are solved simultaneously in the Chase model, which reflects the fact that personal income is a function of employment and that employment categories are a function of income.

Personal income is expressed as a function of total employment, the unemployment rate, and industrial output variables. The following categories of personal income are determined endogenously:

- Total personal income,
- Disposable personal income,
- Manufacturing wages,
- Nonmanufacturing wages (government, construction and mining, and private service producing),
- Other labor income,
- Farm proprietors' income,
- Business proprietors' income,
- Transfer payments, and
- Contributions to social insurance programs (negative offset to income).

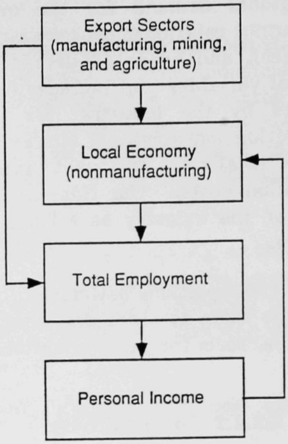

FIGURE 6 Simultaneous Determination of Income and Employment in the Chase Modeling System (Source: Chase Econometrics 1985)

In addition, total wages, proprietor's income, and property income are calculated by summing over the appropriate income groups.

The manufacturing wage in each state depends on labor productivity, state manufacturing output relative to the U.S. total, the state ratio of unemployment to population, and the industry mix of the state. The weights in the industry mix variable are the endogenous employment levels in the two-digit SIC code industries. The wage in the construction/mining sector is a function of industry mix and the relative unemployment rate of the state. The wage in the private service producing sector depends upon these two variables plus the manufacturing wage to capture any wage rollout effects. The government (state and local) wage is a function of the wage in the private service producing sector.

The Chase modeling system has included careful specifications for business proprietors' income, farm proprietors' income, and contributions to social insurance programs. The computation of personal income is a strong feature of the Chase modeling system. Personal income is the best published measure of economic activity in a state. The additional components needed to estimate "gross state product," such as corporate income and depreciation, are not available at the state level and must be imputed from national data. Chase, similar to other regional model builders, has chosen not to make such imputations.

3.2.2.3 Demographic Activity

The population component of the state models represents a more ambitious undertaking than the population-projection models in most other regional or multiregional models. It attempts to relate population dynamics to economic conditions while capturing demographic factors through cohort component techniques.* State- and age-specific birth and mortality rates are determined exogenously using Census Bureau and state birth and mortality rate information.

Migration in the Chase model is assumed to be related to regional differences in economic activity: people are assumed to move from low-wage, high-unemployment areas to high-wage, low-unemployment regions. Thus, annual net migration in each state is modeled as a function of relative economic performance variables, specifically, relative employment growth, relative unemployment, relative income growth, relative housing costs, housing market activity, and the U.S. unemployment rate.

3.2.3 Summary

The Chase system is a sophisticated econometric forecasting model of economic activity at the state and Standard Metropolitan Statistical Area (SMSA) levels. It exemplifies some unique features for regional energy policy analysis. General advantages of the Chase system include the following:

- Energy prices of electricity and natural gas are explicitly included in the estimation of manufacturing industry activity. Most regional or multiregional models do not include this feature.

- The system is driven by national variables and operates within the context of macroeconomic forecasts (when all the state models are solved together). However, to some extent, the state models are independent of the initial macroeconomic forecasts, because state economic activity is estimated econometrically as a function of state-specific factors as well as national variables. This formulation combines features of both top-down and bottom-up models: the state forecasts capture the structural dynamics of the state economies, but the whole system of models is constrained to match predetermined national totals, a feature not normally associated with bottom-up models.

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*The cohort component technique makes it possible for the demographic factors in population change to be built into the model. This method projects a given population by applying age- and sex-specific rates of fertility, mortality, and migration.

- The Chase modeling system provides reasonably good detail on manufacturing activity, with disaggregation to the two-digit SIC code level. More-detailed industry breakdowns can be obtained by linking the Chase state model with the Regional Industrial Planner (RINPLAN).

Two disadvantages associated with the Chase system are as follows:

- The system assumes that industries in the manufacturing, mining, and agricultural sectors produce for national markets, and that the other sectors usually produce for local demand. Some allowance is made on an ad hoc basis for those regions and industries where the export sectors produce for local demand and where the local sectors produce for export markets. However, in our view, more research on these matters would be useful.

- The system appears to be oriented toward analyzing interregional economic impacts. Its export industry employment formulation explicitly weighs the relative costs of doing business and includes interregional demand, thus considering economic conditions in other states. But it is not clear how suitable this method is for estimating how events in one region affect economic activity in other regions. Also, it is not clear that it adequately models the industry relocation process over time.

The current Chase system is relatively new, and its documentation is rather sketchy. A longer history of applications and more complete documentation could eliminate these concerns.

3.3 MULTIREGIONAL MULTI-INDUSTRY FORECASTING MODEL*

The Multiregional Multi-industry Forecasting (MRMI) model is a county-level econometric model. Developed by C. Harris at the University of Maryland in the early 1970s, the MRMI model is a highly disaggregated industry and regional model with 99 industry sectors and 3,111 counties. Annual forecasts of industry output, earnings, employment, population, and migration are generated for each county.

The driving concept of the MRMI model is contained within a locational analysis equation, which forecasts the change in output of a specific industry in a particular county as a function of several regional-attractiveness variables, such as (1) market prices for required inputs and outputs, (2) wage rates and labor supply, and (3) transportation costs associated with obtaining inputs and selling outputs. Changes in population, employment, and migration rates are then forecast on the basis of changes in output location. The model analyzes the movement of industry, employment

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*The discussion in this section is based on two sources: Tierney (1981) and Harris (1980).

opportunities, and population to more favorable locations in response to developments in some given industrial sector, region, or period.

The MRMI model is recursive, i.e., forecasts for year t+1 form the basis for forecasting year t+2. However, the regional and industrial forecasts generated by the MRMI model are constrained to equal national forecasts obtained from a macroeconomic model (usually the INFORUM model), and population forecasts are brought into balance with Census Bureau projections.

3.3.1 General Structure

The primary economic concept of the MRMI model is a locational analysis method based on the theory of Ricardian rents. Each firm in an industry is assumed to face a cost structure that is largely a function of location. The marginal producer in a competitive market, who is just able to cover costs at prevailing prices, earns zero economic profits. Other producers with lower or more favorable cost structures are said to earn positive economic profits, or accrue Ricardian rents equal to the difference between market price and cost of production.

The existence of rents in the market due to lower costs of production in some locations motivates higher-cost firms to consider relocation. Over time, firms are assumed to move closer to raw materials, skilled labor pools, and more favorable markets so as to maximize rents. Eventually, in the absence of external shocks, the economy should settle into long-run equilibrium. But in the MRMI model -- and in reality -- this long-run equilibrium is never attained; rather, the relocation process is continuous and gradual. There are several reasons for this. First, in the short run, most firms are constrained from relocating because of high levels of investment made in the existing capital base. As capital stock depreciates, relocation becomes a more viable alternative. Second, from period to period, new factors enter into the relocation decision. Since, in general, a county or regional economy is open, it is sensitive to exogenous shocks, such as public or private development plans, changes in the relative prices of imported and exported intermediate and final goods, or changes in transportation costs. These events cause shifts in the relative attractiveness of different regions over time. Third, many firms face multiple markets. Managers who wish to maximize profits must continually monitor and adjust production plans so as to obtain equal rents across all markets. Relocation is a complex decision because the major (as well as minor) variables change over time. Nevertheless, in each period some firms are assumed to move in the direction of lower costs. The MRMI model attempts to model this period-by-period shifting of industry, employment, and people.

The major driving equation of the MRMI model forecasts the change in output in a given sector and region as a function of several lagged variables, including lagged output, lagged transport and factor costs, lagged investment activity, and lagged agglomeration factors. These agglomeration factors are both positive (such as readily accessible markets, access to good transportation facilities, and support service availability), and negative (such as highway congestion and population density). This forecast is then used as an independent variable in subsequent equations. Capital development and investment activity is estimated as a function of change in output.

Change in employment in a given industry and region is estimated as a function of lagged output and investment activity and change in output. Net regional migration is forecast as a function of lagged wages, labor surplus/shortage, and changes in employment. Regional population is calculated by adding births and net migration to the preceding year's population and subtracting deaths. Income by economic sector and region is estimated as a function of employment and lagged equipment investment.

The MRMI model is currently available in two versions. One is a county-level model, encompassing all 3,111 counties in the United States; the other is a BEA economic-area-level model, encompassing the 173 BEA areas.* Each version has 99 industry sectors, 4 extra labor sectors for employment and earnings at different levels of government, 69 equipment purchasing or investment sectors that map directly onto the industry sectors, and 28 construction sectors. County population is divided into four age groups (0-14, 15-34, 35-64, and 65+) and two races (white and black).

The MRMI output for each year is a county or BEA area and sector-specific forecast of industry output and change in output, industry employment and change in employment, investment and construction activity, net migration, and population change. The county-level forecasts are aggregated into national totals and then brought into balance with control forecasts supplied by a national macroeconomic model. The industry sectoring scheme in the MRMI model is designed to be compatible with INFORUM, an interindustry macroeconomic model developed by Almon et al. (1974).

The MRMI model attempts to capture interregional interactions by assuming that the national transportation network provides the primary interregional link. The model includes a linear programming submodel that solves for the optimum, low-cost highway or rail route for shipping goods from one region to another. These cost data are used in the MRMI model as an explanatory variable for forecasting changes in output. As an additional feature, the MRMI model can be solved across all counties simultaneously, or it can be used to study economic development in individual counties or groups of counties, such as DOE areas or states. Once forecasts have been generated at the county level, they can be aggregated to BEA economic areas, SMSAs, states, or any desired unit of regional analysis.

The MRMI data base has both advantages and disadvantages. It is a massive collection of some 10,000 items per county, but it is also essentially a synthetic data base. Since, in most cases, county- and sector-specific data on output, investment, equipment purchases, income, and population growth and migration are not available, state-level data collected by federal agencies are allocated to the county level. The Census Bureau's publication *County Business Patterns* provides employment/output ratios or payroll/output ratios that can be used for this purpose. County-level industry input

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*During the last two years, the MRMI regionalization scheme has been changed to now encompass 585 economic regions (Harris 1985). These regions consist of SMSAs, "rest-of-BEA economic areas within SMSAs," and economic areas subdivided when necessary because of state boundaries. Each of the 585 regions is contained within a single state. Now, the model is first run for the 585 regions, and then, if county forecasts are necessary, the county model within each economic region is run.

requirements were estimated using national input/output technical coefficients. (To estimate the parameters of the equations of the model, cross-section time series data for 1970-1974 were analyzed to determine the year-to-year changes in the relevant independent variables of the various dependent variables.)

3.3.2 Summary

The MRMI model has been used for a variety of long-term impact studies of regional structural changes, including highway development, energy-facility construction and plant closings, and natural-resource development, such as offshore oil drilling and coal mining. Most of these applications have been designed to analyze the regional, interregional, and national impacts of specific regional developments or policies rather than the interregional impacts of national public policy. The MRMI model has been used primarily for long-term analysis, in part because it is constrained to operate within the forecasts of INFORUM (a long-run growth model), and in part because of its location-analysis design. There are several advantages and disadvantages associated with the MRMI model. Among the disadvantages are the following:

- Using the county as the primary unit of regional analysis does not reflect regional economic reality; available documentation does not offer an adequate rationale for this choice. In reality, groups of counties are inextricably bound into an economic unit. When these units are arbitrarily split into counties that, in the model, are linked only by input/output relationships and transportation cost data, a probable consequence is that some information on economic interrelationships is lost. This difficulty has been alleviated to a large extent by developing the BEA economic area version of the MRMI model. For the Phase 1 test runs, however, use of the BEA-level model would still entail aggregating (or disaggregating) BEA-level forecasts to correspond with the state and regional projections needed.

- As a top-down, recursive, and sequential model, the MRMI model does not capture important feedback loops between the regional and national economy, or between certain variables within the region. The sequential nature of the MRMI model means that certain variables that in theory influence each other (such as output and employment or income and consumption) are actually modeled as one-way relationships. The regional economic models are not solved simultaneously with the national model, so regional economic developments cannot influence macroeconomic performance. Since the MRMI model is a long-term model focusing on the movement of industry and population over time, rather than on short-term impacts, these characteristics are perhaps of somewhat less importance.

- It is not clear that the MRMI model adequately captures interregional activity or linkages. In relying on optimum transportation cost information generated by a highway/rail linear program to represent interregional activity, the model assumes somewhat unrealistically that the economic system really works in this way. It does not capture other cost or behavioral factors that influence interregional trade patterns.

In conclusion, these characteristics imply that MRMI is probably best suited for medium- to long-term analysis (5-25 years). Its location-analysis framework captures changes in the distribution of economic activity over time, but given that the data base consists of annual time series, the model cannot effectively analyze short-run impacts of economic changes. There is some question as to how reliable the county-level version of MRMI is as a forecasting tool, in part because much of the data base either consists of national totals proportioned by county or BEA area or is synthetic. It seems more reasonable to use the MRMI model as an impact analysis model to study how the process of industry relocation and migration might vary under different regional or national development scenarios.

3.4 FINAL RECOMMENDATION

Although any of the three regional models discussed in Secs. 3.1-3.3 would be satisfactory for the Phase 1 test runs of the TG-B emission model set, we believe that the DRI/RIS model is the best choice. Our reasons are given below.

First, there is some question about the capabilities of the Chase model to make long-run projections (see Sec. 3.3). Second, the DRI/RIS model is immediately compatible with the DRI macroeconomic projections, which were used in preparing the NEPP-85 energy forecast underlying the Phase 1 test runs. The Chase and MRMI models could be run using the DRI macroeconomic projections as inputs, but some conversion of input data would be required. In addition, the MRMI model currently produces projections for 173 BEA economic areas. These BEA areas would have to be combined (in some cases, disaggregated and recombined) to produce state projections. Consequently, it is our contention that the other attributes of these models, in comparison with the DRI/RIS model, do not justify the additional expense associated with the data conversion activities. Thus, the least-cost alternative is to use the DRI/RIS model.

In summary, the DRI/RIS model is at the right level of detail for present purposes; it runs directly from alternative DRI macroeconomic projections; it makes projections to the year 2009 (meaning that the projections need to be extended only 21 years); and it is based on sound microeconomic principles (Sec. 3.1). The chief disadvantages with the DRI/RIS model are its lack of documentation of the empirical results underlying the model and the short application history for the current version of the model. On the other hand, the current versions of both the Chase and MRMI models also suffer from these drawbacks.

For these reasons, the DRI/RIS model will be used to provide the regional (or state) economic activity forecasts for input to ARAM as part of the Phase 1 test runs of the TG-B emissions model set. Figure 1 (see Sec. 1.1) depicts the role of the DRI/RIS model in the energy/economic driver data task. The DRI/RIS model will supply the regional (or state) forecasts for economic activity variables employed in ARAM to (1) regionalize national driver variables and (2) derive shift-share factors for base year driver data. Use of the regional activity forecast in ARAM is described elsewhere (Hanson, South, and Oakland 1985). In addition, the DRI/RIS model will directly supply driver data to the sector models of the TG-B model set.

4 SAMPLE SIMULATIONS USING THE DRI/RIS MODEL

This section presents two sample simulations using the regional economic forecasting model recommended for inclusion in the TG-B emissions model set, i.e., the DRI/RIS model. These simulations are based on two alternate sets of DRI macroeconomic projections, developed in fall 1984, that were used as the inputs to the DRI/RIS model: the "pessimistic case" (referred to by DRI as its "lower" case) and a case referred to here as the DOE reference case.* These two sets of macroeconomic projections, which extend from 1980 to 2009, are described in Sec. 4.1. The resulting DRI/RIS model outputs, i.e., two alternate sets of state and regional projections to 2009, are described in Sec. 4.2.

4.1 MODEL INPUTS: MACROECONOMIC PROJECTIONS FOR 1980-2009

Table 3 summarizes the two sets of macroeconomic projections in terms of annual rates of growth. The DOE reference case contains more-rapid growth rates for real GNP, employment, and labor force than does the DRI pessimistic case. The differences in growth rates between the two cases are greater in the earlier years (1985-1990) than in the later years (1990-1995 and 1995-2009) of the projection period. This pattern emerges because the DOE reference case is based on a set of fiscal and monetary policies that result in 4% growth per year in real GNP for 1985-1988, 3% growth for 1989-1990, and the middle (or "trend") DRI growth rate thereafter. The DRI pessimistic case assumes that (1) productivity growth will be lower (1.6% versus 1.8%), (2) inflation will be about 2% per year greater than in the DOE reference case, and (3) fiscal policy will be severely constrained by a growing federal deficit.

The growth rate of total manufacturing employment for 1985-1990 is -0.14% per year in the DRI pessimistic case and 1.57% per year in the DOE reference case -- a difference of 1.71% per year. However, the difference between these two scenarios for the same sector in 1990-1995 is only 0.17%, and there is no difference for the period 1995-2009. The growth rates for manufacturing employment by two-digit SIC code and scenario are shown in Table 4. Substantial variation in employment growth rates across manufacturing industries is projected. In fact, in the DOE reference case, 14 of 20 manufacturing sectors are projected to experience absolute declines in employment after 1990. On the other hand, employment levels in chemicals (SIC 28), machinery except electrical (SIC 35), and instruments (SIC 38) are projected to grow appreciably after 1990. In contrast to the period after 1990, the 1985-1990 period of rapid growth in the DOE reference case is evident at the two-digit SIC code level. Seventeen of the 20 industries are projected to experience employment growth in this period, and 12 are projected to experience employment growth in excess of 1.0% per year.

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*These same sets of projections, extended to 2030 by DRI, were used in the Phase 1 test runs of the TG-B emissions model set. The projections are described in DRI (1985d) and Pieper et al. (1985).

TABLE 3 Average Annual Growth Rates under Two Macroeconomic Scenarios (%)

Macroeconomic Variables	DOE Reference Case	DRI Pessimistic Case	Difference between the Cases
Real GNP			
1985-1990	3.61	2.28	1.33
1990-1995	2.54	1.95	0.59
1995-2009	2.35	1.94	0.41
Total nonfarm employment			
1985-1990	1.94	1.08	0.86
1990-1995	0.84	0.67	0.17
1995-2009	0.97	0.97	0
Manufacturing employment			
1985-1990	1.57	-0.14	1.71
1990-1995	-0.23	-0.52	0.29
1995-2009	0.03	-0.03	0.06
Labor force			
1985-1990	1.45	0.97	0.48
1990-1995	0.98	0.53	0.45
1995-2009	0.93	0.92	0.01
Population (total)			
1985-1990	0.91	0.91	0
1990-1995	0.78	0.78	0
1995-2009	0.58	0.58	0

Source: Tabulated from projections in DRI (1985c).

There is substantial variation across industries in the sensitivity of employment growth to the increase in national growth when a switch is made from the DRI pessimistic case to the DOE reference case. This sensitivity is evidenced by values in the third column of Table 4, which shows the difference in growth rates between the two scenarios for each industry. For the period 1985-1990, the industries exhibiting an increase in employment growth in excess of the national increase of 1.71% are lumber and wood products (SIC 24), furniture and fixtures (SIC 25), primary metals (SIC 33), fabricated metals (SIC 34), machinery except electrical (SIC 35), transportation equipment (SIC 37), instruments (SIC 38), and miscellaneous manufacturing (SIC 39). During the periods 1990-1995 and 1995-2009, the leather and leather products industry (SIC 31) exhibits a substantial jump in employment growth; the other changes are less pronounced. During the period 1995-2009, four industries grow more rapidly (or decline

TABLE 4 Average Annual Growth Rates in Manufacturing Employment under Two Macroeconomic Scenarios (%)

Manufacturing Sector, Time Period	SIC Code	DOE Reference Case	DRI Pessimistic Case	Difference between the Cases
Food and kindred products	20			
1985-1990		-1.04	-1.29	0.25
1990-1995		-1.58	-1.90	0.32
1995-2009		-2.06	-2.32	0.26
Tobacco manufacturers	21			
1985-1990		-0.05	-0.23	0.18
1990-1995		-0.17	-0.23	0.31
1995-2009		-0.07	-0.23	0.16
Textile mill products	22			
1985-1990		-1.08	-1.33	0.25
1990-1995		-1.63	-1.96	0.33
1995-2009		-1.35	-1.79	0.44
Apparel	23			
1985-1990		0.24	-1.11	1.35
1990-1995		-1.89	-2.48	0.59
1995-2009		-0.77	-0.96	0.19
Lumber and wood products	24			
1985-1990		2.77	0.63	2.14
1990-1995		-0.40	-0.98	0.58
1995-2009		-0.03	-0.22	0.19
Furniture and fixtures	25			
1985-1990		2.72	0.15	2.57
1990-1995		-0.68	-1.09	0.41
1995-2009		0.03	-0.11	0.14
Paper and allied products	26			
1985-1990		0.02	-0.28	0.30
1990-1995		0.04	-0.27	0.31
1995-2009		-0.40	-0.54	0.14
Printing and publishing	27			
1985-1990		0.97	0.57	0.40
1990-1995		0	0.01	-0.01
1995-2009		0.30	0.26	0.04
Chemicals	28			
1985-1990		1.75	0.68	1.07
1990-1995		0.70	0.61	0.09
1995-2009		0.35	0.38	-0.03

TABLE 4 (Cont'd)

Manufacturing Sector, Time Period	SIC Code	DOE Reference Case	DRI Pessimistic Case	Difference between the Cases
Petroleum refining	29			
1985-1990		0.83	0.80	0.03
1990-1995		-0.03	-0.24	0.21
1995-2009		0.00	-0.12	0.12
Rubber and plastics	30			
1985-1990		2.62	1.19	1.43
1990-1995		0.19	0.03	0.16
1995-2009		0.55	0.14	0.41
Leather and leather products	31			
1985-1990		0.67	-0.95	1.62
1990-1995		-1.26	-2.16	0.90
1995-2009		-1.82	-2.73	0.91
Stone, clay, glass, and concrete products	32			
1985-1990		1.83	0.53	1.30
1990-1995		-0.44	-0.56	0.12
1995-2009		-0.27	-0.34	0.07
Primary metals	33			
1985-1990		2.55	0.55	2.00
1990-1995		-0.21	-0.57	0.36
1995-2009		0.07	-0.36	0.43
Fabricated metals	34			
1985-1990		3.23	0.56	2.67
1990-1951		-0.36	-0.25	-0.11
1995-2009		0.21	-0.06	0.27
Machinery, except electrical	35			
1985-1990		4.34	1.58	2.76
1990-1995		1.49	1.36	0.13
1995-2009		1.10	1.48	-0.38
Electrical machinery	36			
1985-1990		1.12	-0.39	1.51
1990-1995		-0.80	-1.31	0.52
1995-2009		-0.30	-0.03	-0.27

TABLE 4 (Cont'd)

Manufacturing Sector, Time Period	SIC Code	DOE Reference Case	DRI Pessimistic Case	Difference between the Cases
Transportation equipment	37			
1985-1990		1.38	-1.15	2.53
1990-1995		-0.81	-0.95	0.14
1995-2009		0.22	0.05	0.17
Instruments	38			
1985-1990		3.92	1.74	2.18
1990-1995		1.34	0.81	0.53
1995-2009		0.68	0.70	-0.02
Miscellaneous	39			
1985-1990		1.63	-0.54	2.17
1990-1995		-0.06	-0.70	0.64
1995-2009		-0.75	-1.00	0.25

Source: Tabulated from projections in DRI (1985c).

less) in the DRI pessimistic case. Given that there is not much difference between the two scenarios after 1995 at the macroeconomic level (see Table 3), it is reasonable to expect that a few industries would actually grow more rapidly in the DRI pessimistic case.

4.2 MODEL OUTPUTS: STATE AND REGIONAL PROJECTIONS FOR 1980-2009

This section presents the DRI's state projections of four aggregate variables, followed by regional projections of manufacturing employment at the two-digit SIC code level. The states in each DRI/RIS region are shown in Fig. 4.

4.2.1 State Projections of Key Aggregate Variables

This section presents the DRI projections at the state level for four key aggregates: total nonfarm employment, total manufacturing employment, total population, and real disposable income. The DOE reference case projections for these variables are shown in Tables 5-8, and the DRI pessimistic case projections for them are presented in Tables 9-12. Each table shows the individual states' shares of the national total in 1985; the average annual growth rates for 1985-1990, 1990-1995, and 1995-2009; and the state's share of the national total in 2009. The periods 1985-1990 and 1990-1995 have been separated because the most pronounced differences between the two cases occur in these periods.

TABLE 5 Shares and Average Annual Growth Rates of Total Nonfarm Employment by State: DOE Reference Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.44	1.87	0.42	0.96	1.40
Alaska	0.22	0.38	1.94	0.74	0.21
Arizona	1.27	2.97	1.84	1.66	1.52
Arkansas	0.82	2.10	1.03	0.71	0.80
California	11.25	2.86	1.45	1.26	12.50
Colorado	1.49	2.85	1.29	1.30	1.65
Connecticut	1.58	2.48	1.50	0.75	1.61
Delaware	0.29	1.87	0.85	0.84	0.29
District of Columbia	0.63	1.79	0.73	1.10	0.63
Florida	4.46	2.57	1.31	1.58	5.07
Georgia	2.57	2.18	0.75	1.15	2.63
Hawaii	0.44	2.23	1.04	1.10	0.45
Idaho	0.35	1.46	1.06	0.65	0.32
Illinois	4.89	1.74	0.28	0.57	4.41
Indiana	2.20	1.78	0.43	0.40	1.96
Iowa	1.13	1.47	0.66	0.85	1.07
Kansas	1.02	2.22	1.11	1.32	1.09
Kentucky	1.26	1.89	0.46	1.02	1.23
Louisiana	1.65	2.18	1.47	1.02	1.72
Maine	0.46	2.24	1.24	0.65	0.45
Maryland	1.86	1.83	0.81	1.37	1.93
Massachusetts	2.91	2.59	1.56	0.73	2.98
Michigan	3.59	1.25	0.18	0.59	3.16
Minnesota	1.99	1.93	0.97	1.07	2.01
Mississippi	0.87	1.43	0.41	0.79	0.80
Missouri	2.08	1.69	0.50	0.70	1.93
Montana	0.29	1.98	1.36	1.00	0.30
Nebraska	0.70	1.21	0.42	0.59	0.63
Nevada	0.47	3.73	2.31	2.33	0.65
New Hampshire	0.46	2.95	1.65	0.99	0.50
New Jersey	3.52	1.81	0.42	0.56	3.20
New Mexico	0.54	2.63	1.50	1.45	0.62
New York	7.93	1.83	0.33	0.71	7.35
North Carolina	2.69	2.17	0.61	1.00	2.67
North Dakota	0.26	1.59	0.03	0.29	0.22
Ohio	4.49	1.45	0.21	0.44	3.91
Oklahoma	1.27	1.90	1.36	1.17	1.33
Oregon	1.05	1.83	1.50	0.94	1.07
Pennsylvania	4.89	1.86	0.37	0.71	4.55
Rhode Island	0.43	2.07	0.92	0	0.37
South Carolina	1.32	2.13	0.73	0.94	1.31
South Dakota	0.26	1.62	0.75	0.50	0.23
Tennessee	1.96	1.56	0.30	0.96	1.87
Texas	6.78	2.35	1.39	1.21	7.27
Utah	0.65	3.20	1.44	1.42	0.75
Vermont	0.22	2.77	1.78	0.90	0.24
Virginia	2.45	2.38	0.89	1.38	2.64
Washington	1.72	1.71	1.47	1.10	1.77
West Virginia	0.64	2.33	0.71	0.85	0.63
Wisconsin	2.05	1.37	0.21	0.61	1.82
Wyoming	0.22	3.97	1.67	0.97	0.26

Source: Tabulated from projections in DRI (1985c).

TABLE 6 Shares and Average Annual Growth Rates of Manufacturing Employment by State: DOE Reference Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.86	2.39	-0.23	-0.02	1.90
Alaska	0.06	2.92	0.94	-0.65	0.06
Arizona	0.91	2.81	0.36	0.43	1.04
Arkansas	1.08	2.68	0.22	-0.13	1.12
California	10.62	2.44	0.18	0.22	11.47
Colorado	1.00	2.97	0.74	0.78	1.23
Connecticut	2.13	1.88	0.36	0.34	2.30
Delaware	0.36	1.35	0.09	-0.10	0.35
District of Columbia	0.07	1.37	-0.27	0.03	0.07
Florida	2.62	2.86	0.51	0.22	2.93
Georgia	2.73	1.55	-0.55	-0.32	2.53
Hawaii	0.11	1.51	-0.08	-0.49	0.10
Idaho	0.28	2.39	0.13	-0.30	0.28
Illinois	5.17	1.40	-0.62	-0.13	4.85
Indiana	3.23	1.52	-0.14	-0.20	3.09
Iowa	1.08	1.28	-0.67	-0.45	0.96
Kansas	0.91	2.17	0.44	0.36	1.00
Kentucky	1.32	2.09	-0.12	0.16	1.37
Louisiana	0.93	2.14	-0.08	-0.05	0.94
Maine	0.56	2.43	-0.01	0.13	0.60
Maryland	1.11	0.64	-0.84	-0.04	1.01
Massachusetts	3.35	2.59	0.57	-0.02	3.59
Michigan	4.98	0.34	-0.47	0.18	4.66
Minnesota	1.96	2.19	0.19	0.23	2.09
Mississippi	1.12	2.34	-0.22	-0.14	1.12
Missouri	2.22	1.35	-0.58	-0.30	2.04
Montana	0.11	2.20	0.20	-0.12	0.11
Nebraska	0.47	1.68	-0.19	-0.24	0.45
Nevada	0.11	2.77	0.50	0.51	0.12
New Hampshire	0.63	3.42	1.06	1.09	0.84
New Jersey	3.79	1.30	-0.21	0.04	3.71
New Mexico	0.19	2.83	0.57	0.47	0.22
New York	6.79	1.44	-0.50	0.01	6.55
North Carolina	4.25	1.89	-0.49	-0.22	4.06
North Dakota	0.08	1.79	-0.39	-0.12	0.08
Ohio	5.91	1.19	-0.37	-0.15	5.54
Oklahoma	0.93	4.19	0.89	0.55	1.19
Oregon	1.02	2.01	0.33	0.11	1.08
Pennsylvania	5.86	1.49	-0.99	-0.01	5.51
Rhode Island	0.61	1.70	-0.20	-1.15	0.52
South Carolina	1.95	1.93	-0.46	-0.29	1.85
South Dakota	0.15	1.52	-0.40	-0.17	0.14
Tennessee	2.60	1.64	-0.72	-0.22	2.43
Texas	5.21	2.29	-0.13	0.09	5.40
Utah	0.49	2.70	0.53	0.43	0.56
Vermont	0.26	3.94	1.41	0.90	0.35
Virginia	2.15	1.48	-0.58	-0.23	2.00
Washington	1.46	2.26	0.27	0.16	1.56
West Virginia	0.49	2.34	-0.08	-0.09	0.50
Wisconsin	2.66	1.13	-0.86	0.02	2.49
Wyoming	0.05	2.27	0.61	-0.04	0.05

Source: Tabulated from projections in DRI (1985c).

TABLE 7 Shares and Average Annual Growth Rates of Population by State: DOE Reference Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.68	0.53	0.41	0.38	1.57
Alaska	0.21	0.24	0.62	0.37	0.20
Arizona	1.32	2.60	2.04	1.70	1.78
Arkansas	1.00	1.09	1.11	0.63	1.04
California	10.97	1.71	1.31	0.96	12.37
Colorado	1.37	1.74	1.50	1.29	1.64
Connecticut	1.34	0.78	0.70	0.44	1.30
Delaware	0.26	0.80	0.77	0.62	0.26
District of Columbia	0.26	-0.42	-0.03	0.08	0.22
Florida	4.74	2.38	1.99	1.68	6.31
Georgia	2.50	1.33	0.98	0.82	2.67
Hawaii	0.44	1.41	1.20	1.00	0.49
Idaho	0.42	0.67	0.87	0.32	0.40
Illinois	4.80	0.28	0.22	0.11	4.24
Indiana	2.30	0.31	0.15	-0.05	1.98
Iowa	1.21	-0.08	-0.05	-0.11	1.00
Kansas	1.03	0.55	0.32	0.35	0.95
Kentucky	1.57	0.52	0.42	0.41	1.48
Louisiana	1.92	0.80	1.39	0.97	2.08
Maine	0.49	0.88	0.80	0.55	0.48
Maryland	1.84	0.72	0.57	0.49	1.78
Massachusetts	2.45	0.80	0.72	0.41	2.37
Michigan	3.80	0.43	-0.05	0.05	3.31
Minnesota	1.75	0.69	0.37	0.45	1.67
Mississippi	1.09	0.52	0.55	0.56	1.06
Missouri	2.09	0.23	0.01	-0.08	1.78
Montana	0.35	0.76	0.73	0.18	0.32
Nebraska	0.67	0.01	-0.30	-0.22	0.54
Nevada	0.39	3.00	2.61	2.15	0.59
New Hampshire	0.41	1.36	1.04	0.80	0.44
New Jersey	3.19	0.66	0.52	0.05	2.89
New Mexico	0.61	1.73	1.55	1.30	0.73
New York	7.51	0.49	0.29	0.18	6.79
North Carolina	2.62	1.01	0.75	0.56	2.62
North Dakota	0.28	-0.09	-0.27	0.04	0.24
Ohio	4.51	0.24	0.10	-0.03	3.88
Oklahoma	1.42	0.68	1.15	0.74	1.46
Oregon	1.13	1.07	1.24	0.64	1.17
Pennsylvania	4.97	0.38	0.31	0.12	4.44
Rhode Island	0.40	0.37	0.16	-0.21	0.34
South Carolina	1.41	1.26	1.01	0.78	1.49
South Dakota	0.29	-0.17	-0.09	-0.30	0.24
Tennessee	1.99	0.56	0.36	0.37	1.86
Texas	6.80	1.10	1.31	0.87	7.34
Utah	0.71	2.22	1.42	1.18	0.85
Vermont	0.22	0.96	0.84	0.58	0.22
Virginia	2.39	0.91	0.78	0.68	2.43
Washington	1.83	0.93	1.21	0.68	1.90
West Virginia	0.83	0.49	0.33	0.28	0.76
Wisconsin	2.00	0.42	0.15	0.14	1.78
Wyoming	0.22	1.70	1.54	0.76	0.24

Source: Tabulated from projections in DRI (1985c).

TABLE 8 Shares and Average Annual Growth Rates of Real Disposable Income by State: DOE Reference Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.32	1.81	1.86	2.15	1.23
Alaska	0.27	1.29	3.30	1.96	0.25
Arizona	1.23	4.12	3.68	3.01	1.57
Arkansas	0.77	2.64	3.05	2.13	0.79
California	12.44	3.50	3.02	2.44	13.77
Colorado	1.45	3.50	3.04	2.82	1.69
Connecticut	1.69	2.81	2.94	2.28	1.76
Delaware	0.28	2.59	2.44	2.57	0.29
District of Columbia	0.36	0.39	1.51	1.79	0.29
Florida	4.68	3.51	3.26	3.09	5.73
Georgia	2.19	2.76	2.42	2.47	2.28
Hawaii	0.44	2.27	2.30	2.10	0.42
Idaho	0.34	2.74	2.43	1.75	0.32
Illinois	5.10	1.51	1.73	1.77	4.39
Indiana	2.13	1.85	1.77	1.55	1.81
Iowa	1.20	1.15	1.88	1.95	1.05
Kansas	1.10	2.49	2.66	2.66	1.17
Kentucky	1.23	2.14	2.08	2.28	1.19
Louisiana	1.61	2.48	3.19	2.61	1.76
Maine	0.40	3.54	3.28	2.15	0.43
Maryland	2.05	2.02	1.90	2.23	1.94
Massachusetts	2.75	3.25	3.23	2.25	2.96
Michigan	3.84	1.43	1.39	1.69	3.20
Minnesota	1.80	3.03	2.99	2.51	1.96
Mississippi	0.75	1.60	2.06	2.22	0.70
Missouri	2.01	2.33	2.15	2.06	1.91
Montana	0.32	2.32	1.99	1.29	0.27
Nebraska	0.68	1.58	1.80	1.61	0.58
Nevada	0.42	4.20	3.84	3.63	0.59
New Hampshire	0.42	4.06	3.55	2.63	0.50
New Jersey	3.78	2.15	1.85	1.91	3.44
New Mexico	0.50	2.93	2.71	2.54	0.54
New York	8.40	2.18	1.98	1.99	7.80
North Carolina	2.16	2.63	2.43	2.32	2.19
North Dakota	0.32	2.28	1.77	1.31	0.27
Ohio	4.40	1.76	1.76	1.54	3.71
Oklahoma	1.32	2.31	3.07	2.47	1.39
Oregon	1.04	2.01	2.56	1.87	0.96
Pennsylvania	4.89	1.93	1.76	1.93	4.40
Rhode Island	0.40	2.50	2.54	1.51	0.37
South Carolina	1.05	2.54	2.56	2.47	1.09
South Dakota	0.25	2.43	2.45	1.69	0.23
Tennessee	1.60	2.29	2.33	2.39	1.61
Texas	6.81	2.91	2.88	2.50	7.34
Utah	0.57	4.49	3.09	2.82	0.70
Vermont	0.19	3.43	3.38	2.22	0.21
Virginia	2.41	2.70	2.23	2.52	2.49
Washington	1.89	2.45	2.51	2.19	1.87
West Virginia	0.61	2.08	2.26	2.30	0.60
Wisconsin	1.89	2.24	1.93	1.89	1.73
Wyoming	0.22	5.43	3.09	2.35	0.27

Source: Tabulated from projections in DRI (1985c).

TABLE 9 Shares and Average Annual Growth Rates of Total Nonfarm Employment by State: DRI Pessimistic Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.44	1.01	0.24	0.85	1.37
Alaska	0.22	-0.13	2.24	1.43	0.24
Arizona	1.27	2.17	1.71	1.66	1.54
Arkansas	0.82	1.28	0.92	0.64	0.80
California	11.24	2.01	1.25	1.23	12.46
Colorado	1.49	2.04	1.29	1.38	1.69
Connecticut	1.59	0.99	0.68	0.88	1.55
Delaware	0.29	1.00	0.64	0.89	0.29
District of Columbia	0.63	1.57	0.73	1.22	0.67
Florida	4.46	1.98	1.31	1.65	5.25
Georgia	2.57	1.47	0.72	1.21	2.69
Hawaii	0.44	1.66	1.01	1.12	0.46
Idaho	0.35	0.86	0.63	0.57	0.32
Illinois	4.88	0.74	0.03	0.59	4.38
Indiana	2.20	0.66	0.06	0.42	1.92
Iowa	1.13	0.67	0.39	0.80	1.05
Kansas	1.02	1.32	0.80	1.13	1.06
Kentucky	1.26	0.96	0.34	1.00	1.23
Louisiana	1.65	1.47	1.54	1.01	1.76
Maine	0.46	1.09	0.63	0.78	0.45
Maryland	1.86	1.34	0.89	1.49	2.03
Massachusetts	2.92	1.23	0.76	0.86	2.88
Michigan	3.57	0.08	-0.14	0.57	3.07
Minnesota	1.99	1.03	0.82	1.07	2.01
Mississippi	0.87	0.52	0.06	0.72	0.78
Missouri	2.08	0.82	0.28	0.69	1.92
Montana	0.30	1.35	1.09	0.89	0.30
Nebraska	0.69	0.50	0.04	0.39	0.60
Nevada	0.47	3.02	2.55	2.49	0.69
New Hampshire	0.47	1.66	0.96	1.15	0.50
New Jersey	3.52	1.00	0.12	0.46	3.15
New Mexico	0.54	1.98	1.60	1.48	0.63
New York	7.93	0.97	0.01	0.64	7.23
North Carolina	2.69	1.14	0.42	1.00	2.66
North Dakota	0.26	1.04	-0.12	-0.05	0.22
Ohio	4.48	0.33	-0.05	0.49	3.87
Oklahoma	1.27	1.23	1.29	1.11	1.34
Oregon	1.06	1.02	1.12	0.91	1.07
Pennsylvania	4.89	0.97	0.06	0.63	4.47
Rhode Island	0.43	0.81	0.19	0.23	0.37
South Carolina	1.32	1.24	0.60	0.98	1.32
South Dakota	0.26	1.06	0.50	0.37	0.23
Tennessee	1.96	0.59	0.11	0.85	1.82
Texas	6.78	1.67	1.49	1.22	7.47
Utah	0.65	2.30	1.47	1.36	0.75
Vermont	0.23	1.47	1.09	1.02	0.23
Virginia	2.45	1.70	0.96	1.48	2.73
Washington	1.74	0.91	1.11	1.04	1.77
West Virginia	0.64	1.76	0.73	0.82	0.65
Wisconsin	2.05	0.32	-0.03	0.66	1.81
Wyoming	0.23	3.38	1.67	0.88	0.26

Source: Tabulated from projections in DRI (1985c).

TABLE 10 Shares and Average Annual Growth Rates of Manufacturing Employment by State: DRI Pessimistic Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.87	0.81	-0.50	-0.21	1.89
Alaska	0.06	2.04	0.63	-0.79	0.06
Arizona	0.91	0.94	-0.16	0.36	1.02
Arkansas	1.08	1.05	0.08	-0.18	1.14
California	10.61	0.64	-0.10	0.20	11.52
Colorado	0.99	1.22	0.34	0.78	1.23
Connecticut	2.15	-0.52	-0.32	0.38	2.23
Delaware	0.36	-0.03	-0.08	-0.19	0.36
District of Columbia	0.07	0.67	-0.26	0.09	0.08
Florida	2.61	1.19	0.14	0.21	2.95
Georgia	2.73	0.08	-0.91	-0.51	2.50
Hawaii	0.11	0.34	-0.43	-0.62	0.11
Idaho	0.28	1.27	-0.26	-0.33	0.29
Illinois	5.16	-0.57	-0.92	-0.24	4.76
Indiana	3.21	-0.12	-0.42	-0.27	3.09
Iowa	1.07	-0.27	-0.92	-0.48	0.97
Kansas	0.91	0.32	0.26	0.29	1.00
Kentucky	1.33	0.39	-0.41	0.05	1.37
Louisiana	0.93	0.62	-0.25	-0.16	0.96
Maine	0.57	0.33	-0.61	0.09	0.58
Maryland	1.11	-0.86	-1.16	-0.08	1.02
Massachusetts	3.37	0.31	-0.06	0.11	3.56
Michigan	4.91	-1.28	-0.74	0.12	4.63
Minnesota	1.95	0.54	-0.09	0.22	2.11
Mississippi	1.12	0.57	-0.71	-0.21	1.11
Missouri	2.21	-0.22	-0.91	-0.41	2.03
Montana	0.11	0.91	-0.23	-0.18	0.11
Nebraska	0.47	0.21	-0.49	-0.27	0.46
Nevada	0.11	1.19	0.14	0.42	0.12
New Hampshire	0.63	1.07	0.31	1.11	0.81
New Jersey	3.80	-0.24	-0.53	-0.05	3.72
New Mexico	0.19	1.13	0.12	0.35	0.22
New York	6.80	-0.30	-0.79	0.01	6.61
North Carolina	4.25	0.26	-0.81	-0.37	4.03
North Dakota	0.08	0.18	-0.60	-0.08	0.08
Ohio	5.90	-0.58	-0.56	-0.22	5.54
Oklahoma	0.93	2.13	0.80	0.46	1.18
Oregon	1.04	0.64	-0.05	0.11	1.12
Pennsylvania	5.87	-0.07	-1.20	-0.10	5.57
Rhode Island	0.62	-0.74	-0.96	-1.21	0.49
South Carolina	1.95	0.39	-0.79	-0.46	1.84
South Dakota	0.15	0.10	-0.76	-0.18	0.14
Tennessee	2.60	-0.09	-0.98	-0.35	2.41
Texas	5.23	0.54	-0.40	0.04	5.44
Utah	0.49	0.85	0.14	0.30	0.55
Vermont	0.26	1.51	0.74	1.00	0.34
Virginia	2.15	-0.03	1.03	-0.43	1.97
Washington	1.49	0.91	-0.17	0.08	1.61
West Virginia	0.49	0.59	-0.32	-0.25	0.49
Wisconsin	2.65	-0.61	-1.04	0.01	2.51
Wyoming	0.05	1.21	0.23	-0.12	0.05

Source: Tabulated from projections in DRI (1985c).

TABLE 11 Shares and Average Annual Growth Rates of Population by State: DRI Pessimistic Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.68	0.48	0.42	0.33	1.56
Alaska	0.21	0.20	0.96	0.83	0.21
Arizona	1.32	2.65	2.08	1.72	1.79
Arkansas	1.00	1.11	1.12	0.61	1.04
California	10.97	1.71	1.31	0.95	12.33
Colorado	1.37	1.77	1.60	1.34	1.66
Connecticut	1.34	0.77	0.74	0.54	1.32
Delaware	0.26	0.80	0.74	0.64	0.26
District of Columbia	0.26	0.29	0.35	0.33	0.24
Florida	4.74	2.51	2.06	1.73	6.40
Georgia	2.50	1.38	1.05	0.86	2.69
Hawaii	0.44	1.56	1.28	1.03	0.50
Idaho	0.42	0.73	0.85	0.30	0.40
Illinois	4.80	0.23	0.13	0.11	4.21
Indiana	2.30	0.15	0.06	-0.10	1.94
Iowa	1.21	-0.10	-0.09	-0.14	0.99
Kansas	1.03	0.50	0.32	0.28	0.94
Kentucky	1.57	0.49	0.43	0.41	1.47
Louisiana	1.92	0.85	1.52	1.00	2.10
Maine	0.49	0.96	0.89	0.59	0.49
Maryland	1.84	0.86	0.68	0.57	1.82
Massachusetts	2.45	0.87	0.74	0.49	2.41
Michigan	3.80	0.16	-0.07	0.01	3.24
Minnesota	1.75	0.65	0.35	0.45	1.66
Mississippi	1.09	0.48	0.51	0.51	1.05
Missouri	2.09	0.20	-0.02	-0.10	1.77
Montana	0.35	0.81	0.76	0.15	0.32
Nebraska	0.67	0.05	-0.35	-0.29	0.54
Nevada	0.39	3.08	2.80	2.28	0.61
New Hampshire	0.41	1.43	1.12	0.90	0.45
New Jersey	3.19	0.71	0.45	0	2.86
New Mexico	0.61	1.82	1.68	1.34	0.74
New York	7.51	0.53	0.20	0.14	6.73
North Carolina	2.62	0.95	0.73	0.57	2.61
North Dakota	0.28	0	-0.27	-0.04	0.24
Ohio	4.51	0.09	0.04	-0.05	3.82
Oklahoma	1.42	0.76	1.20	0.74	1.47
Oregon	1.13	1.04	1.25	0.63	1.17
Pennsylvania	4.97	0.35	0.25	0.06	4.38
Rhode Island	0.40	0.43	0.24	-0.09	0.35
South Carolina	1.41	1.25	1.01	0.81	1.50
South Dakota	0.29	-0.11	-0.09	-0.36	0.23
Tennessee	1.99	0.50	0.31	0.31	1.83
Texas	6.80	1.20	1.44	0.92	7.47
Utah	0.71	2.16	1.54	1.19	0.85
Vermont	0.22	0.99	0.94	0.64	0.23
Virginia	2.39	0.99	0.90	0.75	2.47
Washington	1.83	0.91	1.21	0.66	1.89
West Virginia	0.83	0.58	0.38	0.29	0.70
Wisconsin	2.00	0.32	0.07	0.10	1.75
Wyoming	0.22	1.77	1.66	0.79	0.25

Source: Tabulated from projections in DRI (1985c).

TABLE 12 Shares and Average Annual Growth Rates by Real Disposable Income by State: DRI Pessimistic Case (%)

State	Share in 1985	Average Annual Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
Alabama	1.32	1.20	1.27	1.67	1.21
Alaska	0.27	0.85	3.61	2.60	0.30
Arizona	1.24	3.72	3.21	2.61	1.60
Arkansas	0.77	2.11	2.29	1.55	0.77
California	12.45	2.95	2.37	1.93	13.59
Colorado	1.45	3.04	2.75	2.52	1.75
Connecticut	1.70	1.91	2.04	1.89	1.73
Delaware	0.28	1.86	1.82	2.33	0.29
District of Columbia	0.36	0.87	1.13	1.57	0.31
Florida	4.70	3.35	2.80	2.66	5.90
Georgia	2.19	2.30	2.09	2.24	2.39
Hawaii	0.44	2.24	1.98	1.64	0.43
Idaho	0.34	2.40	2.02	1.37	0.33
Illinois	5.10	0.77	0.94	1.42	4.35
Indiana	2.12	0.82	0.80	1.07	1.71
Iowa	1.20	0.52	1.05	1.36	1.01
Kansas	1.10	1.84	2.00	2.10	1.14
Kentucky	1.23	1.50	1.59	1.96	1.21
Louisiana	1.61	2.12	2.96	2.23	1.81
Maine	0.40	2.96	2.42	1.54	0.42
Maryland	2.04	1.85	1.68	2.00	2.06
Massachusetts	2.70	2.42	2.24	1.83	2.87
Michigan	3.82	0.26	0.59	1.39	3.11
Minnesota	1.80	2.33	2.35	2.10	1.95
Mississippi	0.74	1.06	1.26	1.73	0.68
Missouri	2.01	1.68	1.42	1.58	1.87
Montana	0.33	2.04	1.75	0.82	0.28
Nebraska	0.68	1.19	1.00	0.91	0.55
Nevada	0.42	3.95	3.83	3.46	0.64
New Hampshire	0.42	3.26	2.78	2.37	0.50
New Jersey	3.78	1.67	1.09	1.43	3.40
New Mexico	0.50	2.82	2.70	2.14	0.57
New York	8.41	1.70	1.11	1.38	7.53
North Carolina	2.16	1.86	1.80	2.03	2.20
North Dakota	0.32	2.02	1.14	0.55	0.26
Ohio	4.39	0.75	0.93	1.17	3.61
Oklahoma	1.32	2.00	2.50	1.96	1.39
Oregon	1.04	1.44	2.15	1.47	0.98
Pennsylvania	4.89	1.28	0.96	1.40	4.26
Rhode Island	0.41	1.87	1.69	1.16	0.37
South Carolina	1.05	1.88	2.07	2.27	1.12
South Dakota	0.25	2.08	1.73	0.89	0.22
Tennessee	1.60	1.59	1.55	1.92	1.57
Texas	6.82	2.65	2.65	2.15	7.66
Utah	0.57	3.95	2.82	2.43	0.72
Vermont	0.19	2.67	2.48	1.80	0.20
Virginia	2.40	2.36	2.09	2.33	2.60
Washington	1.90	1.84	2.12	1.78	1.91
West Virginia	0.61	1.89	1.85	1.89	0.61
Wisconsin	1.89	1.40	1.07	1.35	1.66
Wyoming	0.23	5.10	3.12	2.01	0.29

Source: Tabulated from projections in DRI (1985c).

As shown in Tables 5-8, several states are projected to significantly increase their shares of the national totals in the DOE reference case. Four states (Arizona, California, Florida, and Texas) increase their shares by at least 0.25% for three of the four aggregates examined. On the other hand, seven states (Illinois, Indiana, Michigan, New Jersey, New York, Ohio, and Pennsylvania) decrease their shares of the national totals by at least 0.25% for three of the four aggregate measures. California is projected to gain the most in terms of its share of the national total, while New York and Ohio are projected to experience the greatest declines.

As shown in Tables 9-12, under the DRI pessimistic case, the states projected to gain or lose 0.25% in terms of their shares of the national total for three of the four aggregates are identical to those in the DOE reference case.

The results reported in Tables 5-12 can also be evaluated by computing the change in the rate of growth for a state minus the change in the national growth rate that results when the DOE reference case (with faster growth) is substituted for the DRI pessimistic case (with slower growth). In the terminology of shift-share analysis, as presented by Stevens and Moore (1980), this calculation is the sum of the industry mix and regional shift factors. In symbolic notation the calculation is defined as:

$$D = \left(r_i^H - r_i^L\right) - \left(R^H - R^L\right) \tag{11}$$

or analogously as:

$$D = \left(r_i^H - R^H\right) - \left(r_i^L - R^L\right) \tag{12}$$

where:

r_i^H (or r_i^L) = growth rate in state i for the higher growth (or lower growth) case, and

R_i^H (or R_i^L) = corresponding national growth rates.

The value of D can be interpreted as the difference in relative growth rate differentials for the two scenarios or scenario-induced relative growth factors.

This computation reveals that shifting from the slower growth of the DRI pessimistic case to the faster growth of the DOE reference case does not generate appreciable shifts in the distribution of employment, population, and real disposable income across states for the year 2009. The instances in which a state's share of the national total varies by 0.1% or more are listed in Table 13. New York and Massachusetts gain total nonfarm employment shares when economic growth is accelerated, while Florida and Texas lose shares of total nonfarm employment. No state

TABLE 13 States with ≥0.1% Shifts in Shares of the National Total When Higher Economic Growth Is Assumed (i.e., when the DOE Reference Case growth rate is inserted in the DRI Pessimistic Case)

State	Shift in Share of U.S. Total (%)		
	Total Nonfarm Employment	Population	Real Disposable Income
California			+0.18
Florida	-0.18		-0.17
Georgia			-0.11
Indiana			+0.10
Maryland			-0.12
Massachusetts	+0.10		
New York	+0.12		+0.27
Ohio		+0.10	
Pennsylvania			+0.14
Texas	-0.20	-0.13	-0.32
Virginia			-0.17

Source: Derived using Eqs. 11 and 12.

experiences a change in its share of manufacturing employment equal to or greater than 0.10%, and only Texas experiences a change of such magnitude in population share (-0.13%). Ten states experience a change in their share of real disposable income equal to or greater than 0.10%. The states gaining are California, Indiana, New York, Ohio, and Pennsylvania; the states losing are Florida, Georgia, Maryland, Texas, and Virginia.

4.2.2 Regional Projections of Manufacturing Employment

This section presents the regional projections of manufacturing employment for selected two-digit SIC code industries. The most important industries included in the industrial sector of the TG-B emissions model set are food and kindred products (SIC 20), textile mill products (SIC 22), paper and allied products (SIC 26), chemicals (SIC 28), petroleum refining (SIC 29), and primary metals (SIC 33). Figures 7-12 illustrate the shifts in employment shares over time and between regions for these industry groups only. Moreover, since the differences are negligible between scenarios, these figures present only the DOE reference case projections. However, regional projections under both scenarios and for all manufacturing sectors (SIC 20 through SIC 39) are reported in the appendix.

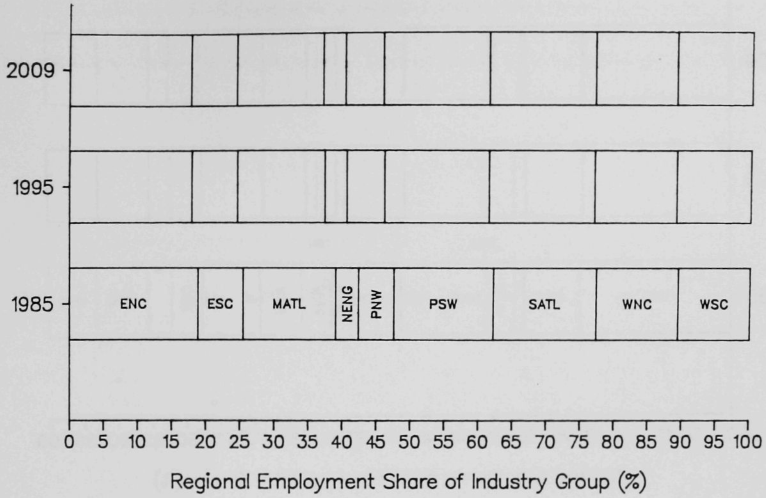

FIGURE 7 Shift in Regional Employment Shares for SIC 20: DOE Reference Case (see Fig. 4 for key to abbreviations)

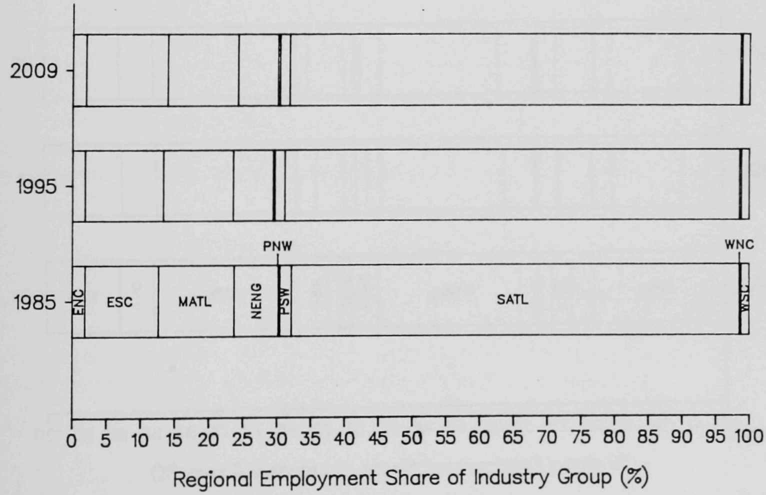

FIGURE 8 Shift in Regional Employment Shares for SIC 22: DOE Reference Case (see Fig. 4 for key to abbreviations)

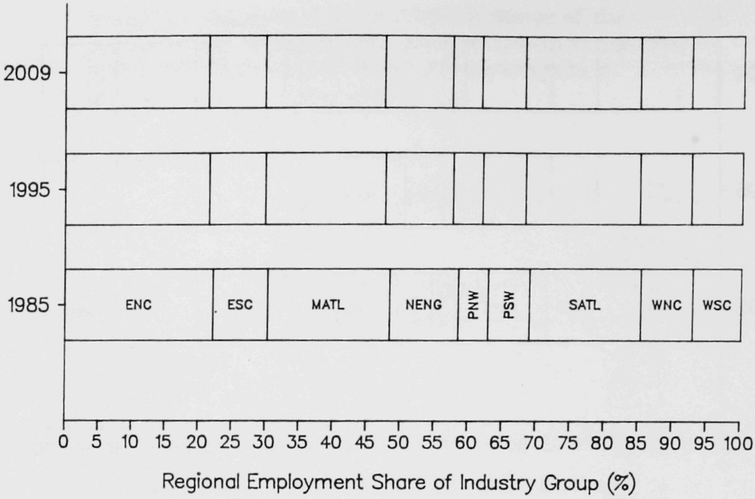

FIGURE 9 Shift in Regional Employment Shares for SIC 26: DOE Reference Case (see Fig. 4 for key to abbreviations)

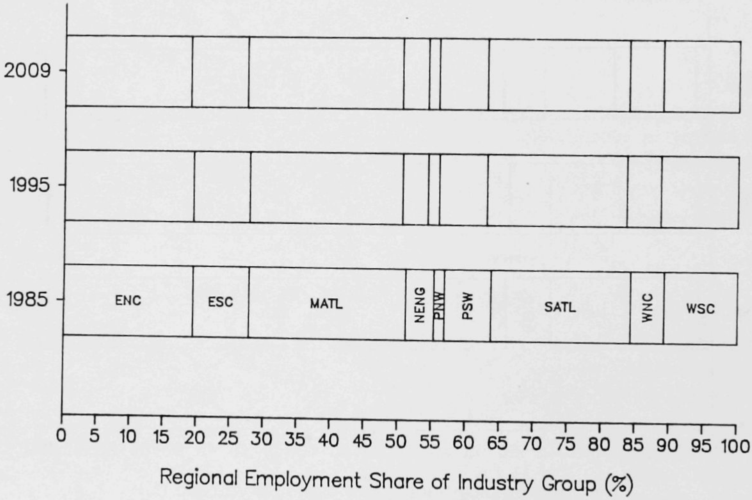

FIGURE 10 Shift in Regional Employment Shares for SIC 28: DOE Reference Case (see Fig. 4 for key to abbreviations)

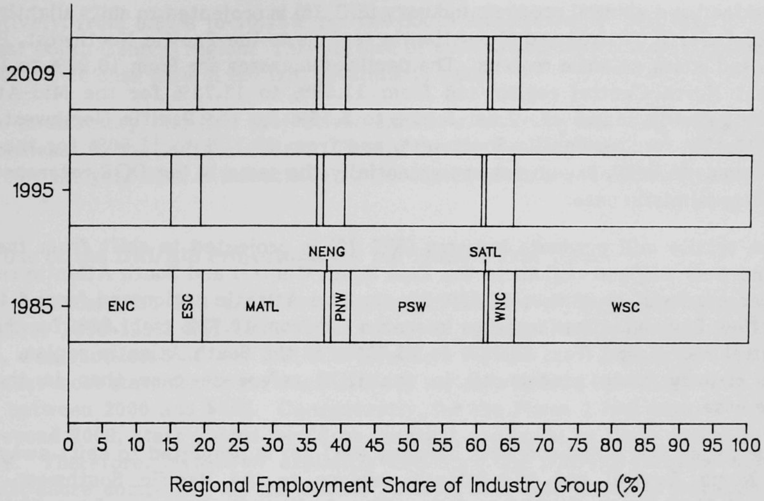

FIGURE 11 Shift in Regional Employment Shares for SIC 29: DOE Reference Case (see Fig. 4 for key to abbreviations)

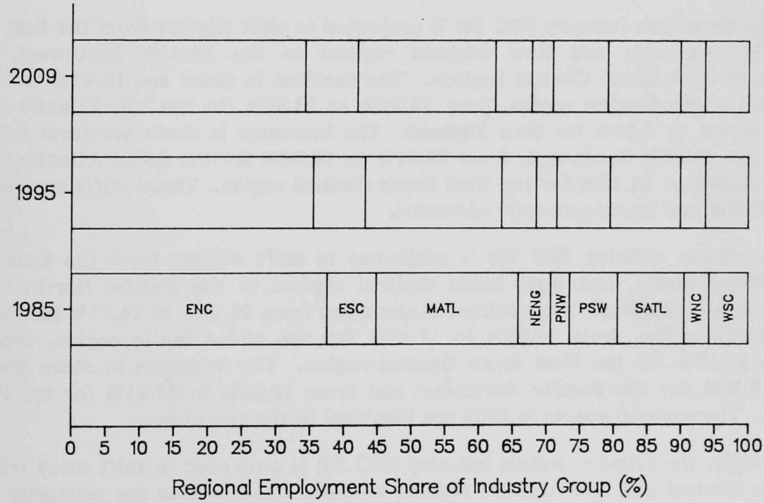

FIGURE 12 Shift in Regional Employment Shares for SIC 33: DOE Reference Case (see Fig. 4 for key to abbreviations)

The food and kindred products industry (SIC 20) is projected to shift slightly away from the East North Central and Mid-Atlantic regions to the Pacific Northwest, Pacific Southwest, and South Atlantic regions. The declines in shares are from 18.90% to 17.82% for the East North Central region and from 13.59% to 12.73% for the Mid-Atlantic region. The gains in shares are from 5.19% to 5.56% for the Pacific Northwest, from 14.59% to 15.47% for the Pacific Southwest, and from 15.11% to 15.50% for the South Atlantic region. In 2009, the shares are essentially the same in the DOE reference case and the DRI pessimistic case.

The textile mill products industry (SIC 22) is projected to shift from the Mid-Atlantic and New England regions to the East South Central and South Atlantic regions. The declines are from 11.09% to 10.33% for the Mid-Atlantic region and from 6.49% to 5.88% for New England. The increases in shares are from 10.77% to 11.96% for the East South Central region and from 66.36% to 66.76% for the South Atlantic region. These shifts are slightly more pronounced in the DOE reference case than in the DRI pessimistic case.

The paper and allied products industry (SIC 26) is projected to shift away from the East North Central and Mid-Atlantic regions to the Pacific Southwest, South Atlantic, and West South Central regions. The declines in share are from 22.18% to 21.39% for the North Central region and from 18.10% to 17.61% for the Mid-Atlantic region. The increases in share are from 6.06% to 6.37% for the Pacific Southwest, from 16.32% to 16.89% for the South Atlantic region, and from 7.11% to 7.54% for the West South Central region. These shifts are identical in the two scenarios.

The chemicals industry (SIC 28) is projected to shift slightly from the East North Central, Mid-Atlantic, and New England regions to the Pacific Southwest, South Atlantic, and West South Central regions. The declines in share are 19.41% to 18.94% for the East North Central region, from 23.39% to 23.09% for the Mid-Atlantic region, and from 4.16% to 3.80% for New England. The increases in share are from 6.89% to 7.15% for the Pacific Southwest, from 20.55% to 20.86% for the South Atlantic region, and from 10.76% to 11.10% for the West South Central region. These shifts are virtually identical in the two macroeconomic scenarios.

Petroleum refining (SIC 29) is projected to shift slightly from the East North Central, Mid-Atlantic, and West South Central regions to the Pacific Northwest and Pacific Southwest regions. The declines in share are from 15.18% to 14.21% for the East North Central region, from 17.88% to 17.49% for the Mid-Atlantic region, and from 34.58% to 34.17% for the West South Central region. The increases in share are from 2.84% to 3.25% for the Pacific Northwest and from 19.61% to 20.81% for the Pacific Southwest. The regional shares in 2009 are identical in the two cases.

Finally, the primary metals industry (SIC 33) is projected to shift away from the East North Central and Mid-Atlantic regions to most other regions due primarily to the growth of "mini-mills." The declines in share are from 37.57% to 34.26% for the East North Central region, from 21.06% to 20.39% for the Mid-Atlantic region, and from 3.68% to 3.64% for the West North Central region. The increases in share are from 7.27% to 7.76% for the East South Central region, from 4.81% to 5.41% for New England, from 2.79% to 3.13% and from 7.14% to 8.17% for the Pacific Northwest and Southwest, respectively; from 9.87% to 10.75% for the South Atlantic, and from 5.81% to 6.48% for the West South Central region. This pattern of shift is somewhat more pronounced in the DOE reference case than in the DRI pessimistic case.

In summary, the DRI projections exhibit a tendency for industries to shift from the Northeast to the South and West. Except for the primary metals industry, the degree of shift by the year 2009 is insensitive to the choice of macroeconomic case.

4.2.3 Use of the DRI/RIS Projections for the Phase 1 Test Runs

In Secs. 4.2.1 and 4.2.2, the discussion focused on projections for the periods 1985-1990, 1990-1995, and 1995-2009. A more detailed analysis, not covered in this report, was conducted on the DRI/RIS forecasts for the post-2000 period. This review found that most state shares for each activity variable needed by ARAM were essentially stable between 2000 and 2009. Consequently, for the Phase 1 test runs, it was assumed that beyond 2009, state shares would be constant and equal to those shares that existed in 2009. Therefore, instead of explicitly extending the DRI/RIS forecast beyond 2009, the shift-share component of the ARAM formula was held constant between 2010 and 2030, and equaled the value calculated for 2009. The procedure used is further explained in the reports applying ARAM to the driver data for each sector emissions model (South, Bragen, and Macal 1985; and South et al. 1985a, 1985b, and 1985c.)

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APPENDIX:

REGIONAL MANUFACTURING EMPLOYMENT STATISTICS BY SIC CODE: DOE REFERENCE CASE AND DRI PESSIMISTIC CASE

APPENDIX:

REGIONAL MANUFACTURING EMPLOYMENT STATISTICS BY SIC CODE: DOE REFERENCE CASE AND DRI PESSIMISTIC CASE

Regional shares for manufacturing employment within each industry group (SIC codes 20-39) are presented for the years 1985 and 2009. Average annual growth rates are also included for the periods 1985-1990, 1990-1995, and 1995-2009. These periods reflect the trends in projected regional manufacturing employment. Most of the forecasted employment growth is expected to occur during the periods 1985-1990 and 1990-1995. By presenting regional shares and growth rates, each table indicates when manufacturing employment shares shift in each industrial group and which regions gain or lose employment shares.

These manufacturing employment statistics are reported in Tables A.1-A.20 for two scenarios: the DOE reference case and the DRI pessimistic case. The states that constitute the DRI/RIS regions mentioned in these tables are shown in Fig. 4. The DRI/RIS regions roughly correspond with census divisions, but with some slight differences.

TABLE A.1 Regional Shares and Average Annual Growth Rates for Employment in SIC 20 Industries (food and kindred products) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	18.90	-1.85	-1.75	-2.12	17.82
East South Central	6.62	-0.74	-1.60	-2.03	6.74
Mid-Atlantic	13.59	-1.63	-2.16	-2.10	12.73
New England	3.34	-1.48	-1.83	-2.01	3.25
Pacific Northwest	5.19	-0.32	-1.01	-2.04	5.56
Pacific Southwest	14.59	-0.53	-1.19	-1.97	15.47
South Atlantic	15.11	-0.61	-1.52	-2.05	15.50
West North Central	12.07	-1.02	-1.60	-2.13	11.94
West South Central	10.59	-0.63	-1.38	-2.00	11.00

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	18.90	-2.07	-2.05	-2.40	17.82
East South Central	6.62	-0.99	-1.93	-2.30	6.73
Mid-Atlantic	13.59	-1.89	-2.46	-2.35	12.76
New England	3.34	-1.72	-2.15	-2.24	3.26
Pacific Northwest	5.19	-0.57	-1.33	-2.28	5.58
Pacific Southwest	14.59	-0.79	-1.53	-2.22	15.46
South Atlantic	15.11	-0.87	-1.85	-2.33	15.46
West North Central	12.07	-1.26	-1.92	-2.38	11.96
West South Central	10.59	-0.90	-1.73	-2.27	10.98

TABLE A.2 Regional Shares and Average Annual Growth Rates for Employment in SIC 21 Industries (tobacco manufacturers) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central					
East South Central	19.42	0.07	-0.04	0.04	19.98
Mid-Atlantic	9.07	-0.66	-0.22	0.14	9.04
New England					
Pacific Northwest					
Pacific Southwest					
South Atlantic	71.51	-0.01	-0.20	-0.13	70.97
West North Central					
West South Central					

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central					
East South Central	19.42	-0.05	-0.26	-0.14	20.00
Mid-Atlantic	9.07	-0.81	-0.22	0.18	9.45
New England					
Pacific Northwest					
Pacific Southwest					
South Atlantic	71.51	-0.20	-0.57	-0.32	70.48
West North Central					
West South Central					

TABLE A.3 Regional Shares and Average Annual Growth Rates for Employment in SIC 22 Industries (textile mill products) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	1.86	-1.85	-1.75	-0.88	1.97
East South Central	10.77	-0.84	-1.80	-1.05	11.96
Mid-Atlantic	11.09	-1.65	-2.21	-1.29	10.33
New England	6.49	-1.48	-1.83	-1.36	5.88
Pacific Northwest	0.24	-0.32	-1.01	-0.76	0.27
Pacific Southwest	1.72	-0.53	-1.19	-1.40	1.45
South Atlantic	66.36	-0.73	-1.80	-1.41	66.76
West North Central	0.25	-1.02	-1.60	-1.31	0.27
West South Central	1.21	-0.63	-1.38	-1.82	1.10

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	1.85	-2.07	-2.05	-1.36	1.98
East South Central	10.77	-1.10	-2.14	-1.48	12.00
Mid-Atlantic	11.09	-1.92	-2.52	-1.65	10.50
New England	6.49	-1.72	-2.15	-1.66	6.02
Pacific Northwest	0.24	-0.57	-1.33	-1.10	0.27
Pacific Southwest	1.72	-0.79	-1.53	-1.78	1.46
South Atlantic	66.37	-1.01	-2.13	-1.88	66.41
West North Central	0.25	-1.26	-1.92	-1.69	0.27
West South Central	1.21	-0.90	-1.73	-2.26	1.09

TABLE A.4 Regional Shares and Average Annual Growth Rates for Employment in SIC 23 Industries (apparel) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	5.79	-0.48	-1.54	-0.24	6.13
East South Central	16.06	0.91	-1.41	-0.43	17.84
Mid-Atlantic	25.84	0.07	-1.77	-0.77	25.80
New England	4.81	-1.32	-3.21	-0.99	4.03
Pacific Northwest	0.79	3.01	-2.10	0.08	1.01
Pacific Southwest	10.84	-0.05	-2.50	-0.64	10.54
South Atlantic	24.70	0.41	-1.74	-1.12	23.91
West North Central	3.30	0.49	-2.27	-0.51	3.41
West South Central	7.87	0.29	-2.26	-1.15	7.34

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	5.79	-1.64	-2.05	-0.52	6.13
East South Central	16.06	-0.41	-2.03	-0.64	17.81
Mid-Atlantic	25.84	-1.30	-2.27	-0.90	26.09
New England	4.81	-2.59	-3.77	-1.03	4.14
Pacific Northwest	0.79	1.65	-2.67	-0.03	1.02
Pacific Southwest	10.84	-1.43	-3.16	-0.80	10.53
South Atlantic	24.70	-0.96	-2.38	-1.37	23.61
West North Central	3.30	-0.77	-2.84	-0.68	3.44
West South Central	7.87	-1.13	-2.98	-1.37	7.23

TABLE A.5 Regional Shares and Average Annual Growth Rates for Employment in SIC 24 Industries (lumber and wood products) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	11.60	3.09	-0.03	0.57	13.06
East South Central	11.67	3.42	-0.18	-0.10	12.05
Mid-Atlantic	6.26	3.54	-0.53	0.40	6.85
New England	4.29	0.69	-2.34	-0.36	3.36
Pacific Northwest	19.60	2.85	-0.20	-0.76	17.93
Pacific Southwest	10.27	1.35	-1.18	0.04	9.30
South Atlantic	20.57	3.12	-0.03	0.43	22.73
West North Central	4.16	2.07	-0.64	-0.14	3.91
West South Central	11.59	2.79	-0.62	-0.45	10.82

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	11.59	1.17	-0.46	0.27	13.10
East South Central	11.67	1.30	-0.78	-0.34	11.98
Mid-Atlantic	6.26	1.33	-0.98	0.26	6.94
New England	4.29	-1.34	-2.83	-0.32	3.49
Pacific Northwest	19.59	0.72	-0.72	-0.78	18.43
Pacific Southwest	10.27	-0.84	-1.87	-0.12	9.25
South Atlantic	20.57	0.93	-0.68	0.14	22.31
West North Central	4.16	0.05	-1.17	-0.31	3.95
West South Central	11.59	0.54	-1.37	-0.72	10.56

TABLE A.6 Regional Shares and Average Annual Growth Rates for Employment in SIC 25 Industries (furniture and fixtures) (%)

DOE Reference Case

DRI/RIS Regon	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	18.60	2.27	-0.80	-0.15	17.64
East South Central	9.98	2.53	-0.95	-0.33	9.27
Mid-Atlantic	11.41	2.75	-1.04	0.21	11.50
New England	3.99	1.55	-1.59	-0.06	3.56
Pacific Northwest	1.25	4.70	0.08	0.42	1.51
Pacific Southwest	13.41	3.08	-0.43	0.37	14.50
South Atlantic	30.64	2.99	-0.39	0.07	31.69
West North Central	4.55	2.65	-0.76	0	4.50
West South Central	6.17	2.60	-0.84	-0.27	5.83

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	18.59	-0.13	-1.11	-0.35	17.69
East South Central	9.98	-0.02	-1.38	-0.47	9.27
Mid-Atlantic	11.41	0.12	-1.36	0.16	11.66
New England	4.00	-0.96	-1.97	0.01	3.68
Pacific Northwest	1.25	2.07	-0.30	0.41	1.54
Pacific Southwest	13.41	0.44	-0.90	0.29	14.52
South Atlantic	30.64	0.36	-0.85	-0.11	31.34
West North Central	4.55	0.13	-1.15	-0.08	4.55
West South Central	6.17	-0.08	-1.39	-0.41	5.76

TABLE A.7 Regional Shares and Average Annual Growth Rates for Employment in SIC 26 Industries (paper and allied products) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	Growth Rates 1990-1995	Growth Rates 1995-2009	Share in 2009
East North Central	22.18	-0.34	-0.17	-0.46	21.39
East South Central	8.15	0.35	0.20	-0.35	8.42
Mid-Atlantic	18.10	-0.23	-0.13	-0.45	17.61
New England	10.10	-0.15	-0.05	-0.42	9.95
Pacific Northwest	4.41	-0.07	-0.04	-0.44	4.35
Pacific Southwest	6.06	0.58	0.30	-0.33	6.37
South Atlantic	16.32	0.36	0.24	-0.35	16.89
West North Central	7.58	-0.09	-0.03	-0.42	7.49
West South Central	7.11	0.52	0.42	-0.30	7.54

DOE Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	Growth Rates 1990-1995	Growth Rates 1995-2009	Share in 2009
East North Central	22.18	-0.64	-0.49	-0.60	21.37
East South Central	8.15	0.05	-0.10	-0.48	8.42
Mid-Atlantic	18.10	-0.53	-0.45	-0.59	17.60
New England	10.11	-0.46	-0.38	-0.55	9.94
Pacific Northwest	4.41	-0.36	-0.30	-0.58	4.36
Pacific Southwest	6.05	0.28	0.01	-0.47	6.38
South Atlantic	16.32	0.06	-0.05	-0.49	16.90
West North Central	7.57	-0.39	-0.32	-0.56	7.49
West South Central	7.10	0.22	0.14	-0.43	7.55

TABLE A.8 Regional Shares and Average Annual Growth Rates for Employment in SIC 27 Industries (printing and publishing) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	19.64	0.03	-0.43	0.15	17.96
East South Central	4.81	1.59	0.24	0.37	5.08
Mid-Atlantic	21.76	0.48	-0.34	0.19	20.55
New England	7.18	0.57	0.30	0.24	6.88
Pacific Northwest	2.56	1.91	0.40	0.39	2.77
Pacific Southwest	12.70	1.61	0.29	0.46	13.58
South Atlantic	14.01	1.72	0.30	0.38	14.92
West North Central	9.51	1.27	0.22	0.34	9.80
West South Central	7.83	1.57	0.54	0.45	8.46

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	19.64	-0.34	-0.38	0.10	18.00
East South Central	4.81	1.18	0.25	0.32	5.07
Mid-Atlantic	21.76	0.06	-0.32	0.16	20.58
New England	7.18	0.16	-0.28	0.22	6.90
Pacific Northwest	2.56	1.49	0.42	0.35	2.77
Pacific Southwest	12.70	1.19	0.28	0.41	13.56
South Atlantic	14.01	1.30	0.30	0.33	14.88
West North Central	9.51	0.87	0.24	0.29	9.81
West South Central	7.83	1.14	0.53	0.39	8.43

TABLE A.9 Regional Shares and Average Annual Growth Rates for Employment in SIC 28 Industries (chemicals) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	Growth Rates 1990-1995	Growth Rates 1995-2009	Share in 2009
East North Central	19.41	1.59	0.87	0.17	18.94
East South Central	8.37	1.94	0.62	0.41	8.48
Mid-Atlantic	23.39	1.05	0.26	0.45	23.09
New England	4.16	-0.07	0.41	0.44	3.80
Pacific Northwest	1.55	2.65	0.91	0.15	1.59
Pacific Southwest	6.89	1.86	1.12	0.43	7.15
South Atlantic	20.55	1.73	0.77	0.44	20.85
West North Central	4.92	2.05	0.72	0.34	4.99
West South Central	10.76	2.47	0.98	0.23	11.10

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	Growth Rates 1990-1995	Growth Rates 1995-2009	Share in 2009
East North Central	19.41	0.52	0.79	0.20	18.95
East South Central	8.37	0.87	0.54	0.44	8.49
Mid-Atlantic	23.39	0.58	0.18	0.47	23.08
New England	4.16	-1.12	0.33	0.47	3.80
Pacific Northwest	1.55	1.61	0.84	0.20	1.60
Pacific Southwest	6.89	0.78	1.03	0.45	7.14
South Atlantic	20.55	0.65	0.68	0.46	20.82
West North Central	4.92	0.98	0.64	0.37	5.00
West South Central	10.76	1.41	0.91	0.26	11.13

TABLE A.10 Regional Shares and Average Annual Growth Rates for Employment in SIC 29 Industries (petroleum refining) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	15.18	0.31	0.06	-0.32	14.21
East South Central	4.41	0.73	0.02	-0.01	4.39
Mid-Atlantic	17.88	0.52	-0.75	0.21	17.49
New England	0.98	0.40	-0.18	0.25	0.99
Pacific Northwest	2.84	2.00	0.78	0.25	3.25
Pacific Southwest	19.61	1.20	0.04	0.26	20.81
South Atlantic	0.64	0.82	-0.15	0.26	0.66
West North Central	3.88	1.40	0.43	-0.10	4.03
West South Central	34.58	0.86	0.13	-0.15	34.17

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	15.18	0.28	-0.15	-0.44	14.21
East South Central	4.41	0.70	-0.19	-0.13	4.39
Mid-Atlantic	17.88	0.49	-0.97	0.09	17.49
New England	0.98	0.37	-0.39	0.14	0.99
Pacific Northwest	2.84	1.97	0.57	0.14	3.25
Pacific Southwest	19.61	1.18	-0.17	0.14	20.81
South Atlantic	0.64	0.80	-0.37	0.14	0.66
West North Central	3.88	1.38	0.22	-0.22	4.03
West South Central	34.58	0.83	-0.09	-0.27	34.17

TABLE A.11 Regional Shares and Average Annual Growth Rates for Employment in SIC 30 Industries (rubber and plastics) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates			Share in 2009
		1985-1990	1990-1995	1995-2009	
East North Central	34.00	2.19	0.14	0.30	32.09
East South Central	8.67	3.38	0.75	0.77	9.55
Mid-Atlantic	16.04	2.55	-0.29	0.84	16.26
New England	10.01	1.54	-0.40	0.48	9.14
Pacific Northwest	0.40	2.01	-0.25	0.70	0.39
Pacific Southwest	10.30	2.90	0.65	0.83	11.13
South Atlantic	8.77	3.67	0.62	0.68	9.61
West North Central	3.61	2.22	0.07	0.11	3.31
West South Central	8.20	3.63	0.31	0.43	8.52

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates			Share in 2009
		1985-1990	1990-1995	1995-2009	
East North Central	34.00	0.79	-0.02	-0.11	32.11
East South Central	8.67	1.95	0.54	0.33	9.48
Mid-Atlantic	16.04	1.13	-0.52	0.40	16.12
New England	10.01	0.12	-0.44	0.14	9.27
Pacific Northwest	0.40	0.61	-0.59	0.21	0.38
Pacific Southwest	10.30	1.48	0.40	0.37	10.99
South Atlantic	8.77	2.22	0.55	0.32	9.71
West North Central	3.61	0.80	-0.05	-0.28	3.33
West South Central	8.20	2.18	0.24	0.07	8.61

TABLE A.12 Regional Shares and Average Annual Growth Rates for Employment in SIC 31 Industries (leather and leather products) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	13.46	0.07	-0.96	-1.50	13.89
East South Central	9.22	1.34	-1.04	-1.99	9.41
Mid-Atlantic	21.72	0.13	-1.66	-1.92	20.43
New England	23.75	0.24	-1.63	-2.01	22.21
Pacific Northwest	0.27	-0.38	-0.31	-2.09	0.26
Pacific Southwest	6.51	1.20	-1.19	-1.46	7.07
South Atlantic	6.44	1.78	-0.86	-1.96	6.81
West North Central	10.46	1.41	-0.97	-1.68	11.22
West South Central	8.16	1.27	-0.81	-1.74	8.69

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	13.45	-1.31	-1.90	-2.51	13.83
East South Central	9.22	-0.20	-2.03	-2.95	9.34
Mid-Atlantic	21.73	-1.58	-2.46	-2.81	20.51
New England	23.78	-1.48	-2.43	-2.84	22.48
Pacific Northwest	0.28	-2.11	-1.11	-2.99	0.26
Pacific Southwest	6.51	-0.45	-2.18	-2.37	7.03
South Atlantic	6.44	0.11	-1.80	-2.94	6.72
West North Central	10.46	-0.24	-1.83	-2.60	11.23
West South Central	8.15	-0.24	-1.93	-2.69	8.60

TABLE A.13 Regional Shares and Average Annual Growth Rates for Employment in SIC 32 Industries (stone, clay, glass, and concrete products) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	21.65	1.24	-0.52	-0.38	20.60
East South Central	6.36	1.70	-1.04	-0.17	6.22
Mid-Atlantic	18.53	1.59	-1.03	-0.38	17.49
New England	3.57	2.98	-0.11	-0.09	3.94
Pacific Northwest	1.85	2.96	-0.45	0.27	2.11
Pacific Southwest	12.51	2.65	-0.07	0.13	14.02
South Atlantic	17.51	2.26	-0.41	-0.28	17.87
West North Central	5.96	1.48	-0.90	-0.49	5.54
West South Central	12.06	1.44	0.56	-0.41	12.20

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	21.65	-0.07	-0.63	-0.46	20.61
East South Central	6.36	0.40	-1.17	-0.25	6.21
Mid-Atlantic	18.54	0.28	-1.15	-0.45	17.50
New England	3.57	1.70	-0.27	-0.17	3.93
Pacific Northwest	1.85	1.61	-0.53	0.20	2.11
Pacific Southwest	12.51	1.34	-0.20	0.06	14.02
South Atlantic	17.49	0.97	-0.55	-0.36	17.85
West North Central	5.96	0.17	-1.02	-0.57	5.54
West South Central	12.07	0.13	0.45	-0.48	12.21

TABLE A.14 Regional Shares and Average Annual Growth Rates for Employment in SIC 33 Industries (primary metals) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	37.57	1.60	-0.41	-0.19	34.26
East South Central	7.27	3.25	0.13	0.18	7.76
Mid-Atlantic	21.06	2.52	-0.96	0.12	20.39
New England	4.81	3.01	0.69	0.43	5.41
Pacific Northwest	2.79	3.65	0.42	0.27	3.13
Pacific Southwest	7.14	4.13	0.36	0.28	8.17
South Atlantic	9.87	3.33	0.15	0.28	10.75
West North Central	3.68	2.67	-0.14	-0.07	3.64
West South Central	5.81	3.49	0.67	0.21	6.48

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	37.46	-0.36	-0.77	-0.58	34.36
East South Central	7.27	1.27	-0.26	-0.26	7.75
Mid-Atlantic	21.15	0.40	-1.21	-0.29	20.60
New England	4.81	1.08	-0.21	-0.05	5.36
Pacific Northwest	2.81	1.62	-0.01	-0.24	3.09
Pacific Southwest	7.15	2.13	-0.06	-0.19	8.12
South Atlantic	9.87	1.30	-0.20	-0.14	10.76
West North Central	3.67	0.77	-0.61	-0.52	3.62
West South Central	5.82	1.50	0.24	-0.26	6.44

TABLE A.15 Regional Shares and Average Annual Growth Rates for Employment in SIC 34 Industries (fabricated metals) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	32.32	1.87	-0.77	0.09	29.10
East South Central	5.52	3.82	-0.25	0.29	5.77
Mid-Atlantic	14.86	3.41	-0.90	0.17	14.51
New England	8.87	3.13	-0.45	0.28	8.87
Pacific Northwest	1.57	4.54	-0.32	0.13	1.66
Pacific Southwest	11.84	4.51	0.47	0.40	13.48
South Atlantic	9.14	3.95	-0.01	0.47	9.98
West North Central	6.81	2.96	-0.54	0.09	6.55
West South Central	9.06	4.86	0.42	0.15	10.09

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	32.09	-0.62	-0.78	-0.20	28.89
East South Central	5.53	1.10	-0.12	0.02	5.78
Mid-Atlantic	14.95	0.63	-0.71	-0.10	14.58
New England	8.90	0.41	-0.29	0	8.89
Pacific Northwest	1.60	1.55	-0.01	-0.13	1.68
Pacific Southwest	11.86	1.78	0.60	0.13	13.49
South Atlantic	9.11	1.35	0.04	0.19	9.95
West North Central	6.79	0.36	-0.47	-0.19	6.53
West South Central	9.19	1.85	0.72	-0.11	10.21

TABLE A.16 Regional Shares and Average Annual Growth Rates for Employment in SIC 35 Industries (machinery, except electrical) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	Growth Rates 1990-1995	Growth Rates 1995-2009	Share in 2009
East North Central	28.40	3.42	1.04	0.78	25.40
East South Central	4.60	4.87	1.63	1.10	4.75
Mid-Atlantic	15.12	3.66	0.93	1.05	14.14
New England	8.88	4.73	2.19	1.42	9.79
Pacific Northwest	1.71	4.17	1.72	1.23	1.75
Pacific Southwest	13.74	5.43	2.38	1.35	15.66
South Atlantic	8.94	5.18	1.72	1.32	9.71
West North Central	9.59	3.66	1.06	0.85	8.78
West South Central	9.03	5.83	1.64	1.29	10.02

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	Growth Rates 1990-1995	Growth Rates 1995-2009	Share in 2009
East North Central	28.41	0.68	0.91	1.15	25.42
East South Central	4.59	2.09	1.50	1.48	4.74
Mid-Atlantic	15.15	0.92	0.81	1.43	14.19
New England	8.88	1.95	2.06	1.80	9.78
Pacific Northwest	1.71	1.40	1.60	1.61	1.75
Pacific Southwest	13.71	2.63	2.25	1.73	15.61
South Atlantic	8.94	2.39	1.59	1.70	9.71
West North Central	9.57	0.91	0.93	1.23	8.75
West South Central	9.04	3.02	1.52	1.67	10.05

TABLE A.17 Regional Shares and Average Annual Growth Rates for Employment in SIC 36 Industries (electrical machinery) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	19.03	-0.60	-2.36	-1.07	14.48
East South Central	5.51	1.56	-1.12	-0.48	5.40
Mid-Atlantic	16.46	0.15	-1.17	-0.43	15.11
New England	10.86	1.78	-0.28	-0.06	11.90
Pacific Northwest	1.21	2.29	-0.40	-0.12	1.34
Pacific Southwest	21.67	1.76	-0.13	0.01	24.15
South Atlantic	12.60	2.15	-0.11	-0.13	14.06
West North Central	5.44	1.44	-0.63	-0.34	5.55
West South Central	7.22	2.08	-0.55	0.02	8.01

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	18.98	-2.21	-2.77	-0.73	14.57
East South Central	5.49	-0.40	-1.61	-0.23	5.26
Mid-Atlantic	16.50	-1.23	-1.79	-0.18	15.12
New England	10.87	0.26	-0.84	0.20	11.87
Pacific Northwest	1.21	0.49	-0.76	0.25	1.35
Pacific Southwest	21.74	0.37	-0.68	0.27	24.30
South Atlantic	12.58	0.63	-0.61	0.14	14.06
West North Central	5.42	-0.03	-1.21	-0.16	5.45
West South Central	7.22	0.54	-1.06	0.30	8.03

TABLE A.18 Regional Shares and Average Annual Growth Rates for Employment in SIC 37 Industries (transportation equipment) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	34.77	0.08	-1.24	-0.12	30.38
East South Central	4.57	2.09	-0.91	0.20	4.69
Mid-Atlantic	7.93	1.69	-1.20	0.18	7.85
New England	7.07	2.53	0.15	0.28	7.92
Pacific Northwest	5.00	2.65	0.71	1.30	6.66
Pacific Southwest	16.44	2.21	-0.58	0.29	17.48
South Atlantic	9.91	1.81	-0.51	0.35	10.46
West North Central	7.61	1.23	-0.91	0.15	7.45
West South Central	6.66	2.38	-1.48	0.56	7.08

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	34.39	-2.04	-1.61	-0.25	30.48
East South Central	4.63	-0.92	-0.72	-0.03	4.69
Mid-Atlantic	7.94	-0.94	-1.29	0.02	7.86
New England	7.26	-0.87	0.63	0.05	7.98
Pacific Northwest	4.95	0.36	0.34	1.15	6.64
Pacific Southwest	16.54	-0.54	-0.65	0.08	17.39
South Atlantic	9.86	-0.58	-0.81	0.18	10.41
West North Central	7.59	-1.19	-1.13	0.00	7.45
West South Central	6.81	-0.93	-1.13	0.29	7.07

TABLE A.19 Regional Shares and Average Annual Growth Rates for Employment in SIC 38 Industries (instruments) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	13.43	2.05	-0.01	0.16	10.66
East South Central	1.63	3.05	0.87	0.46	1.48
Mid-Atlantic	30.34	2.85	0.76	0.43	27.01
New England	15.11	4.76	1.86	0.93	16.70
Pacific Northwest	3.52	5.81	2.52	1.32	4.46
Pacific Southwest	20.32	5.04	1.91	0.89	22.69
South Atlantic	5.30	5.45	2.22	0.90	6.14
West North Central	6.16	4.76	1.85	0.65	6.55
West South Central	4.19	4.10	1.40	0.79	4.30

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	13.44	-0.06	-0.49	0.20	10.74
East South Central	1.63	0.88	0.30	0.47	1.47
Mid-Atlantic	30.42	0.69	0.25	0.47	27.17
New England	15.09	2.56	1.32	0.95	16.68
Pacific Northwest	3.49	3.61	1.90	1.32	4.40
Pacific Southwest	20.25	2.84	1.33	0.89	22.50
South Atlantic	5.31	3.24	1.68	0.92	6.14
West North Central	6.17	2.57	1.32	0.68	6.56
West South Central	4.21	1.91	0.90	0.82	4.34

TABLE A.20 Regional Shares and Average Annual Growth Rates for Employment in SIC 39 Industries (miscellaneous) (%)

DOE Reference Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	17.92	1.35	0.23	-0.49	18.59
East South Central	3.91	2.15	-0.01	-0.89	3.94
Mid-Atlantic	26.35	1.14	-0.48	-0.91	24.60
New England	14.22	0.60	-0.82	-1.27	12.07
Pacific Northwest	2.73	3.25	1.07	-0.17	3.39
Pacific Southwest	12.43	2.08	0.22	-0.73	12.91
South Atlantic	9.79	2.65	0.40	-0.90	10.31
West North Central	7.74	2.45	0.16	-0.58	8.34
West South Central	4.91	2.38	0.33	0.10	5.84

DRI Pessimistic Case

DRI/RIS Region	Share in 1985	Growth Rates 1985-1990	1990-1995	1995-2009	Share in 2009
East North Central	17.95	-0.73	-0.33	-0.83	18.56
East South Central	3.90	0	-0.75	-1.18	3.90
Mid-Atlantic	26.35	-1.08	-1.07	-1.13	24.72
New England	14.21	-1.53	-1.48	-1.42	12.25
Pacific Northwest	2.73	1.03	0.42	-0.40	3.40
Pacific Southwest	12.42	-0.15	-0.51	-0.97	12.84
South Atlantic	9.78	0.43	-0.30	-1.21	10.17
West North Central	7.74	0.29	-0.48	-0.83	8.36
West South Central	4.93	0.08	-0.35	-0.18	5.80