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MODEL DOCUMENTATION REPORT:
MACROECONOMIC ACTIVITY MODULE (MAM)
OF THE
NATIONAL ENERGY MODELING SYSTEM

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1. Introduction

Purpose of This Report

This report documents the objectives, analytical approach, and development of the National Energy Modeling System (NEMS) Macroeconomic Activity Module (MAM) used to develop the Annual Energy Outlook for 2002(AEO2002). The report catalogues and describes the module assumptions, computations, methodology, and parameter estimation techniques.

This document serves three purposes. First, it is a reference document providing a description of the NEMS MAM used for the AEO2002 production runs for model analysts, users, and the public. Second, this report meets the legal requirement of the Energy Information Administration (EIA) to provide adequate documentation in support of its models (*Public Law 94-385, section 57.b.2*). Third, it facilitates continuity in model development by providing documentation from which energy analysts can undertake model enhancements, data updates, and parameter refinements as future projects.

Model Purpose

NEMS

The National Energy Modeling System (NEMS) is a comprehensive mid-term energy forecasting and policy analysis tool used by EIA. NEMS projects energy supply, demand, prices, and environmental emissions, by region, given assumptions about the state of the economy, international markets, and energy policies. The MAM links NEMS to the rest of the economy by providing projections of economic driver variables for use by the supply, demand, and conversion modules of NEMS. Macroeconomic variables such as GDP, disposable income, industrial gross output, inflation, interest rates, and employment drive energy demands and are important determinants of energy prices and quantities. Changes in energy supplies and prices can in turn affect GDP, inflation, interest rates, and other macroeconomic variables. To capture these effects, NEMS allows for feedback to and from the macroeconomy.

MAM

The MAM is able to address the macroeconomic impacts associated with changing energy market conditions and alternative macroeconomic growth cases. Energy price changes represent a critical source of interaction between energy markets and the economy. Consumers facing higher prices for energy may reduce their energy consumption. Nonetheless, because a large component of energy expenditures is non-discretionary, nominal expenditures on energy are likely to rise, consuming a larger share of the household budget. As a result, consumers are likely to reduce expenditures on other goods and services.

Energy services also represent a key intermediate input in the production of goods and services. After energy prices increase, production costs per unit of output are likely to rise for firms, at least initially. Reacting to higher prices in general, wages increase as consumers attempt to maintain real disposable income. Higher wage costs and spillover price effects on other variable costs further escalate production costs throughout the economy. This process places upward pressure on the nominal prices of all intermediate goods and final goods and services in the economy. As prices increase, so do interest rates. The increase in interest rates in turn causes reductions in interest-rate sensitive components of aggregate demand. Aggregate demand declines, leading to reductions in output as a result of rising energy prices. The MAM provides such dynamic macroeconomic impacts to the rest of the NEMS.

Model Summary

The MAM of NEMS is composed of five submodules: the National Submodule, the Interindustry Submodule, the Employment Submodule, the Regional Submodule, and the Commercial Floorspace Submodule. The first four submodules are based on large, proprietary econometric models developed by DRI-WEFA, a Global Insight Company. The National Submodule of MAM uses the Eviews version of the DRI-WEFA U.S. Quarterly Macroeconomic Model. The Interindustry Submodule of MAM uses DRI-WEFA's Personal Computer Input-Output (PCIO) Model in conjunction with the Macroeconomic Model. The Employment Submodule of MAM uses the DRI-WEFA's Employment Model in addition to the Macroeconomic Model. The Regional Submodule is a straightforward sharing algorithm that applies factors based on simulations of DRI-WEFA's U.S. Quarterly Macroeconomic, PCIO, Employment, and Regional Models to disaggregate the National, Interindustry, and Employment Submodule results to the nine Census Division level. The regional shares used in the module change over the forecast period, reflecting the changing growth patterns across regions over time. The Commercial Floorspace Submodule, developed by the EIA, uses regionalized variables to compute changes in regional forecasts for 13 floorspace types.

The structural DRI-WEFA models are designed to work in tandem with each other, and are used in this way by EIA to create the macroeconomic baselines which are input to the MAM. DRI-WEFA's PCIO uses final demands generated by the DRI-WEFA U.S. Quarterly Model as inputs; DRI-WEFA's Employment Model uses the gross output generated by PCIO as well as some macroeconomic concepts as inputs; the DRI-WEFA Regional Model uses DRI-WEFA U.S. Quarterly Model, PCIO Model, and Employment Model outputs as inputs.[1] The Commercial Floorspace Model calculates baseline values for regional floorspace based on inputs of the DRI-WEFA models.

The Submodules of MAM operate in a similar, sequential manner. The set of variables generated by the National Submodule includes final demands for goods and services, interest rates, inflation, housing starts, and disposable income. The Interindustry Submodule calculates the industrial gross output needed to satisfy the final demands forecasted by the National Submodule. The Employment Submodule calculates 2-digit SIC level employment by manufacturing industries, as well as

[1] DRI-WEFA is in the process of preparing documentation of the four structural DRI-WEFA models used to develop the baseline forecast: Macroeconomic, Personal Computer Computer Input-Output, Employment, and Regional models. Although these four models are proprietary, the documentation under preparation, which will be available to the public in April, 2002, will give an overview of the four models and how they link together.

employment for aggregated construction, services and trade sectors based on the gross output projections of the Interindustry Submodule. The Regional Submodule disaggregates the forecasts generated by the National, Interindustry, and Employment Submodules so that they can be used by the NEMS end-use sector demand models. The Commercial Floorspace Model forecasts regional floorspace based on regional disposable income, population and inflation adjusted interest rates.

The configuration of MAM is flexible. If one of the NEMS models is modified to require a new macroeconomic input variable, MAM can be expanded to add the new driver, as long as the new variable is contained in one of the full DRI-WEFA models. Currently, MAM forecasts roughly 120 macroeconomic variables, a subset of which is passed back to the NEMS common data structure to be used by the energy demand, supply, and conversion models.

MAM National Submodule

The MAM National Submodule calls the DRI-WEFA Quarterly Model of the U.S. economy, which was recently converted to operate in the Eviews system. The National Submodule supports the NEMS energy supply, demand, and conversion modules by providing mid-range macroeconomic projections for the period from 1990-2020. The National Submodule also provides feedback effects for analyses of different energy scenarios by capturing the macroeconomic effects of changes in energy variables.

The growth potential of the economy is rooted in the growth of the factors of production, specifically, labor, capital, and energy, and the aggregate productivity of these factors. The user may choose one of the three growth scenarios provided in the National Submodule (low, mid, or high growth) and subsequently incorporate energy market feedbacks.

The National Submodule responds to information concerning energy price and quantity changes from the other NEMS modules. NEMS determines the reaction of energy prices and quantities to changes in events or policies. These energy impacts are passed to the National Submodule of MAM and the economy reacts, producing altered macroeconomic variables. The altered macroeconomic variables are then passed back to the other NEMS modules for the next solution iteration

MAM Interindustry Submodule

The Interindustry Submodule provides industrial gross output projections to NEMS for use principally by the Industrial Demand Module. The Interindustry Submodule also calculates the interindustry impacts based upon changes in the final demand forecasts generated by the National Submodule. The feedback mechanism in the Interindustry Submodule is based on changes in generated output concepts found in the Macroeconomic Model. Generated output reflects the input-output relationship between the producing industry and both intermediate industries and final demand. The generated output forecast is used to calculate changes from the baseline forecast created with the full PCIO model

The Interindustry Submodule contains detail for thirty-five industrial (manufacturing, agriculture, mining, and construction) sectors and ten non-industrial service sectors and develops projections for the period of 1990-2020. The Interindustry Submodule calculates deviations from a given baseline industrial gross output projection when macroeconomic final demands change and generated output changes in the Macroeconomic Model. Because of the structure of input-output modeling, the Interindustry and National Submodules do not iterate directly with each other, but are instead processed sequentially. However, through their effect on the projections of the energy supply and demand submodules, which in turn alter the macroeconomic outlook, changes in interindustry projections do affect the results of the National Submodule during the next solution cycle. The NEMS energy supply and demand modules determine the reaction of energy variables to changes in energy market conditions. These energy market results are passed to the National Submodule and the economy reacts to the altered inputs. The altered industrial gross output projections are then passed back to the other NEMS modules, and the system iterates until convergence is attained.

MAM Employment Submodule

The Employment Submodule calculates the employment impacts of altered energy market conditions based on the following causal relationships. When energy market conditions change, the level and composition of macroeconomic final demands are affected. In turn, the level and composition of industrial gross outputs required to satisfy the new final demands are changed. Finally, faced with new demands for their output, industries will adjust the number of workers employed. The Employment Submodule represents this last link in the chain.

MAM Regional Submodule

The Regional Submodule is a sharing algorithm based upon simulations of the DRI-WEFA U.S. Quarterly Macroeconomic Model, the DRI-WEFA PCIO Model, the DRI-WEFA Employment Model, and the DRI-WEFA Regional Model. This sharing algorithm is utilized to disaggregate some of the National, Interindustry, and Employment forecasts to the nine Census Division level of detail. The regional shares vary over time through the forecast period.

MAM Commercial Floorspace Submodule

The Commercial Floorspace Submodule uses the regional forecasts of real disposable income on a per capita bases, regional population, and interest rates adjusted for regional inflation to calculate thirteen floorspace types for the nine Census Divisions.

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2. Alternative Modeling Approaches and Selection Rationale

Background

The following theoretical discussion was primarily written during the design phase for the MAM (circa 1992). The issues raised and taken into consideration when selecting the modeling approach for the MAM are still relevant and informative.

National Submodule

This section identifies and critically discusses alternative macroeconomic and interindustry modeling approaches. The discussion first treats the most widely used large macroeconomic models. Small structural macroeconomic models are next reviewed as possible alternatives to the chosen response surface approach. General equilibrium models that focus on the long-run growth path of the economy are then addressed. A discussion of input-output based macroeconomic models that attempt to bridge between the large macroeconomic models and the general equilibrium approaches is provided next. Last, vector autoregressive models are explored.

Large Macroeconomic Models. DRI, The WEFA Group, and other macroeconomic forecasters produce large econometric models of the U.S. economy. The DRI model has been used at EIA for many years. A large macroeconomic model such as the DRI model has the advantage of sufficient detail that it is likely to be able to address the majority of requested analyses. It is also likely to include the variables required as drivers by the NEMS supply, demand, and conversion models. Such models also have large staffs devoted to the maintenance and improvement of the model and the provision of base case forecasts.

The DRI Quarterly model is composed of 1200 equations.[2] It provides detail on final demands,

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2 Brinner, Roger E. "Philosophy and Properties of the DRI Model of the U.S. Economy." Quarterly Model of the U.S. Economy: Version US89A., March 1990.

aggregate supply, prices, incomes, interest rates, and U.S. trade flows. The DRI model incorporates a short-term specification of financial conditions, output, and prices into a long-term growth model. The level of inflation-adjusted demand is driven by prices, income, wealth, expectations, and financial conditions. The capacity to supply goods and services is keyed to a production function combining the basic inputs of labor, capital, and energy. Prices adjust when there is excess demand or supply or when the prices of inputs change.

The DRI Quarterly Model excels at short-run and mid-term analyses and forecasts and does reasonably well in long term analyses through the potential GDP equation and its components. It is extremely useful in the assessment of the time-profile of the adjustment path over the 5 to 20 year horizon. The DRI model is capable of analyzing the effects of price changes for energy or other goods, or any policy having only direct price effects, such as energy taxes. It is also able to differentiate estimates of both short-run and long-run adjustment costs, with the long-run being dependent on their depiction of one long-term aggregate production function.

The types of analysis in which the DRI model is suboptimal include the effects of incorporating specific types of energy technology changes and the issue of efficiency in energy use. DRI includes energy use as part of its long-run production function. However, the long-term general equilibrium constraints imposed in the model are weak.

There is also a fundamental inconsistency in the use of a large macroeconomic model as a part of NEMS. Since NEMS focuses primarily on energy, the objective of MAM, as one of twelve modules in NEMS, is to provide the feedbacks between the energy markets and the rest of the economy. Large macroeconomic models are designed as stand alone models, and therefore typically include an energy block within their own structure. Consequently, use of these large models implies the use of *two* energy models: EIA's and the energy sector in the macroeconomic model. These two energy models may not be consistent.

A second alternative is to utilize a large macroeconomic model and replace its energy sector representation with a set of equations that replicate NEMS behavior for the energy sector. In one mode, the macroeconomic model's energy equations are disabled and simply pass through unaltered the energy price and quantity calculated from the other NEMS components. In another mode, the macroeconomic model energy equations are run separately from the energy model if standalone macro simulations are appropriate. It must be recognized, however, that stripping out the energy sector of a macro model is not trivial and may significantly alter the behavior of the remaining equations.

Small Macroeconomic Models. One alternative to a large macro model is a small model tailored precisely to the needs of NEMS. A small model has the advantages of ease of development and maintenance. However, problems with this approach, and any approach in which an independent macroeconomic model is developed, include lack of support for the provision of base case forecasts and considerable resource costs for development and maintenance of a tailored macroeconomic model.

The lack of detail in a small macroeconomic model another potential concern. A small model may not provide sufficient detail to execute all scenarios that a large model is able to address. Also, small models suffer from the criticism that important linkages are necessarily omitted in their design. Small models also have the potential to grow into large models, because adding new variables required by the NEMS may involve creating one or more new blocks within the model, each consisting of several additional equations. The result may be a much larger model than originally intended with attendant increases in the time and resource costs of maintenance.

General Equilibrium Models. The fundamental theme of the general equilibrium model is that the production side of the economy (the transformation of commodities into other commodities) is distinguished from the consumption side (the acquisition and eventual consumption of goods and services). The two are then linked to provide a simultaneous determination of equilibrium balances between the production and consumption sides of the economy.[3]

Stocks of commodities, which may be consumed directly, maintained as inventories or offered as factors of production, are owned by households in their physical form or by means of a variety of financial instruments. Each consumer's income, or wealth, is determined by evaluating the consumer's stock of commodities in terms of those prices at which the commodities can be sold. Income and a knowledge of relative prices permit the consumer to express demands for goods and services and supply of labor that are made available for the productive side of the economy.

In the general equilibrium model, producers are assumed to be informed of the prices of all inputs and the prices at which outputs can be sold. These prices are taken to be independent of the scale and composition of productive activity; each producer then selects, from the technically available choices, the production plan that maximizes profits. The general equilibrium model explicitly addresses the substitutability of factors of production (or consumption) by either incorporating separate translog production functions (such as Jorgenson's DGEM model[4]) or CES functions for each industry and then obtaining the aggregate production.

A standard procedure has evolved among general equilibrium modelers to calibrate the whole model to a benchmark observation coupled with use of literature estimates for certain key parameters, particularly elasticities. A sequence of data adjustments is frequently used to force equilibrium conditions on observed data before calibration begins. With these adjustments in mind, no test of the model to data is employed, and sensitivity analysis is widely used for parameters whose values are uncertain and/or crucial to the results.

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3 Much of the general equilibrium analysis draws heavily from the following sources: Applied General Equilibrium Analysis by Herbert Scarf and John Shoven, Cambridge University Press, 1984 and Dale Jorgenson and Peter Wilcoxen, "Environmental Regulation and U.S. Economic Growth", Energy and Environmental Policy Center Discussion Paper, November 1989.

4 Dale Jorgenson and Peter Wilcoxen, "Environmental Regulation and U.S. Economic Growth," Energy and Environmental Policy Center Discussion Paper, November 1989.

The assumption of an "observable" equilibrium leads directly to the construction of a data set that fulfills the equilibrium conditions for some form of general equilibrium models. A benchmark equilibrium data set is a collection of data in which equilibrium conditions of an assumed underlying equilibrium model are satisfied. If equilibrium is reflected, demands equal market supplies for all commodities and supplies and demands can be separately disaggregated by agent. Four sets of equilibrium conditions satisfied by most of the constructed benchmark equilibrium data sets are: (1) Demands equal supplies for all commodities; (2) Nonpositive profits are made in all industries; (3) All domestic agents (including the government) have demands that satisfy their budget constraints; and (4) The economy is in zero external sector balance.

These conditions are not all satisfied in input-output or other national income account data. In constructing benchmark data sets, various adjustments are necessary to the blocks of data involved and the nature of these adjustments varies from case to case as alternate sets of benchmark accounts are constructed to fit differing models. The data usually refer to a single year, although some averaging across years is done in constructing portions of those data sets where substantial volatility occurs.

Although most general equilibrium models use literature estimates of crucial elasticities, Jorgenson's model uses econometrically estimated values of these elasticities. The endogenous variables in his model of producer behavior are the value shares of sectoral inputs for the four commodity groups. There are 14 unknown parameters for each industry. These parameters are estimated using data from 1974-1985 for each industry, subject to restrictions implied by the monotonicity of the input value shares. Some authors have argued that there is an hierarchy of submodels, and that the number of restrictions required to estimate the parameters for each industry may present interpretational problems.[5]

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[5] See Chapter 3, "Numerical Specification of Applied General Equilibrium Models: Estimation, Calibration, and Data," written by Mansur and Whalley in the Scarf and Shoven book.

In addition, the general equilibrium models are full employment models. These models cannot calculate disequilibrium costs because the models describe equilibrium points. Factors of production are treated as perfectly mobile between alternative uses and the allocation of factors by industry in equilibrium equalize the returns received net of taxes and gross of subsidies in all industries. The models solve for a steady-state equilibrium, but ignore the path of adjustment.

Much of the policy analysis that the macroeconomic models analyze implies some calculation of the adjustment costs. Some authors have argued that the general equilibrium model results show relatively rapid change in capital stock in the face of a price change. Additionally, neither the financial nor the international sectors are fully modeled and the working assumption is that all private and public agents are bound by the budget constraint.[6]

The difficulty in incorporating system energy price and quantity results is a significant drawback to incorporating a general equilibrium macroeconomic model for NEMS, because estimates of energy's substitutability in the production functions and the consumer choice equations are implicit in the general equilibrium component.

A more fundamental problem with general equilibrium models is that their scope is far beyond that of macroeconomic analysis; they embody a fully developed energy-economy feedback mechanism. As such, general equilibrium models have even more fully developed energy sectors than the large macroeconomic models and are capable of substituting for the entire NEMS system. It would be extremely difficult to strip out the energy sector from a general equilibrium model and make it exogenous. Also, because general equilibrium models are academic rather than commercial tools, it is not clear that support is available for provision of base case forecasts.

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[6] See the preface of the Scarf and Shoven book for a good description of the advantages and disadvantages to general equilibrium modeling. See also John Shoven and John Whalley, "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey," in the Journal of Economic Literature, Vol. XXII, September 1984, pp. 1007-1051.

General equilibrium models have the advantage that they explicitly incorporate general equilibrium constraints, are based on optimizing behavior on the part of economic agents, and have a considerable amount of detail for investment decisions. The latter point makes these models particularly well equipped to analyze the capital costs of environmental policies and the introduction of new technologies. The inability to address the path of adjustment is a problem. They are therefore of little use in answering questions concerning the short-run disequilibrium costs associated with energy taxes, although they are well equipped to predict long-term impacts.

Input-Output Based Macro Models. The LIFT (Long-term Interindustry Forecasting Tool) available from INFORUM at the University of Maryland is a large macroeconomic model based on a 78-sector input-output model.[7] The advantage of this approach is that, like the DGEM model, the computable general equilibrium constraints imposed by theory are maintained by the model so that the model is theoretically satisfying. The bottom up approach to modeling is ideal for analyses of technology, productivity change and capital costs.

LIFT is a blend of the econometrically estimated equations coupled with the general equilibrium emphasis on building a model of the aggregate economy based on producer and consumer decisions. While conforming to these equilibrium conditions, the model forecasts the path to the equilibrium. Final demands are determined by behavioral equations, which were estimated with econometric techniques. These categories are based on the National Income and Product Accounts (NIPA). It uses input-output coefficients that change over time to calculate industrial output.

LIFT consists of three general blocks. The first block calculates output for 78 industrial sectors, using dynamic input-output coefficients. The second part of the model is the price block, which

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[7] The LIFT analysis draws heavily from the following sources: "The INFORUM Approach to Interindustry Modeling" by Clopper Almon and "LIFT: INFORUM's Model of the U.S. Economy" by Margaret Buckler McCarthy. Both articles are contained in special issue of Economics Systems Research, Vol. 3, No. 1, 1991.

calculates factor income, by estimating the components of gross product originating by industry (value-added) and unit prices by product. The final component is what Inforum refers to as the accountant. This is the part of the model that insures that the aggregations of individual components are calculated, and is concerned with macroeconomic variables that are not industry-specific, such as the savings rate, interest rates, government sector, and the unemployment rate.

Personal consumption expenditure (PCE) equations have been estimated for the categories corresponding to the NIPA. The PCE equations are derived from a two-stage estimation procedure. First, from cross-sectional data, parameters are estimated for the level and distribution of consumption expenditures by income size class, the age structure, and other demographic characteristics. Second, the cross sectional estimates are combined with time series data to estimate parameters for relative prices, changes in income, and trends. Total consumption is disposable income less savings.

A strength of the model lies in its treatment of investment decisions. Investment consists of equipment, construction, and inventory change, corresponding to the NIPA. The level of disaggregation available in the model is a distinguishing feature. Equipment investment equations have been estimated for approximately 50 industries. Investment depends on changes in industry output and changes in the relative prices of capital, labor, and energy, with a lag of 5 years. Construction is determined for approximately 30 categories of structures. The private residential categories depend upon consumption or income, interest rates, stocks, and demographic data. The private non-residential categories depend upon industry outputs, interest rates, and stocks.

The input-output model determines the unit prices for the 78 products by solving the dual pair of equations. The real side of the model is in terms of products. Income is defined in terms of industries. This portion of the model contains a bridge that translates value added between its product and industry classification. In the equation formulation, there are variables that capture the tightness of the economy in determining prices and incomes.

The model derives aggregated totals consistent with the detailed information contained in the other two components concerning production techniques and consumption equations. It also consists of macroeconomic variables that are not industry-specific yet are needed in order to arrive at industry totals. Examples of such variables include the government sector, interest rates, unemployment rates, and the savings function.

The LIFT model derives aggregate totals of final demands based on a detailed specification of industrial output. In addition, investment categories are analyzed in terms of the 78 industrial sectors, so capital stock changes reflect detailed investment specifications. Third, LIFT is capable of addressing income distributional effects as the consumption equations are estimated with data from 20 income groups, aggregated in the model to five income classes.

The LIFT model, having large amounts of detailed sectoral information, requires more analysis of both inputs and model results. The complexity and integrated aspects of LIFT increase the challenge and time required to identify and analyze the contributing factors underlying anomalous results obtained from a model run.

The model contains an accounting system that considers both income and price effects, with a complete representation of both the production and consumption sides of the economy. In this respect, the model resembles the general equilibrium models. Unlike general equilibrium models, LIFT does not focus on the derivation of the steady state equilibrium, but instead on the path to reach the equilibrium. The model is explicit in the treatment of investment, and capital cost effects when energy prices change are better handled in these models. However, the ease of use and the relative simplicity of calculating energy price feedback effects may be sacrificed.

Vector Autoregressive Models. VAR models are pure time series models estimated on historical data. The approach is non-theoretic in that the theoretical linkages between variables (the model structure) are ignored. The model is entirely specified by the length of lags and the endogenous variables. For example, if five endogenous variables are to be forecasted, then there are five equations in the model and each equation contains the lags of the dependent variable and lags of all of the other endogenous variables. If the lag length is one, then each of the five equations would contain five lagged variables. If the lag length is two, then each equation would have ten arguments, etc.

Ease of model development is the primary advantage of the VAR approach. Implementation requires only the list of variables to be predicted and the correct lag length. One drawback to VAR models is their tendency to become cumbersome as the number of variables increases, because the lag terms required for this approach impact the degrees of freedom and result in potential collinearity issues. In addition, it is difficult to specify the correct lag length, because too many lags implies inefficiency while too few implies omitted variable bias. Imposing a priori constraints is difficult in that there is little guidance from theory and the behavior of the model is fundamentally altered with each constraint.

Another consideration with this approach is that VAR models are fundamentally altered whenever an equation is added or removed. If a sixth variable is added to the original five equation model, the model behavior is likely to change. This feature is a source of instability and unreliability as the model develops. Finally, it is difficult to imagine the ability of a VAR model to address complex analyses such as a carbon tax with revenue neutrality.

Comparison of approaches. The **time period of the forecast** varies among the model approaches reviewed. The DGEM currently extends the furthest to 2050, while the DRI model forecasts to the year 2023 and LIFT goes to 2015. The theoretical underpinnings of each approach differ, and affect the level of support for long-run analysis. Accordingly, the applicability of a functional form is partly dependent upon the forecast horizon.

Most large scale macroeconomic models such as DRI and WEFA are essentially demand-driven and contain key equations to address the aggregate supply curve of the economy. In the short and mid-run, this structure may be the most desirable depiction of the economy. The DRI and WEFA models are capable of extension to the year 2030, but this strains the credibility of a quarterly model. The theoretical structure of the LIFT model lends itself to extension to the year 2030, but the model is data intensive and the extension challenging and difficult to support. DGEM exclusively focuses on the long-term.

The **path of adjustment to the new equilibrium** is an important component of the modeling system. The general equilibrium approach addresses the supply and demand of each industrial sector and consumer group assuming no short-run dislocation costs in getting from one equilibrium position to another. These models are capable of comparing two steady-state situations, where all factors are fully employed, as compared to explicit modeling of dislocation costs.

Large macroeconomic models, such as those developed by DRI and WEFA, are strongest in evaluating short to mid-term changes in aggregate demand, as opposed to detailed sectoral demands. These models incorporate aggregate supply constraints, but not at the sectoral level of detail. Consequently, aggregate supply is determined by a single production function driven by labor supply, the aggregate capital stock, energy, and a technology trend. This results in a weak treatment of the sectoral tradeoffs among capital, labor, energy, and other materials. This lack of detail fundamentally weakens the large models' ability to address long-run issues.

The LIFT model represents an effort to blend explicit treatment of the adjustment path into a long-run general equilibrium view of growth. LIFT represents both the production and demand sides of the model, incorporating detailed industrial and investment detail.

All three modeling systems provide extensive **industrial detail**, but differ fundamentally in the industrial structure development. The DRI approach is **top-down**, responding to the question "what is the level of industrial output needed to satisfy a given level of final demand?" The DGEM and LIFT approaches both are **bottom-up**. The industrial outputs are integral to the determination of the level of the aggregate economy. Conceptually, the bottom-up view of the economy is more appealing, but the models relying on this view are typically larger and more complex to understand and operate.

Interindustry Submodule

The modeling methodology for industrial activity is linked directly with the choice of the model used for the national economy. Issues introduced in the previous section describing alternative national economic modeling approaches apply to modeling industrial activity as well. The discussion of LIFT and the general equilibrium models are examples of embedded industrial modeling within a national framework. The Industrial Submodule must model industrial activity to support the Industrial Energy Demand Model, as well as other energy modules in NEMS. The choice of which industrial activity model to use as part if MAM depends on several criteria. First, is the industrial model consistent with the National Submodule? Second, does the industrial model forecast output for the energy consuming industries in the detail required by the Industrial Energy Demand Module? Third, is the industrial activity model flexible enough to handle possible future changes in industrial aggregation needed by other NEMS energy modules?

Using an input-output model directly linked to the macroeconomic model which estimates national economic impacts satisfies all of these criteria needed for the Industrial Submodule of MAM. The following section describes input-output modeling in general, along with the extensions to standard input-output analysis that makes the input-output model used by MAM more flexible.

Input-output analysis was developed by Wassily Leontief in the late 1930s to determine the level of output that each of the n industries in an economy must produce in order to just satisfy the total demand for each product, with no shortages or surpluses. A representative equation of this model (for interindustry sector 1) can be expressed as:

$$x_1 = a_{11} x_1 + a_{12} x_2 + \ldots + a_{1n} x_n + d_1 \qquad \textbf{(1)}$$

where

x_1 is output from industry 1,

a_{1j} is the input from industry 1 required for production of

	each unit of output from industry j,
x_j	is output from industry j,
d_1	is the final demand for industry 1's output, and
j	indicates the industry, ranging from 1 to n

Rearranging terms in the above equation gives:

$$(1 - a_{11}) x_1 - a_{12} x_2 - \ldots - a_{1n} x_n = d_1 \tag{2}$$

The variables representing output of every sector within the economy (x_i s) appear on the left side of equation (2). A similar equation is constructed to represent the output of each industrial sector. The system of equations for the entire economy then consists of a square matrix of dimension n whose elements are all $-a_{ij}$ except for those which lie along the principal diagonal of the matrix, which are $(1 - a_{ij})$ for $i = j$, multiplied by the column vector of variables that represent each industry's output, and equated to the column vector of final demands. Switching to matrix notation for brevity, the system can be expressed as:

$$(I - A) * x = d \tag{3}$$

where

I	is the $n \times n$ identity matrix,
A	is the $n \times n$ input coefficient matrix,
x	is the $n \times 1$ variable vector,
d	is the $n \times 1$ final demand vector, and
n	is the number of industrial sectors

The matrix $(I - A)$ is called the technology matrix. In order to solve the above system for interindustry activity, the matrix $(I - A)$ must be inverted, which is possible as long as $(I - A)$ is nonsingular. Premultiplying both sides by $(I - A)^{-1}$ gives:

$$\bar{x} = (I - A)^{-1} * d \qquad \textbf{(4)}$$

where

$\bar{x}$	is the column vector of computed output,
$(I - A)^{-1}$	is the inverse of the technology matrix, and
d	is the column vector of final demand

The model given by equation (4) translates final demand by industrial sector into total output by each sector. However, the National Submodule provides final demands by macroeconomic concepts. These macroeconomic final demands must be passed through a bridge matrix that translates them into the form required by the input-output model.

The model described to this point is a static model. Because the technology matrix is fixed in the model described to this point, a specific level of final demand in one category requires the same level and proportions of output from all interindustry sectors, regardless of the year to which the forecast pertains. This is an unduly restrictive and unrealistic assumption for the purposes of long-term forecasting. In order to provide a more reasonable forecast, DRI employs two methods within the input-output model that introduce temporal change to the interindustry forecasts. The first uses a unique bridge matrix for each year of the forecast (through 2020). The second applies row-scalars to the technology matrix.

The purpose of the bridge matrix is to allocate final demand by macroeconomic concept to those industries which produce the final products. By using a unique bridge matrix for each year of the forecast period, a given level of macroeconomic final demand does not translate into the same levels of final demand broken out by industrial sectors for each year. How the bridge matrix allocates final demand across a number of industrial sectors can be illustrated by looking at the final demand component *Non-Residential Producers' Durable Equipment -- Other* (excludes Automobiles and Office & Computing Equipment). Within the DRI model, final demand in this category is allocated across 47 of the 114 industrial sectors, including: *Farm & Garden Machinery*; *Construction & Mining Machinery*; *Metalworking Machinery & Equipment*; *Electrical Machinery*; and *Radio, TV and Communications Equipment*. Because the bridge matrix simply translates final demand by macroeconomic concepts into final demand by industrial sectors, each column of the bridge matrix must sum to 1.0. Therefore, a unique bridge matrix for each year indicates that the interindustry mix of final products required to satisfy a given level of macroeconomic final demand changes over time. As an illustration of a changing bridge matrix it may be that in the future more *Electrical Machinery* and less *Farm & Garden Machinery* is required to satisfy a given level of *Non-Residential Producers' Durable Equipment -- Other* macroeconomic final demand. In this case the *Electrical Machinery* coefficient within the *Non-Residential Producers' Durable Equipment -- Other* bridge matrix column rises over time while that for *Farm & Garden Machinery* falls. The full DRI-PCIO Model develops the bridge matrix projections through logistic time trends, which are adjusted using recent historical values corresponding to the model components.

The second method of introducing change, applying row-scalars to the technology matrix, has a different intent and a different effect. A row-scalar is a number that changes over time, and is used to multiply all elements in one row of the direct requirements matrix. The row scalars introduce general trends in technical requirements to the input-output modeling framework, but should not be construed as a method for representing specific technological changes within industry. Since each row of coefficients in the matrix represents the usage of that industry as an input into all other industries, the row scalar multiplies the proportion of input usage into all other industries by the same factor for each year. This does not allow for cell-by-cell adjustment of the technical coefficients. The historical row scalars are reconciling terms. Actual historical final demand is provided to the static input-output model. If the resulting computed output exceeds the actual output for a given industry, the row scalar for that industry and that year is less than one. If the computed output is less than the actual output for a given industry, the row scalar for that industry and that year is greater than one. Making this comparison for all industries results in time-series of row scalars over the historical period. Regression on these historical row scalar time-series results in forecasted annual row scalars for each industry through the year 2020. These forecasted row scalars are then analyzed and adjusted if the historical trends are not expected to continue in the future.

The final model, including the bridge matrix and row scalars, is:

$$\overline{x_{i,t}} = [I - (A_{ij} \times rs_{i1,t})]^{-1} * (B_{ik,t} * d_{k1,t}) \qquad \textbf{(5)}$$

where

$\bar{x}$	is the column vector of computed output,
I	is the $n \times n$ identity matrix,
A	is the $n \times n$ direct requirements matrix,
rs_t	is the column vector of row scalars for year t,
B_t	is the bridge matrix for year t,
d	is the column vector of final demand for year t,
i, j	is the interindustry sector, ranging from 1 to n, and
k	is the final demand component, ranging from 1 to m

The full DRI model does not calculate the Leontief inverse matrix ($(I - A)^{-1}$) when computing a solution. Instead, an iterative technique is used because it is computationally simpler than calculating the inverse matrix for each year of the forecast, and it provides a close approximation to the actual Leontief inverse matrix.[8] The technique is based on the identity:

$$(I - A)^{-1} = I + A + A^2 + A^3 + A^4 + . \qquad \textbf{(6)}$$

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8 See Chiang, Fundamental Methods of Mathematical Economics, Third Edition, pp.120-122 for a discussion of approximating an inverse matrix in the context of input-output modeling.

where

$\boldsymbol{I}$	is the identity matrix, and
$\boldsymbol{A}$	is the direct requirements matrix, with each component $\boldsymbol{a}_{ij}$ showing the proportion of good $\boldsymbol{i}$ used in the production of good $\boldsymbol{j}$

Intuitively, this identity expresses the multiplier impact of a change in final demands. The total requirements resulting from a given level of final demand $(\boldsymbol{I} - \boldsymbol{A})^{-1}$ equals the direct impact $\boldsymbol{I}$, plus the first round input requirements of the direct impact $\boldsymbol{A}$, plus the second round input requirements resulting from the first round $\boldsymbol{A}^{2}$, all the way through the $\boldsymbol{n}$th round when the process converges. Usually about eight to ten iterations are required for convergence with the current approach.

The Interindustry Submodule structure in MAM is grounded in the classical approach to I-O modeling. Alternative I-O modeling approaches build upon the framework presented by Leontief and described above, but the foundation is structurally similar for this class of model.

Employment Submodule

Just as maintaining consistency between the Interindustry and National Submodules is critical for deriving meaningful industrial gross output projections, maintaining consistency between the Employment and Interindustry Submodules is critical to ensuring meaningful employment results. The Employment Submodule calculates the employment impacts of altered energy market conditions based on the following causal relationships. When energy prices change, the level and composition of macroeconomic final demands are affected. In turn, the level and composition of interindustry gross outputs required to satisfy the new final demands are changed. Finally, faced with new demands for their products, industries will adjust the number of workers employed. The response surface Employment Submodule represents this last link in the chain.

The DRI Econometric Model of Employment by Industry,[9] uses interindustry gross output from DRI's Personal Computer Input-Output (PCIO) Model[10] as its major input when determining employment. Final demand components are used to calculate interindustry gross outputs, which in turn are used to determine employment.

The DRI Econometric Model of Employment by Industry provides the baseline employment projections for use within MAM. It is linked to forecasts of real Industry output produced by PCIO, and to aggregate macroeconomic variables from the U.S. Quarterly Model. Employment for each sector is derived as labor hours divided by the average number of hours worked per employee:

$$Employment = (LaborHours) \,/\, (Hours\ Worked\ per\ Employee)$$

Labor hours are calculated as:

$$LaborHours = (RealOutput) \,/\, (Hourly\ Output\ per\ Employee)$$

Real output for each industry is an exogenous input passed from the PCIO model. Hourly output per employee (productivity) is the ratio of total output from an industry to the total labor hours required to produce the output. Explanatory variables for labor hours by industry include:

- year-over-year change in output
- ratio of wages to product prices
- ratio of wages to capital costs

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9 DRI/McGraw-Hill, *An Econometric Model of Employment by Industry*, (Lexington, MA, May 1994).

10 DRI/McGraw-Hill, *Description and User Guide for PCIO, the EIA Input-Output Model for the IBM PC*, (Washington, DC, August 1990).

- aggregate sector productivity
- exogenous shifts, represented by time trends

Explanatory variables for hours worked per employee (average hours) include:

- year-over-year change in employee hours
- ratio of actual to potential output
- aggregate hours per week
- ratio of non-wage compensation

The sectoring chosen for the Employment Submodule is based on that used for the Interindustry Submodule, but is somewhat less disaggregated for two reasons. The first is that the raw employment data upon which the structural model was based did not allow for some of the industry disaggregations supported by the gross output data. The second is that some of the manufacturing sectors maintained in the Interindustry Submodule are large in terms of energy use, but small in terms of employment. In these cases, the energy-intensive three- and four-digit SIC manufacturing sectors are combined to the two-digit level in the Employment Submodule.

Regional Submodule

Regional models generally fall into three broad classes: top-down models, bottom-up models, and input/output models. Each class of models has a particular set of characteristics. Top-down or shift-share models are desirable from the perspective of consistency and short-run forecasting capability. A top-down model contains simple sharing techniques that assure that the sum of the parts equals a predetermined national total. In addition, because shares do not change radically over the short-term horizon, the top-down approach forecasts well in the short run. One drawback to top-down models is that they are not designed to explain why one region gains in share at the expense of another.

Bottom-up models are better suited to explain interregional shifts in national market share. These are structural models of a region's economy. There are limitations to bottom-up models. In a national system, each regional model is estimated separately. As a consequence, the sum of the parts rarely equals a predetermined national total. Another disadvantage relates to the unconstrained nature of estimating the models. Because of the unconstrained nature of the models, the elasticities of regional employment or value added with respect to national employment or production may be significantly different from one. In the long run, these models tend to over- or under-forecast economic activity if these elasticities are greater or less than one when aggregated over all regions. Since the data needed to develop detailed models that forecast regional economic activity is not readily available, there is substantial cost of developing and maintaining large-scale, well developed regional econometric models for the nation as a whole.[11]

Regional input-output models are frequently discussed in regional economics literature. Input-output tables contain information about interindustry flows and simulate well over the historic period from which they are constructed. There is nothing in an input-output table that can determine why a state or region is gaining or losing share or why a region's industry mix is changing. In addition, the time path of impacts is difficult to determine using regional input/output multipliers.

Most regional models described in the literature are detailed representations of a particular region of the U.S. as opposed to a regional representation of a national model. Few organizations maintain regional models of the nation as a whole, and those that do use different methodologies depending on the time horizon of the forecast, detail of industrial aggregation, and consistency with national macroeconomic forecasts. WEFA, for example, has 51 state models and does regional analysis, but the WEFA state models are not linked to yield a national aggregate consistent with their national forecasts.

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11 An article by Farrell and Hall (1991) described the extent to which regional economists were engaged in measuring and forecasting local economic activity. They conducted a survey of regional economists and found that roughly 12 percent of the respondents were measuring and forecasting local activity and that data collection was the foremost problem encountered in forecasting regional economic activity.

Of the regional models that incorporate the entire national economy, there are different methodologies, corresponding generally to the three types of regional models. Each class of models has strengths for certain types of analyses. The discussion below focuses on different examples of these classes of regional modeling. Four regional models are presented: the DRI Regional Information Service (RIS), the Bureau of Economic Analysis (BEA) National-Regional Impact Evaluation System (NRIES), the BEA Regional Input-Output Modeling System (RIMS), and the Regional Economic Models, Incorporated (REMI) Economic-Demographic Forecasting and Simulation (EDFS) Model. These models contain regional representations of a model that is national in scope, rather than separate regional models that are not automatically consistent to a national aggregate. In addition, these models are used frequently by other government agencies and businesses in analyzing regional impacts in both forecast and impact analyses.

DRI Regional Information Service (RIS). The RIS uses a system of quarterly models to forecast over 100 concepts for each state and region.[12] The forecast horizon is 25 years, to 2015. The principal indicator of sectoral economic activity is employment, which is forecast separately for 20 manufacturing and about 10 nonmanufacturing industries. Wage rates and major components of income are modeled, and the housing sector is examined in detail, with forecasts of single- and multi-family housing starts, and the corresponding actual and desired stocks. Population, labor force, and unemployment rates are also predicted within the model. Variations in regional energy prices also determine regional output; however, only regional industrial electricity prices are used as part of the RIS model.

The RIS model analyzes the different parts of the U.S. in a two-stage procedure. The country is first broken down into nine regions (approximately the nine Census Divisions[13]) in the core model and then individual state models use the regional results to derive state impacts. This approach has been adopted both because it reduces the costs of solving whenever the complete 50-state detail is not

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[12] Data Resources, Inc., "An Overview of DRI's Regional Information Service."

[13] Two Census regions, the Pacific and Mountain, are instead split into Pacific Northwest and Pacific Southwest.

required, and also for theoretical reasons. DRI argues that the factors determining the choice of location are different at the regional than at the state level.

The focus of DRI's core nine-region model is an analysis of the relative success of each geographical area in attracting and retaining the types of industries that serve national markets. This leads directly to the study of industrial location, in which context it is clear that the factors determining the choice of location are different at the regional level and the state level. For example, when a firm is deciding whether to set up in the West or the South, it considers general cost comparisons, proximity to markets, and general attractiveness. The choice between San Diego and Phoenix, however is more likely to be influenced by many other considerations such as tax burdens and home prices as examples.

One of the fundamental features of the DRI RIS system of nine regional models is the direct link to the other models in the DRI system. In particular, the regional totals are constrained to yield the national control totals from the macro model for key variables such as employment by industry, wage rates, population, and the labor force. While it is possible that the summation of the nine regions may yield different results, a balancing procedure ensures consistent results between the national and regional estimates. The model forces regional relocation and adjustment in order to attain a national result.

The RIS system focuses squarely on the determination of employment by region. Three factors essentially drive the regional growth differentials: national industrial mix, amplitude of the business cycle in each industry, and regional cost differentials. Regional costs, in turn are functions of wage rates, tax burdens, energy prices, unionization and education of the labor force, and home prices. The determination of regional output is derivative from the employment growth patterns given a fixed set of productivity by industry measures. Also, regional investment patterns follow movements in regional employment growth.

Even at only the nine-region level, the RIS model is large and requires much hands on experience to effectively run the system. It is accessible only through the DRI mainframe and is run through the DRI proprietary software package, Economic Programming System (EPS). At present, no one outside of DRI personnel runs the model. The expense of completing an integrated run in conjunction with a DRI macro forecast precludes extensive examination of alternative cases. In addition, because the regional model is so large, it requires a large amount of training in order to become familiar enough with its properties to use model results for policy analysis. The derivation of baseline regional forecasts consistent with a baseline macro forecast, is certainly feasible as is the limited investigation of specific policies or key economic growth paths.

Using the DRI RIS system directly as the regional macroeconomic model in NEMS is not feasible for several reasons. First, the size and specification of regional detail in the model makes it too large for NEMS uses, especially when the purpose of NEMS is to forecast regional energy variables as opposed to regional macroeconomic concepts. Second, it is possible to derive regional shares using forecasts from the DRI RIS model; however, the shares would not change as energy prices change. Third, the complexity and size of the DRI RIS model requires a substantial investment in training of EIA personnel to adequately incorporate the full RIS model into NEMS.

National-Regional Impact Evaluation System (NRIES II). NRIES II is an annual econometric project and impact model used to estimate the distribution of impacts of alternative policies and to provide short- to medium-term projections of state economic activity. The model is maintained by the Regional Economic Analysis Division within the BEA at the Department of Commerce.[14]

NRIES consists of 51 individual state econometric models, a national model, and a set of indexes that measure trade flows among states. The forecast horizon is ten years, through the year 2000. NRIES is structured so that (1) coefficients of equations pertaining to variables that differ little among states, such as Federal fiscal and monetary variables, are estimated within the national model,

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14 J.R. Kort, J.V. Cartwright, R.M. Beemiller, "Linking Regional Economic Models for Policy Analysis," Regional Economic Analysis Division Bureau of Economic Analysis, Department of Commerce, July 1984.

and (2) coefficients of equations pertaining to variables that differ substantially among states, such as industry product, employment, and income, are estimated within the individual state models.

Variables projected within the national model are termed "top-down" while those projected within the state models are termed "bottom-up". When bottom-up variables are aggregated to national totals, they are termed "sum-of-states" and these aggregations are the national projections. Changes in individual state economics can both affect, and be affected by, changes in the national economy.

The 51 individual state models form the core of the system. Each state model forecasts output, employment, wage rates, nonwage sources of income, population, state and local government revenues and expenditures, investment, labor force, unemployment, and retail sales. The national model derives such variables as final demand components, Federal government receipts and expenditures, money supply, interest rates, consumer and producer prices, tax rates, and various Social Security variables. The model also captures interstate commodity flows.

The focus of the state models is on the derivation of output for the 20 two-digit SIC manufacturing sectors and 10 one-digit nonmanufacturing sectors. Manufacturing activity is mainly a function of relative costs of business, interstate flow transactions, and national model variables such as consumption, investment, and interest rates. Output in the nonmanufacturing sectors is mainly a function of local-demand variables such as state disposable income or population and national variables such as interest rates.

Employment is essentially derived as a function of industry output. Investment in nonresidential structures and equipment is specified as a function of interest rates and state total output, but not at the industry level.

The NRIES is particularly useful for evaluating the interregional distributional effects with its explicit representation of interregional flows. Also, NRIES derives a simultaneous solution at the regional and national levels. The bottom-up nature of the model assures complete consistency between the national and regional results. The national model on top provides needed control to assure that the simple summation of the state results does not yield a systematic over or understatement of the growth potential of the aggregate economy.

However, there are limits to its immediate usefulness. First, the model currently projects only through 2000. An extension to the year 2020 would be a major effort and could be done only through BEA. Model size is also a consideration. The bottom-up aggregation of 51-states nature of the model makes it large and cumbersome. But perhaps the most difficult methodological issue is consistency with the National Submodule results. The National Submodule, based on the structural DRI Model of the U.S. Economy, is capable of addressing a large variety of policy issues ranging from specific energy initiatives to accommodating monetary or fiscal policy to supply side effects related to capital formation. These issues cannot be adequately covered using the strict bottom-up approach as typified by NRIES.

Regional Input-Output Modeling System (RIMS II). RIMS is also developed and maintained by BEA. RIMS represents a set of regional input-output coefficients and multipliers for use in estimating the regional impacts of economic policies.[15] Coefficients and multipliers can be estimated for any county or group of counties in the U.S. and for all of the approximately 500 industries in the BEA set of benchmark input-output tables. RIMS can be used to estimate the impacts of project and program expenditures by industry on regional output, earnings, and employment.

The available detail, both in terms of the regional disaggregation and the industrial disaggregation, is the raison d'etre for the RIMS model. RIMS also has major limitations characteristic of other regional and national input/output models. The multipliers are derived from a linear Leontief production function which assumes constant returns to scale and no substitution among inputs. Also, RIMS does not identify the time paths of impacts, and does not take into account the interregional flows of goods and services. In addition, RIMS is a BEA model and is maintained and operated by

15 "Regional Multipliers: A User handbook for the Regional Input-Output Modeling System (RIMS II), Bureau of Economic Analysis, Department of Commerce, May 1986.

BEA. The flexibility of a regional model that is directly linked to NEMS and operated by EIA personnel would be lost.

Regional Economic Models, Incorporated (REMI) Economic-Demographic Forecasting and Simulation (EDFS) Model. The REMI EDFS model, an annual regional forecasting and policy simulation of both the private and public sectors of the United States, has been publicly available since 1980. The model's forecast period extends to the year 2035 and the regions covered include the 50 states and Washington, D.C. Model runs from post sample period forecasts for these 51 regions indicate the model may be more successful in long-term forecasting.[16]

The REMI EDFS model, composed of five blocks, employs a highly simultaneous model structure where most interactions between blocks flow both ways. The structure of the model incorporates interindustry transactions and endogenous final demand feedbacks. The model includes substitution among factors of production in response to changes in relative cost factors, migration response to changes in expected income, wage response to changes in labor market conditions, and changes in the share of local and export markets in response to changes in regional profitability and production costs.

Block-1 of the model, output linkages, interacts extensively with the other blocks of the model. It includes output equations, consumption equations, real disposable income equations, investment equations, and government spending equations.

The output equations employ an input/output structure representing the interindustry and final demand linkages by industry. Outputs for 53 sectors (49 private non-farm industries and three government sectors) are calculated. Regional information is produced by applying regional purchase coefficients to historical and projected input/output tables from the Bureau of Labor and Statistics

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[16] The REMI EDFS analysis draws heavily from George I. Treyz, Dan S. Rickman, Gang Shao, "The REMI Economic-Demographic Forecasting and Simulation Model" International Regional Science Review, Vol. 14, No. 3, p. 251, 1992.

(BLS).

The consumption equations translate real disposable income into consumption demand. Real disposable income (personal income adjusted for taxes and the cost of living) data by sector is based on data from the BEA.

The investment equations are based on residential, non-residential, and equipment investment. Government spending is predicted for six components: federal civilian, federal military, state and local education, health and welfare, safety, and miscellaneous.

Block-2 of the model, factor demands, assumes industries demand profit-maximizing levels of factor inputs. The optimal choice of inputs demands two stages. First, industries demand fixed shares of composite value added and intermediate inputs and, second, industries choose optimal levels of the components of composite factors. Block-2 is composed of labor, capital, and fuel demands. While fuel demand is not explicit in the model, the cost of fuel enters the demands for labor and capital.

Block-3 of the model, regional population and labor supply, determines the interaction of the model's demographic and economic sections. The cohort algorithm applies fertility and survival rates from state-specific 1980 data trended backward and forward by the Bureau of Census (BC). The migrants category consists of international, retired, former military and their dependents, and economic migrants. International migration is calculated by applying a fixed regional share to BC data.

Block-4 of the model consists of production, labor, and capital costs, along with prices and profits. Relative labor cost is based on several BC Current Population Surveys and REMI data.

Block-5 of the model, market shares, is based on the effects of national and regional industries in the region. The model uses the Department of Commerce's 1977 Census of Transportation data for manufacturing industries and subjective estimates for non-manufacturing industries.

Summary of Regional Models Reviewed. Similar to requirements for the national macroeconomic model, three system requirements must be addressed by the Regional Submodule: (1) develop a baseline path for regional economic activity, (2) calculate regional economic feedbacks internal to the modeling system, and (3) evaluate detailed regional impacts. However, decisions about the regional economic modeling are directly tied to decisions about the macroeconomic system of models.

Regional consequences of energy actions and events are partially addressed through the supply and demand models directly. For example, energy production and energy price impacts are derived within the energy components of the system. The regional component of the macroeconomic model addresses the secondary effects which arise because of regional reactions to regional energy issues or regional effects caused by national impacts. For example, the regional macroeconomic model is intended to incorporate economic impacts of differences in regional energy prices and labor costs.

Based upon the above discussion, a system that fully integrates the interindustry structure into the aggregate economy has specific advantages. Bottom-up interindustry/macro modeling is attractive for numerous reasons, which may not apply to regional/interindustry bottom-up models (as in NRIES II). This assertion requires some critical design and segmentation considerations in the sectoral detail versus regional detail. In addition, bottom-up regional models may not be able to confront the type of detailed energy policy options that NEMS requires. For example, neither the imposition of a national tax policy nor the consideration of the disposition of the collected revenues can be addressed using a bottom-up regional economic model.

The ability to address the fundamental determinants of growth is critical to the macroeconomic modeling. The regional models to date are demand-driven systems that simply do not address the underlying supply constraints on the economy. The macroeconomic models address investment behavior in detail; in the regional models, investment behavior is handled poorly or not at all.

Size of the system is a critical constraint. Regional modeling, particularly if bottom-up, forces the entire system to grow rapidly to an unmanageable size.

Conclusions on Regional Submodule Structure. Based upon the discussion of alternative regional modeling considerations presented above, the following conclusions are advanced:

1. The MAM Regional Submodule is compatible with the National, Interindustry, and Employment Submodules and incorporates regional impacts by utilizing regional shares based on a smaller version of the DRI Regional Model estimated at the Interindustry Submodule level of aggregation.

2. Existing regional models have several drawbacks. First, the size and complexity of the DRI regional model is a major hindrance to direct incorporation within NEMS. The system of regional models maintained by BEA is unusable for NEMS because at least one of the following conditions holds: (1) the BEA system contains its own macroeconomic model (a simpler representation than what is required by NEMS analysis); (2) the BEA forecast periods do not match the NEMS requirements; (3) some BEA models are incapable of analyzing the stream of impacts over time. Using models that are maintained or updated on schedules over which EIA has no control would not add to NEMS flexibility.

3. The share approach has three primary advantages: (1) direct linkage and consistency with the national, interindustry, and employment models used in NEMS analysis; (2) regional output corresponds to national aggregates; and (3) the ability to generate regional forecasts consistent with the NEMS energy models' forecasts of production in industries such as refining and mining.

3. Module Structure

Figure 1 graphically illustrates the design and flow of the MAM within NEMS. Figures 2 through 7 provide supporting illustrations of the submodule flows. Key computations and equations used in MAM are described following their graphic representation.

Figure 1 depicts MAM in the context of NEMS. The five primary submodules of MAM: the National, Interindustry, Employment, Regional and Commercial Floorspace Submodules, are shown in the diagram. The National Submodule calculates the national level variables. The Interindustry Submodule creates the industrial gross output projections. The Employment Submodule determines the employment projections. The Regional Submodule generates the regionalized variable forecasts. The Commercial Floorspace Submodule calculates regional commercial floorspace forecasts. The whole of Figure 1 illustrates the role of MAM within NEMS. MAM receives energy price and quantity forecasts, system information, and energy supply sector activity from NEMS and provides national and regional economic projections to NEMS.

Figure 2 illustrates the flow of the National Submodule. The system information (including the number of years, regions, and driver variables), the DRI-WEFA macroeconomic baseline forecast generated externally to NEMS, and additional driver variable information are input to the National Submodule. The feedback mechanism within the National Submodule uses the NEMS energy price and quantity input values to calculate how the macroeconomic concepts change based on a full simulation of the DRI-WEFA Quarterly Macroeconomic Model in Eviews.

Figure 3 illustrates the flow of the Interindustry Submodule. System information including the industries that are modeled and additional information about energy-producing industries, are input to the Interindustry Submodule. Changes in interindustry activity are then calculated by using the reactions forecasted for generated output by the National Submodule, followed by the calculation of industrial outputs, manufacturing outputs, service outputs, and total industrial output. Aggregations provide the composite industrial gross outputs for reporting purposes. The interindustry gross outputs are forecasted in this submodule.

Figure 4 illustrates the Growth Industry component of the Interindustry Submodule. This component models the industrial outputs from energy-producing industries that come from NEMS. These industries are: Coal Mining, Oil and Gas Extraction, Petroleum Refining, Gas Utilities, and Electric Utilities. This component draws upon industry-specific inputs to estimate growth paths for these five sectors, based upon historical gross output levels and the growth in the industry-specific inputs from the appropriate NEMS supply and conversion modules.

Figure 5 illustrates the Employment Submodule. System information along with the changes in gross output calculated by the Interindustry Submodule are input to the Employment Submodule. Employment by industry is forecasted in this submodule.

Figure 6 illustrates the Regional Submodule. The Regional Submodule operates upon a subset of the macroeconomic variables that are forecasted by the National, Employment, and Interindustry Submodules, specifically, the macroeconomic variables that are required by the NEMS demand modules at the Census Division level of detail. The inputs to the Regional Submodule are some of the national macroeconomic variables, the interindustry gross outputs, and employment by industry. The Regional Submodule applies regional shares to each input to calculate the Census Division levels.

Figure 7 illustrates the Commercial Floorspace Submodule. The Commercial Floorspace Submodule forecasts 13 floorspace types for each of the nine Census Divisions. Inputs to this submodule are regional values for disposable income percapita, population, and interest rates adjusted to reflect regional inflation.

Figure 1. MAM Calculational Flows within NEMS

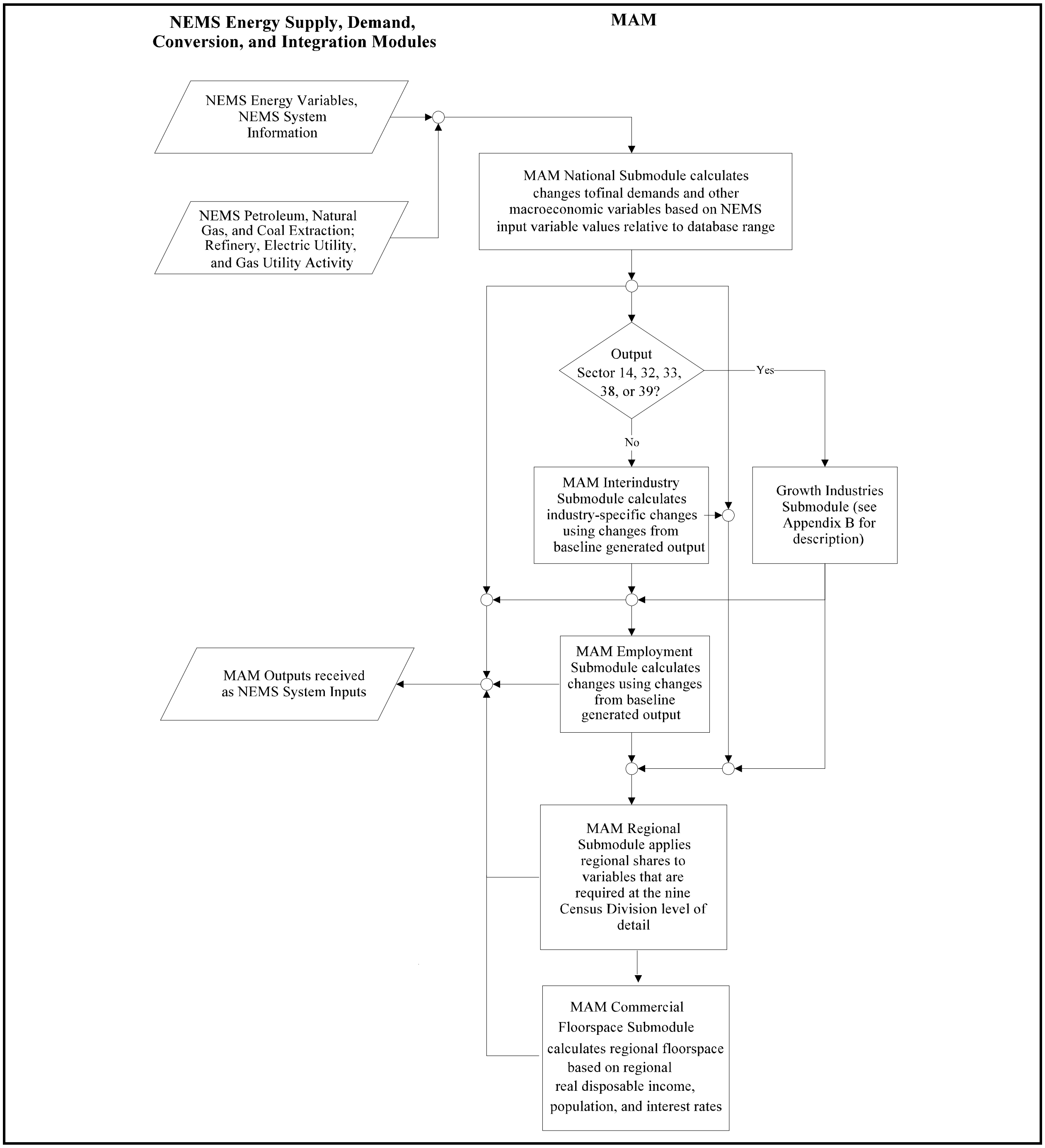
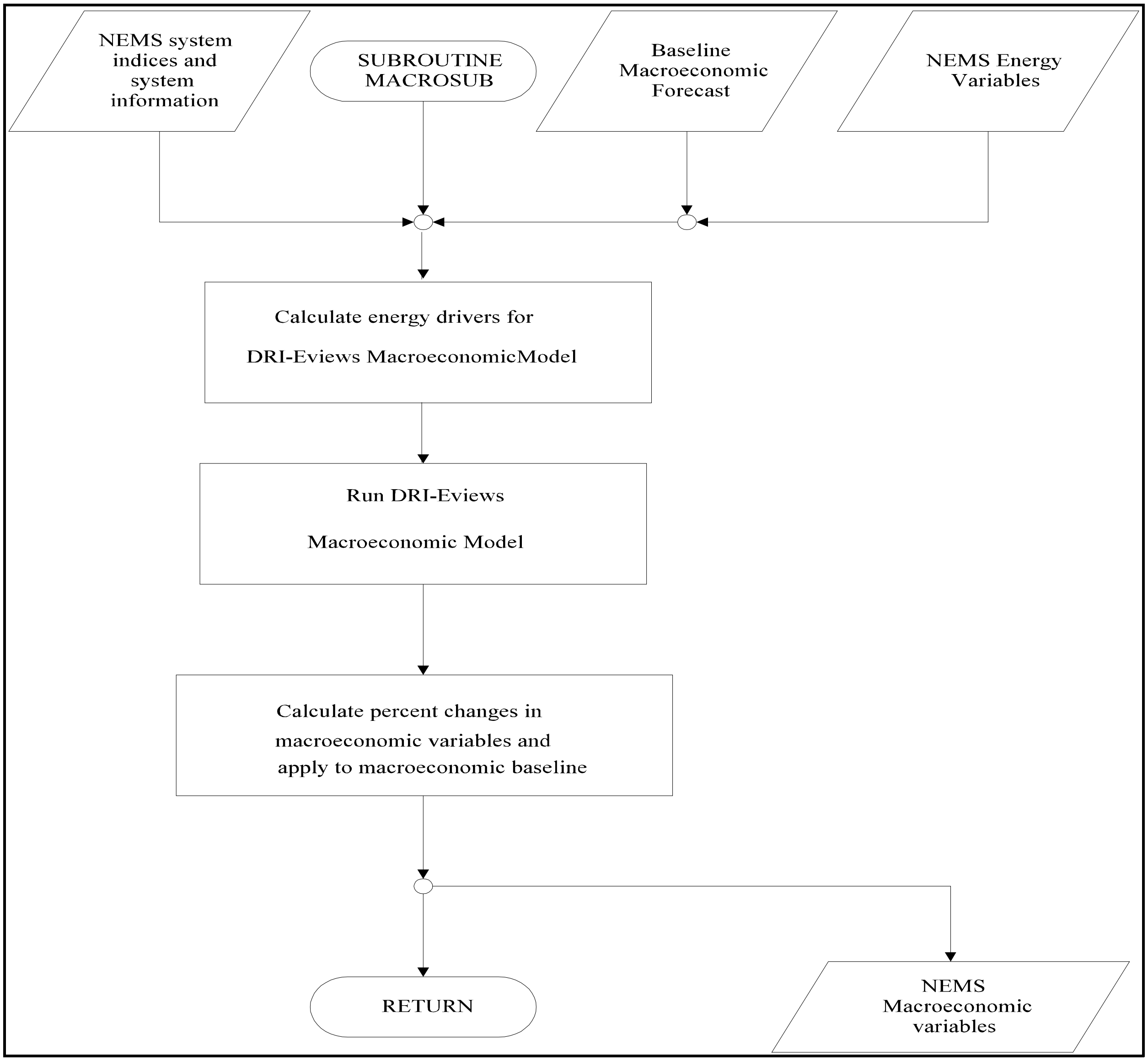
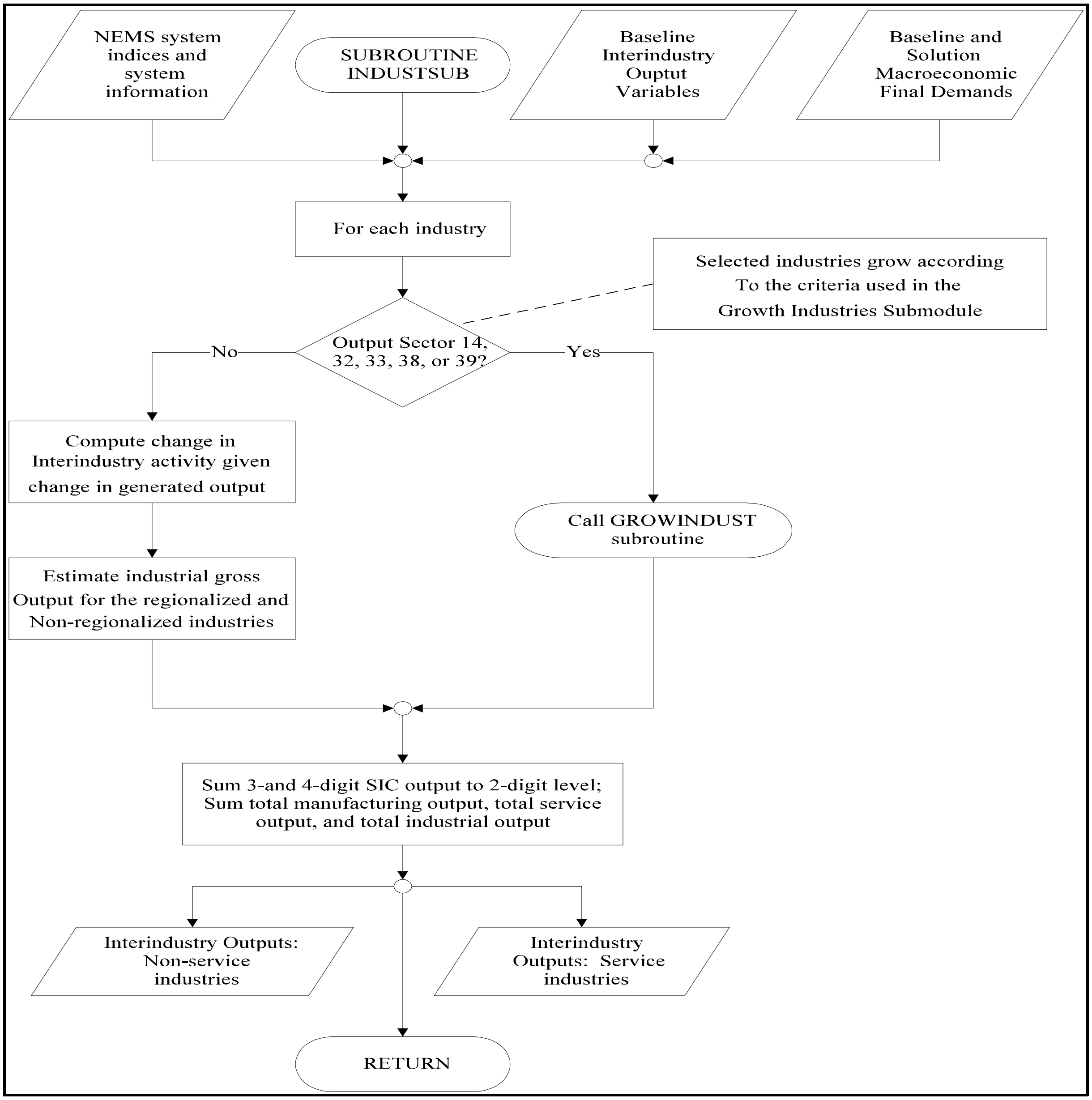


Figure 2. National Submodule Flow[17]



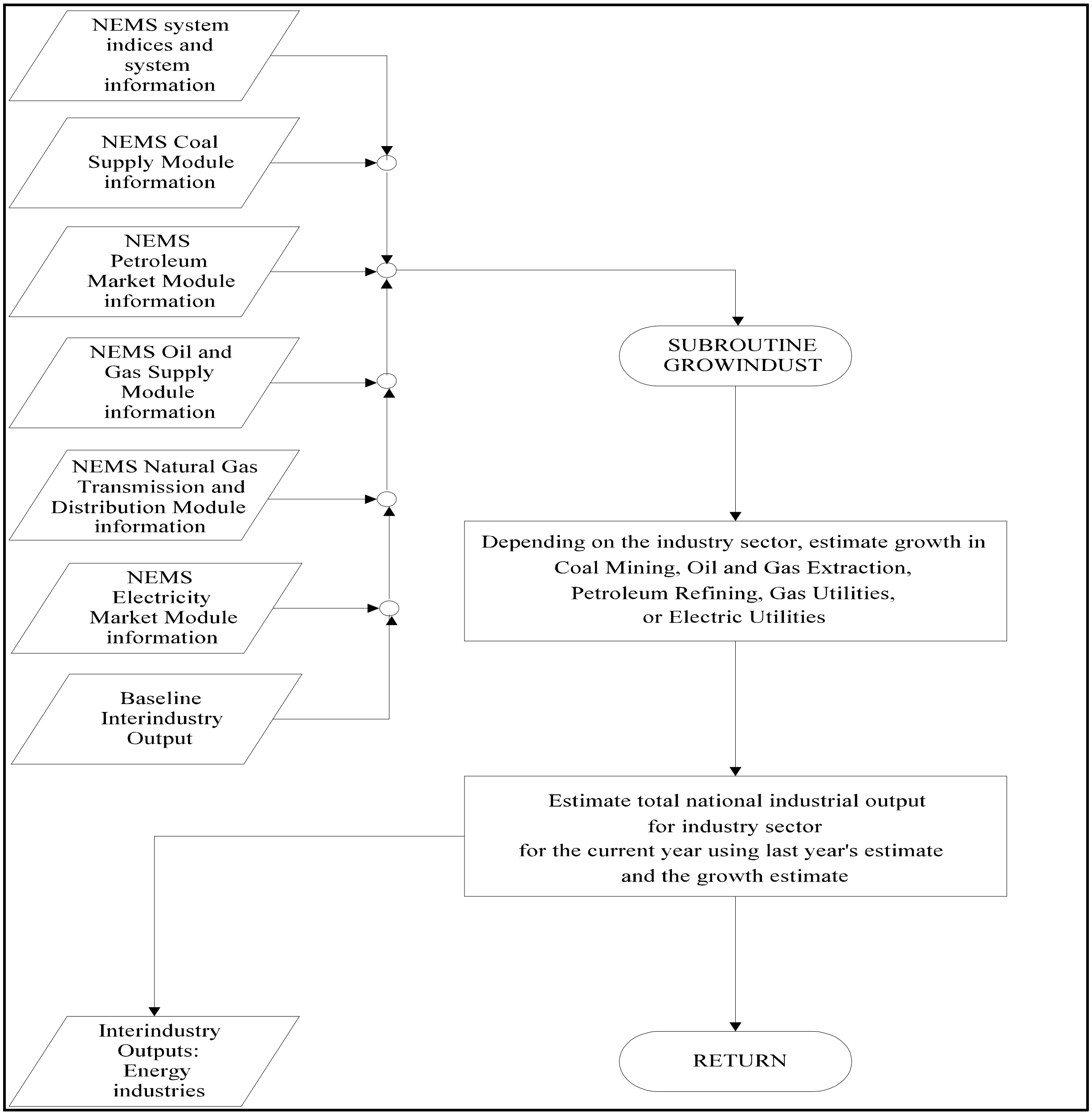
[17] Tables A-1, A-2, A-6, A-7, and A-8 of Appendix A to this report provide the definitions, usage, calculation, and dimensions of the items contained in the input/output blocks (rhombi) of this diagram. The process blocks (rectangles) of this diagram are further discussed in the second section of Appendix B, "The National Submodule".

Figure 3. Interindustry Submodule Flow[18]



18 Tables A-1, A-2, A-3, A-4, A-6, A-7 and A-8 of Appendix A to this report provide the definition, dimensions, and usage of the interindustry components contained in the input/output blocks (rhombi) of this diagram. The calculational steps illustrated in the rectangular blocks of this diagram are further described in the third section of Appendix B to this report, "The Interindustry Submodule".

Figure 4. Growth Industry Component of Interindustry Submodule [19]



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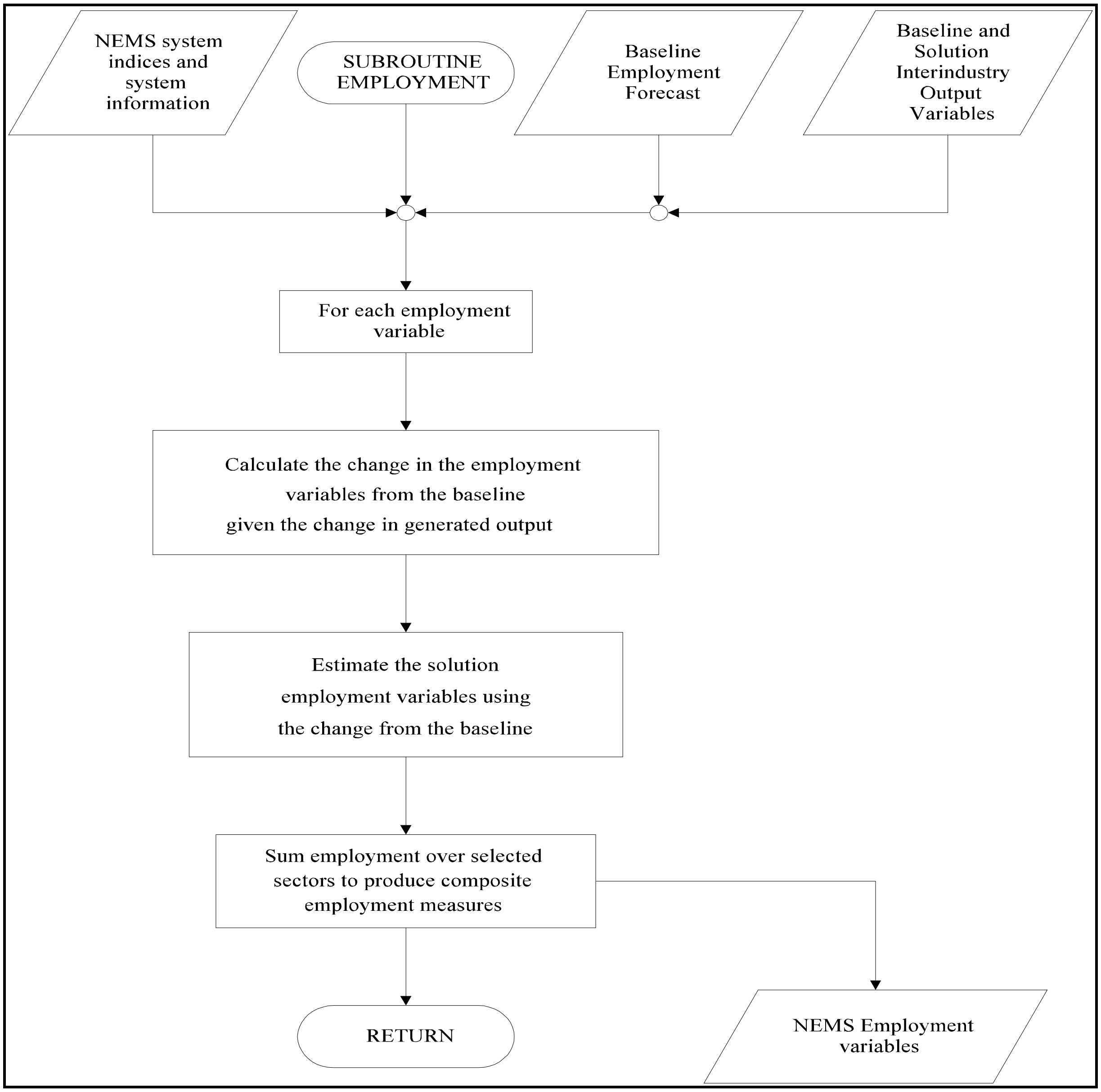
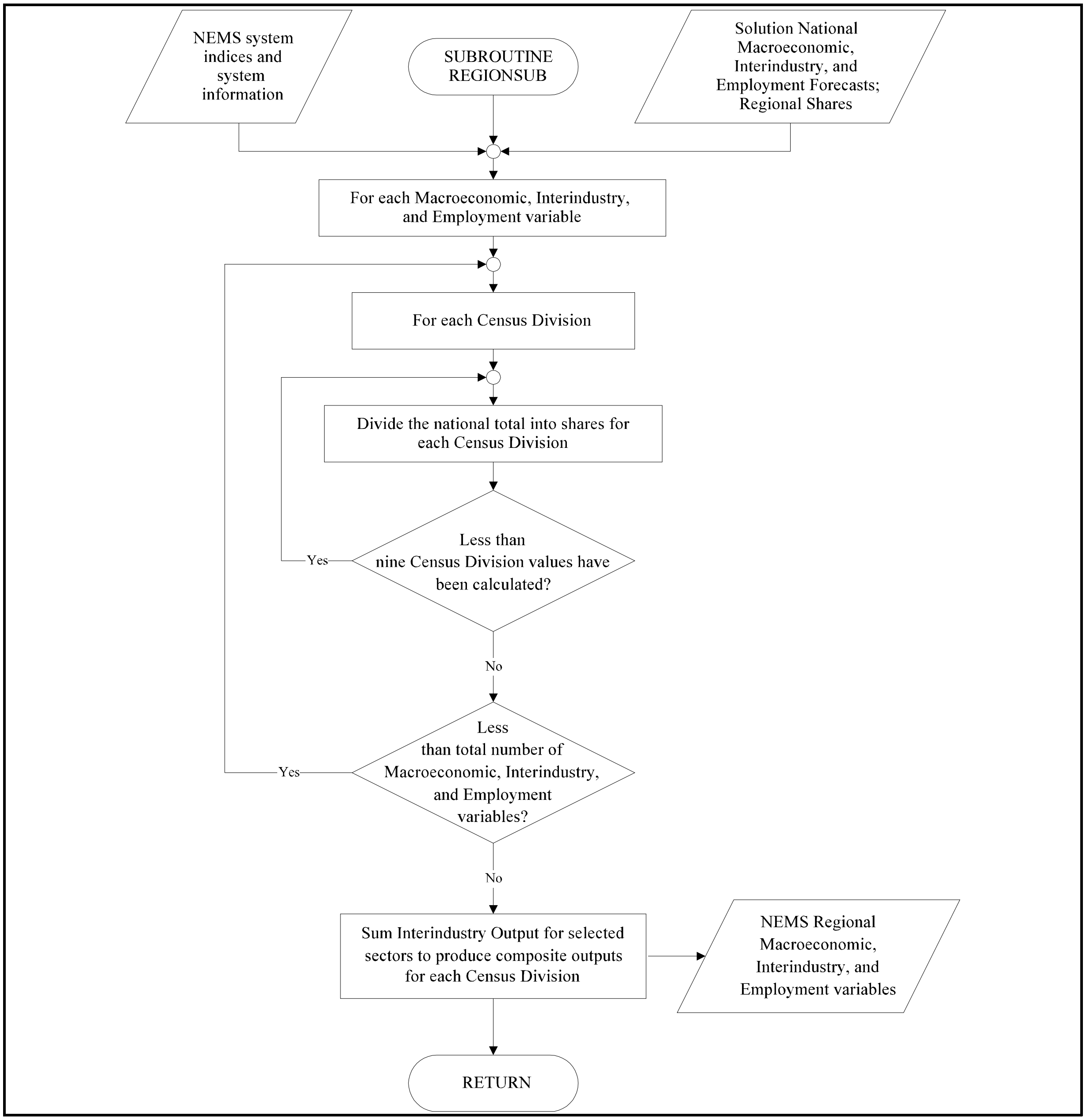
[19] Tables A-1, A-4, and A-8 of Appendix A to this report provide the definitions, dimensions, and usage of the Growth Industry Component items referenced in the input/output blocks (rhombi) of this flow diagram. The calculational processes provided in the rectangular blocks of this diagram are further described in the fourth section of Appendix B to this report, "The Growth Industry Submodule".

Figure 5. Employment Submodule Flow[20]



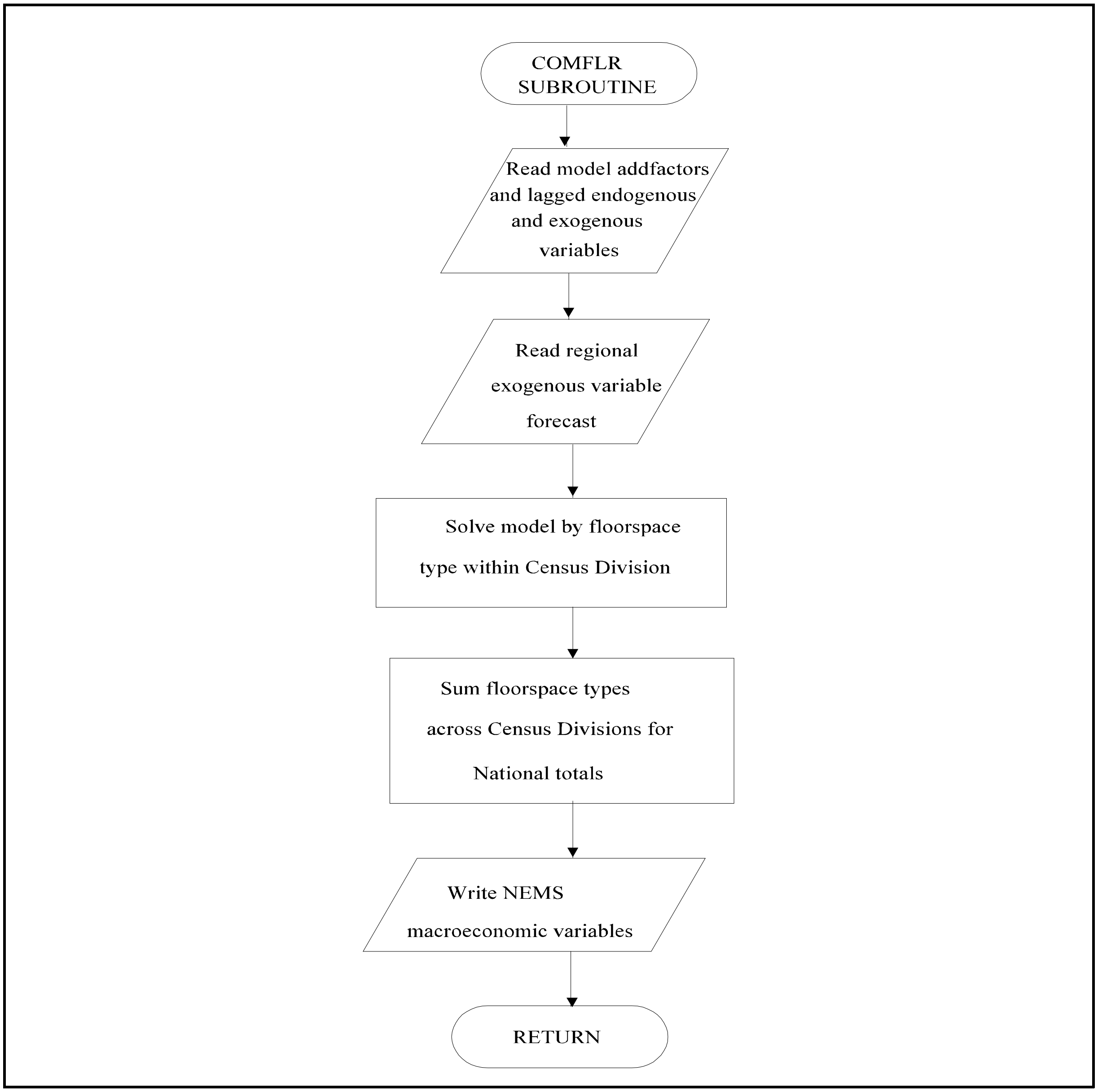
[20] Tables A-1, A-5, and A-8 of Appendix A to this report provide the definition, dimensions, and usage of the Employment Submodule as illustrated in the input/output blocks (rhombi) of this diagram. The calculational steps illustrated in the rectangular blocks of this diagram are further described in the second section of Appendix B to this report, "The Employment Submodule".

Figure 6. Regional Submodule Flow[21]



21 Table A-1, A-2, A-3, A-4, A-5, and A-8 of Appendix A to this report defines NEMS information and indices required by the Regional Submodule as illustrated in the input/output blocks in the upper right corner of this flow diagram and the decision blocks (diamonds) appearing throughout the diagram. The calculations described in the rectangular blocks of the diagram are further detailed in the fifth section of Appendix B to this report, "The Regional Submodule".

Figure 7. Commercial Floorspace Submodule Flow[22]



[22] Tables A-1, A-2, and A-8 of Appendix A to this report provide the definition, dimensions, and usage of the Commercial Floorspace Submodule as illustrated in the input/output blocks (rhombi) of this diagram. The calculational steps illustrated in the rectangular blocks of this diagram are further described in the second section of Appendix B to this report, "The Commercial Floorspace Submodule".

Key Computations and Equations

MAM Approach

The goal of the MAM is to provide a feedback effects between energy market changes and the aggregate economy. Five structural models are used to develop the baseline forecast. The first four are proprietary DRI-WEFA models: the DRI-WEFA U.S. Quarterly Macroeconomic Model, the DRI-WEFA Personal Computer Input-Output Model (PCIO), the DRI-WEFA Employment Model, and the DRI-WEFA Personal Computer Regional Model. For the AEO2002, MAM uses an Eviews-programmed DRI-WEFA Quarterly Macroeconomic Model for the National Submodule, and the DRI-WEFA PCIO and Employment Models for the Interindustry and Employment Submodules respectively. The Regional Submodule of MAM used for the AEO2002 is a set of regional shares developed through simulations of the full slate of DRI-WEFA models.[23] Commercial floor space by building type is calculated by using a regional econometric model developed by the Energy Information Administration.

MAM National Submodule

The National Submodule is a major component of estimating energy market impacts on the national economy. The methodology underlying this submodule has changed from previous years in that the direct insertion of the Eviews-programmed version of the DRI-WEFA Quarterly Macroeconomic Model precludes the necessity of calculating a smaller model to mimic the larger model. All of the energy prices and quantities present in the larger macroeconomic model are directly tied to energy concepts calculated in NEMS. The transformation of NEMS energy concepts into DRI-WEFA energy concepts occurs in the National Submodule.

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[23] DRI-WEFA is in the process of preparing documentation of the four structural DRI-WEFA models used to develop the baseline forecast: Macroeconomic, Personal Computer Computer Input-Output, Employment, and Regional models. Although these four models are proprietary, the documentation under preparation, which will be available to the public in April, 2002, will give an overview of the four models and how they link together.

MAM Interindustry Submodule

The DRI-WEFA Input-Output Model for the Personal Computer (PCIO)[24] is used to prepare the baseline forecast of gross output by sector of the economy.. The Interindustry Submodule of the NEMS MAM calculates how gross output by sector change when macroeconomic final demands change. Changes to macroeconomic final demands are determined within the National Submodule of MAM by simulation of the DRI-WEFA Eviews Macroeconomic Model and these, in turn, drive affect the concept of generated output by sector contained in the macroeconomic model.

This type of input-output model represents a top-down approach to interindustry modeling. Aggregate demand, in the form of the final demand components, is calculated first by the macroeconomic module, and is used in determining the detailed output required of the interindustry sectors to achieve this level of aggregate demand. The disaggregation can be made along several lines which have theoretical appeal: homogeneity of product, homogeneity of process, homogeneity of energy service, etc. From a practical standpoint however, the choice of disaggregation is limited by the availability of data. The PCIO input-output model is disaggregated into 254 output sectors. The Industrial Sector Demand Module does not require this level of detail. Therefore, interindustry projections provided to NEMS are an aggregation of the PCIO input-output sectors to the level requested by the Industrial Sector Demand Module. Because of the structure of the input-output model, and of input-output modeling in general, it is not necessary to directly link the full DRI-WEFA-PCIO model with NEMS in order to capture meaningful changes in interindustry activity. This is accomplished within MAM through the use of the DRI-WEFA Quarterly Macroeconomic Model industrial production forecast concept of "generated output." These generated output equations reflect the input-output relationship between the producing industry and both intermediate industries and final demand. These generated output forecast is used to calculate changes from the baseline forecast created with the full PCIO model.

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[24] The calculations performed by a standard input-output model, of which PCIO is an example, are described in the Alternative Macroeconomic Modeling Approaches section of this report.

Table 1. Major Output Groupings within MAM

Real Gross Output	SIC Coverage
Agriculture	01,02,07,08,09
Mining	10-14
Construction	15,16,17
Manufacturing	20-39
Transportation	40-42,44-47
Communications	48
Utilities	49
Wholesale Trade	50,51
Retail Trade	52-59
Finance, Insurance, and Real Estate	60-67
Services	70-87,89
Government	N/A

Note: SIC is Standard Industrial Classification

Table 2. Detailed MAM Interindustry Submodule Sectors, p. 1

Commodities	Interindustry Submodule Sector
Other Agricultural Products	Agricultural Production - Crops (SIC 01)
Livestock and Products Forestry and Fishery Products Ag., Forestry, and Fishery Services	Other Agriculture Including Livestock (SIC 02,07-09)
Iron Ore Mining Nonferrous Metals Mining Stone/Clay Mining & Quarrying Chem. and Fertilizer Mineral Mining	Metal & Other Non-metallic Mining (SIC 10,14)
Coal Mining	Coal Mining (SIC 11, 12)
Crude Petroleum Natural Gas	Oil & Gas Mining (SIC 13)
New Construction Maintenance & Repair Construction	Construction (SIC 15-17)
Food & Kindred Products	Food & Kindred Products (SIC 20)
Tobacco Manufactures	Tobacco Products (SIC 21)
Fabric, Yarn & Thread Mills Miscellaneous Textile Goods	Textile Mill Products (SIC 22)
Apparel Misc. Fabricated Textile Products	Apparel & Other Textile Products (SIC 23)
Lumber & Wood Products Wood Containers	Lumber & Wood Products (SIC 24)
Household Furniture Other Furniture & Fixtures	Furniture & Fixtures (SIC 25)
Paper Mills, Exc. Building Paper Paper & Allied Products Paperboard Containers & Boxes	Paper & Allied Industries (SIC 26)
Printing & Publishing	Printing & Publishing (SIC 27)
Inorganic & Organic Chemicals	Inorganic Chemicals (SIC 281) -- 29% Organic Chemicals (SIC 286) -- 71%
Plastic Materials & Resins Synthetic Rubber Cellulosic & Noncellulosic Fibers	Plastic Materials & Synthetics (SIC 282)

Fertilizers Agricultural Chemicals, NEC	Agricultural Chemicals (SIC 287)
Miscellaneous Chemical Products Drugs, Cleaning and Toilet Prep. Paints & Allied Products	Other Chemicals & Allied (SIC 28, NEC)
Petroleum Refining	Petroleum Refining (SIC 291)
Misc. Petroleum & Coal Products Paving Mixtures, Asphalt	Asphalt, Coal & Miscellaneous Products (SIC 295,299)
Rubber Products Miscellaneous Plastic Products	Rubber & Miscellaneous Plastic Products (SIC 30)
Leather & Footwear	Leather & Leather Products (SIC 31)
Glass & Glass Products	Glass & Glass Products (SIC 321-323)
Hydraulic Cement	Cement, Hydraulic (SIC 324)
Stone & Clay Products	Other Stone, Clay & Glass (SIC 32, NEC)
Coke Oven Products Blast Furnaces & Basic Steel	Blast Furnace & Basic Steel (SIC 331)
Primary Aluminum	Primary Aluminum (SIC 3334)
Steel Foundries, Heat Treating Primary and Basic Nonferrous Metals	Other Primary Metals (SIC 33, NEC)
Ferrous and Nonferrous Forgings Metal Containers Fabricated Structural Metal Products Screw Machine Products & Fasteners Automotive and Other Stampings Other Fabricated Metal Products	Fabricated Metal Products (SIC 34)
Engines & Turbines Farm & Garden Machinery Construction & Mining Machinery Oil Field Machinery Materials Handling Machinery Metalworking Machinery & Equipment Special Industry Machinery General Industrial Machinery Miscellaneous Nonelectrical Machinery Office, Computing & Account. Machinery Service Industry Machinery	Industrial Machinery & Equipment (SIC 35)

Electrical Machinery Household Appliances Electrical Lighting & Wiring Equipment Radio, TV, and Communications Equipment Electronic Comp. & Accessories Misc. Electrical Machinery & Equipment	Electronic & Other Electric Equipment (SIC 36)
Motor Vehicles & Equipment Aircraft & Parts Ship & Boat Building & Repairing Railroad Equipment Miscellaneous Transportation Equipment Ordnance & Accessories	Transportation Equipment (SIC 37)
Instruments & Supplies Optical, Ophthalmic & Photo Equipment	Instruments & Related Products (SIC 38)
Miscellaneous Manufacturing	Miscellaneous Manufacturing Industries (SIC 39)
Railroads & Related Services Passenger Transportation, NEC Motor Freight Water Transport. & Related Services Air Carriers & Related Services Pipelines, Except Natural Gas Transportation Services, NEC	Transportation Services (SIC 40-47)
Communications, Exc. Radio & TV Radio & TV Broadcasting	Communications (SIC 48)
Electric Utilities	Electric Utilities (SIC 491, pt 493)
Gas Utilities	Gas Utilities (SIC 492, pt 493)
Water & Sewer Services	Water & Sewer Services (SIC 494-497, pt 493)
Wholesale Trade	Wholesale Trade (SIC 50,51)
Retail Trade Eating & Drinking Places	Retail Trade (SIC 52-59, 739)
Finance & Insurance Real Estate & Rentals	F.I.R.E. (SIC 60-63, 65-66, 153)
Personal Services, Exc. Automotive Business Services Automobile Repair & Service Movies & Amusements Medical, Educational Services, NPO	Services (SIC 70, 73, 75, 76, 78-80, 82-84, 86, 89)
Federal Government Enterprises State & Local Government	Government Enterprises (SIC pt 41, 431)

MAM Employment Submodule

The Employment Submodule characterizes employment changes for inclusion in NEMS. These changes are added to, or subtracted from, the baseline projections provided by the structural employment model to derive new employment levels. The Employment Submodule relates changes in employment to changes in generated output from the National Submodule of MAM. This change makes the model more intuitive -- when an industry's output demand increases, its input usage generally increases as well. Labor is one input to the production process. The Employment Submodule is constructed similarly to the Interindustry Submodule of MAM. Within MAM changes in employment are determined by changes in generated output.

MAM Regional Submodule

The Regional Submodule disaggregates the results of the National and Interindustry Submodules to the nine Census Division level of detail. AEO2002 uses regional shares derived from simulations of the DRI-WEFA Personal Computer Regional Model designed to be compatible with both the DRI-WEFA Quarterly Macroeconomic and PCIO models. Regional shares that vary over time for each macroeconomic growth case are included in NEMS for the AEO2002 production runs. These regional shares are developed from simulations of the three full DRI-WEFA models in integrated mode, then applying the appropriate regional shares to the macroeconomic growth case.

Some limitations to the Regional Submodule exist. Regional variations in capital costs are not generated, and all regions are assumed to react to the same national set of interest rates. Technology change influences total factor productivity, and is captured through the derivation of potential GDP at the national level only. However, the various energy modules within NEMS capture the entry of new technology at the regional level. Last, MAM addresses only national decisions on fiscal policy through the National Submodule. *State* tax policy, such as a changes in state gasoline taxes, is not directly considered.

MAM Commercial Floorspace Submodule

New to the 2002 Annual Energy Outlook is a commercial floorspace forecast done with a model independent of the Regional Submodule of the MAM. The C-OMFLR Submodule of MAM contains 140 equations of which 117 (13 commercial floorspace types in each of 9 Census Divisions) are estimated using historical data reaching back into the seventies. The remaining twenty-three equations are identities that aggregate floorspace by Division (9 Divisions), across region by floorspace type (13 types) and across all regions for a national total. The submodule forecasts thirteen floorspace types in each of the nine Census Division regions. The model forecasts thousand square feet of commercial floorspace at a quarterly interval. Since commercial floorspace is a stock measure, the fourth quarter solution is provided to the NEMS common block as the reported annual floorspace forecast. The thirteen commercial floorspace types are:

I. Stores – stores and restaurants

II. Warehouse – manufacturing and wholesale trade, public and federally-owned warehouses

III. Office – private, federal, and state and local offices

IV. Automotive – auto service and parking garages

V. Manufacturing

VI. Education – primary/secondary and higher education

VII. Health – hospitals and nursing homes

VIII. Public – federal and state and local

IX. Religious

X. Amusement

XI. Miscellaneous, non-residential – transportation related and all other not elsewhere classified

XII. Hotel – hotels and motels

XIII. Dormitories – educational and federally-owned (primarily military)

Appendix A: Model Input and Output Inventory

Introduction

This Appendix describes the input data, parameters, variables, and data calibrations that are currently required for the execution of the National, Interindustry (including the Growth Industry Component of the Interindustry Submodule), Employment, Regional and Commercial Floorspace Submodules of the Macroeconomic Activity Module (MAM). These data provide a detailed representation of drivers required to support macroeconomic activity forecasting in support of MAM. Appendix A also presents the primary outputs generated by MAM, and the MAM filenames required for the generation of NEMS scenarios. As described in the main text of this Volume, the National Submodule of MAM uses the Eviews DRI-WEFA Quarterly Macroeconomic Model of the U.S. Economy, and the Interindustry and Employment Submodules of MAM use proprietary econometric models developed by DRI-WEFA.[1]

Table A-1 identifies the controlling MAM input data, including user-specified modeling switches and variable subscripts used in the MAM FORTRAN source code. The user-specified switches presented in Table A-1 enable the modeler to choose between alternative growth path assumptions in the scenario development process.

Table A-2 defines the macroeconomic variables contained within the National Submodule of MAM. All the numbered variables in Table A-2 are both inputs to, as well as outputs from, the National Submodule. The index *i* in Table A-2 indexes the NEMS variable that appears in the *i*th row of the array. The unnumbered variables are calculated outputs from the National Submodule. The DRI-

[1]DRI-WEFA is in the process of preparing documentation of the four structural DRI-WEFA models used to develop the baseline forecast: Macroeconomic, Personal Computer Computer Input-Output, Employment, and Regional models. Although these four models are proprietary, the documentation under preparation, which will be available to the public in April, 2002, will give an overview of the four models and how they link together.

WEFA Name column in Table A-2 gives the DRI-WEFA variable names that are used in the full DRI-WEFA models from which the MAM is developed. The variables which have an entry in the third column are also made available to the other NEMS modules through the MACOUT common block.

Table A-3 defines industrial gross output variables contained within the Interindustry Submodule of MAM. All the variables in Table A-3 are both inputs to, as well as outputs from, the Interindustry Submodule and are also made available to the other NEMS modules through the MACOUT common block.

The Growth Industries Component of the Interindustry Submodule calculates industrial gross output growth rates for the energy sectors (Petroleum Refining, Coal Mining, Oil & Gas Extraction, Electric Utilities, and Gas Utilities) based on physical activity for the appropriate NEMS supply or conversion modules. Table A-4 describes the NEMS variables used to calculate the growth rates for each sector.

Table A-5 defines the employment levels aggregated to the 2-digit SIC category which are passed as solution values to the NEMS common block. The Employment Submodule operates at a more disaggregated level (the same level as the Interindustry Submodule) but the projections are aggregated to provide employment at the 2-digit SIC category level.

Before calling on the Eviews version of the DRI-WEFA Quarterly Macroeconomic model,, MAM must calculate the 26 DRI-WEFA input values using 41 NEMS selection variables. Table A-6 defines the input energy variables. For each, the DRI-WEFA model mnemonic is given along with its definition. The final column of Table A-6 lists the NEMS variables which are used to calculate the corresponding DRI-WEFA selection variable.

Table A-7 identifies the files used by MAM during the NEMS execution process. Table A-7 indicates whether each file is an input or an output file, and describes the general contents of each file.

Table A-8 lists the layout of the MCBASE input file, which is especially important because it is the basis for any MAM run. The NEMS user chooses one of the three macroeconomic growth cases (low, mid, or high) contained in MCBASE to drive the energy market solution. MCBASE is a partitioned workfile, with the entire set of consistent variables listed in Table A-9 provided for each growth case. Each growth case is labeled in the row preceding the variable values. The values contained in the MCBASE file are developed by simulating the four large scale DRI-WEFA models plus the Commercial Floorspace Model sequentially in the following order: U.S. Quarterly Model of the Macroeconomy, PCIO, Employment Model, Regional Model and Commercial Floorspace Model. The required variables from each model are extracted to create MCBASE. The third column of Table A-8 indicates the source model for each variable. The variables in the MCBASE file are national in scope, and cover the period from 1990 through 2020, annually. The fifteen variables derived by the Regional Model are national aggregates of regional model results.

Table A-9 provides a listing of the MACOUT common block variables referenced by other NEMS modules. The entries in the first column indicate the variable row number within each MCBASE growth case as in Table A-8. The final column lists the referencing NEMS modules, with a description of the module abbreviations following Table A-9. As indicated in the first column, the final four entries refer to a range of variables. Table A-9 lists the row descriptions within each range.

Table A-1. Controlling MAM Input Data

Input Name	Input Type (filename)	Input Description
EXM	Run-time option (SCEDES)	MAM Model Switch, 1 = on, 0 = off
MNUMYR = 31	System parameter (PARAMETR)	Number of solution years, 1990 - 2020
CURIYR	System parameter (Integrating Module)	Current solution year, index, 1990 = 1
CURITR	System parameter (Integrating Module)	Current solution iteration
MMAC	Run-time option (SCEDES)	Macroeconomic growth scenario: 1 = Low, 2 = Mid, 3 = High
WWOP	Run-time option (SCEDES)	World Oil Price scenario: 1 = Low, 2 = Mid, 3 = High
MACTAX	Run-time option (SCEDES)	Carbon tax scenario: 0 = none (i.e., AEO case), 1 = Deficit Reduction, 2 = Personal Tax Rebate, 3 = Corporate Tax Rebate, 4 = Social Security Tax Rebate
MACTXYR	Run-time option (SCEDES)	First year of carbon tax
MACFDBK	Run-time option (SCEDES)	Macroeconomic feedback lever, 1 = on
MCNMIND = 35	MAM parameter (MACPARMS)	Number of regionalized interindustry output variables
MCNMSERV = 10	MAM parameter (MACPARMS)	Number of non-regionalized service output variables
MCLHISYR = 1999	MAM parameter (MACPARMS)	Last historical year in the forecast
MCNMMAC = 52	MAM parameter (MACPARMS)	Number of non-regionalized macroeconomic variables in the baseline
MCNMMACREG = 57	MAM parameter (MACPARMS)	Number of regionalized macroeconomic variables in the baseline
MCNUMMNF = 29	MAM parameter (MACPARMS)	Number of manufacturing interindustry variables in the baseline
MCNUMREGS = 11	MAM parameter (MACPARMS)	The nine Census Divisions, a placeholder for California (currently not in use), and the national total of all Census Divisions
MCNMFLTYPE=14	MAM parameter (MACPARMS)	Number of commercial floorspace types, including total
NUMEMPL = 46	MAM parameter (MACPARMS)	Number of Industrial Employment categories
MCBIMPRD9(I), I =1 to 11	MAM parameter (MACPARMS)	Base year (1987) manufacturing gross output by Census Division

Table A-2. MAM National Submodule Variable Description

i	**DRI-WEFA Name**	**MACOUT Common Block Name**	**Macroeconomic Variable Description**
1	CONS96C	MC_CONS96C	Personal Consumption Expenditures, Total, Billions of chained 96$
2	CD96C	MC_CD96C	Personal Consumption Expenditures, Durable Consumer Goods, Billions of chained 96$
3	CDMVAP96C	MC_CDMVAP96C	Consumption of Motor Vehicles and Parts, billions of chained 96$
4	CDFURN96C	MC_FURN96C	Consumption of Furniture, billions of chained 96$
5	CDCMPASW96C	MC_CDCMPASW96C	Consumption of Computers and Software, billions of chained 96$
6	CDFURN_CSW96C	MC_CDFURN_CSW96C	Consumption of Furniture, exc Computers and Software, billions of chained 96$
7	CDOTH96C	MC_CDOTH96C	Consumption of Other Consumer Durables, billions of chained 96$
8	CDOOPHT96C	MC_CDOOPHT96C	Consumption of Ophthalmic Products, billions of chained 96$
9	I96C	MC_I96C	Gross Private Domestic Investment, Total, billions of chained 96$
10	IFIX96C	MC_IFIX96C	Gross Private Fixed Investment, billions of chained 96$
11	IFIXNR96C	MC_IFIXNR96C	Gross Private Fixed Nonresidential Investment, billions of chained 96$
12	IPDENR96C	MC_IPDENR96C	Gross Nonresidential Investment in Equipment, billions of chained 96$
13	IPDENRLV96C	MC_IPDENRLV96C	Net Nonresidential Investment in Light Duty Vehicles, billions of chained 96$
14	IPDENREQC96C	MC_IPDENREQC96C	Gross Nonresidential Investment in Communications Equipment, billions of chained 96$
15	IPDENRMCP96C	MC_IPDENRMCP96C	Gross Nonresidential Investment in Computer Equipment, billions of chained 96$
16	IPDENRSW96C	MC_IPDENRSW96C	Gross Nonresidential Investment in Software, billions of chained 96$
17	IPDENROTHR96C	MC_IPDENROTHR96C	Gross Investment in Nonresidential Producers' Other Durable Equipment, billions of chained 96$
18	ICNR96C	MC_ICNR96C	Gross Nonresidential Investment in Structures, billions of chained 96 $
19	ICNRBAO96C	MC_ICNRBAO96C	Gross Investment in Nonresidential Structures, Buildings and Other, billions of chained 96$
20	ICNRMIAPET96C	MC_ICNRMIAPET96C	Gross Investment in Nonresidential Structures, Mining and Exploration, billions of chained 96$
21	ICNRPU96C	MC_ICNRPU96C	Gross Investment in Nonresidential Structures, Public Utilities, billions of chained 96$
22	IFIXR96C	MC_IFIXR96C	Gross Residential Fixed Investment, billions of chained 96$
23	ICR96C	MC_ICR96C	Gross Residential Investment, billions of chained 96$
24	IPDER96C	MC_IPDER96C	Gross Investment in Residential Equipment, billions of chained 96$
25	GDP96C	MC_GDP96C	Gross Domestic Product, billions of chained 96$

26	GDP96CFE	MC_GDP96CFE	Gross Domestic Product at full employment, billions of chained 96$
27	CONS96C	MC_CONS96C	Personal Consumption Expenditures, Total, billions of chained 96$
28	I96C	MC_I96C	Gross Private Investment, Total, billions of chained 96$
29	EX96C	MC_EX96C	Exports of Goods & Services, billions of chained 96$
30	M96C	MC_M96C	Imports of Goods & Services, billions of chained 96$
31	G96C	MC_G96C	Government Consumption Expenditures & Gross Investment, billions of chained 96$
32	CD96C	MC_CD96C	Personal Consumption Expenditures, Durable Consumer Goods, Billions of chained 96$
33	CN96C	MC_CN96C	Personal Consumption Expenditures, Nondurable Consumer Goods, Billions of chained 96$
34	CS96C	MC_CS96C	Personal Consumption Expenditures, Consumer Services, Billions of chained 96$
35	ICNR96C	MC_ICNR96C	Gross Nonresidential Investment in Structures, billions of chained 96 $
36	ICR96C	MC_ICR96C	Gross Residential Investment, billions of chained 96$
37	IPDENR96C	MC_IPDENR96C	Gross Nonresidential Investment in Equipment, billions of chained 96$
38	IPDER96C	MC_IPDER96C	Gross residential Investment in Equipment, billions of chained 96$
39	IFIX96C	MC_IFIX96C	Gross Private Fixed Investment, billions of chained 96$
40	IFIXNR96C	MC_IFIXNR96C	Gross Private Fixed Nonresidential Investment, billions of chained 96$
41	IFIXR96C	MC_IFIXR96C	Gross Private Fixed Residential Investment, billions of chained 96$
42	EX96CNIA0	MC_EX96CNIA0	Exports, Food Goods, Feeds, & Beverages, billions of chained 96$
43	EX96CNIA1	MC_EX9CNIA1	Exports, Industrial Supplies & Materials, billions of chained 96$
44	EX96CNIA2	MC_EX96CNIA2	Exports, Capital Goods exc autos, billions of chained 96$
45	EX96CNIA3	MC_EX96CNIA3	Exports, Automotive Vehicles, Engines & Parts, billions of chained 96$
46	EX96CNIA4	MC_EX96CNIA4	Exports, Consumer Goods except Automotive, billions of chained 96$
48	EXDAN96C	MC_EXDAN92C	Exports, Goods, billions of chained 96$
49	EXS96C	MC_EXS96C	Exports, Services, billions of chained 96$
50	M96CNIA0	MC_M96CNIA0	Imports, Food Goods, Feeds, and Beverages, billions of chained 96$
51	M96CNIA1	MC_M96NIA1	Imports, Industrial Supplies & Materials, billions of chained 96$
52	M96CNIA2	MC_M96CNIA2	Imports, Capital Goods excl. Autos, billions of chained 96$
53	M96CNIA3	MC_M96CNIA3	Imports, Automotive Vehicles, Engines & Parts, billions of chained 96$
54	M96CNIA4	MC_M96CNIA4	Imports, Consumer Goods except Automotive, billions of chained 96$
55	MS96C	MC_MS96C	Imports, Services, billions of chained 96$
56	INV96CCH	MC_INV96CCH	Change in Business Inventories, billions of chained 96$
57	GFML96C	MC_GFML96C	Federal Government Defense Expenditures on Goods and Services, billions of chained 96$
58	GDP	MC_GDP	Gross Domestic Product, billions of nominal $

59	CONS	MC_CONS	Personal Consumption Expenditures, Total, billions of nominal $
60	I	MC_I	Gross Private Domestic Investment, billions of nominal $
61	GNP96C	MC_GNP96C	Gross National Product, billions of chained 96$
62	PCWGDP	MC_PCWGDP	Chain-Type Price Index, GDP, 1996 = 1.0 (1987 = 1.0 in MC_COMMON)
63	RMGBS3NS	MC_RMGBS3NS	Discount Rate on 3-Month U.S. Treasury Bills
		MC_RLRMGBS3NS	Real Discount Rate on 3-Month U.S. Treasury Bills
64	RMMTGCCNS	MC_RMMTGCCNS	Conventional 30-Year Mortgage Commitment Rate
65	RMPUAANS	MC_RMPUAANS	Yield on AA Utility Bonds
		MC_RLRMPUAANS	Real Yield on AA Utility Bonds
66	REALRMGBLUS	MC_REALRMGBLUS	Real Average Yield on 10-Year U.S. Government Bonds, Constant Maturity
67	ECIWSP	MC_ECIWSP	Employment Cost Index, Wages & Salaries, Private Sector, June 1989 = 1.0
68	SQTRCARS	MC_SQTRCARS	Unit Sales of Automobiles, Total, millions of units
69	SQLV	MC_SQLV	Unit Sales of Light Duty Vehicles, Domestic, millions of units
70	SQDTRUCKSL	MC_SQDTRUCKSL	Truck Deliveries, Light Duty, millions of units
71	SQDTRUCKSHAM	MC_SQDTRUCKSHAM	Truck Deliveries, Heavy and Medium Duty, millions of units
72	RUC	MC_RUC	Unemployment Rate, All Civilian Workers
73	WPI	MC_WPI	Producer Price Index, All Commodities, 1982 = 1.0
74	WPI14	MC_WPI14	Producer Price Index, Transportation Equipment, 1982 = 1.0
75	WPI11	MC_WPI11	Producer Price Index, Machinery & Equipment, 1982 = 1.0
76	LC	MC_LC	Civilian Labor Force, millions of persons
77	RMFEDFUNDNS	MC_RMFEDFUNDNS	Effective Rate on Federal Funds
78	CPI	MC_CPI [1]	Consumer Price Index (All Urban) - All Items, 1982-84 = 1.0
79	YD96C	MC_YD96C[1]	Disposable Personal Income, billions of chained 96$
80	WSD	MC_WSD[1]	Wage & Salary Disbursements, billions of nominal $
81	YP96C	MC_YP96C[1]	Personal Income, billions of chained 96$
97	SHUMBL	MC_SHUMBL[1]	Mobile Homes Shipments, millions of units
98	HUSTS1	MC_HUSTS1[1]	Single-Family Housing Starts, Private including Farm, millions of units
99	HUSTS2A	MC_HUSTS2A [2]	Multi-Family Housing Starts, Private including Farm, millions of units
100	KQMH	MC_KQMH[1]	Stock of Mobile Homes, millions of units
101	KQHUSTS1	MC_KQHUSTS1 [1]	Stock of Single-Family Housing, millions of units
102	KQHUSTS2A	MC_KQHUSTS2A [1]	Stock of Multi-Family Housing, millions of units
103	N	MC_N [1]	Population Including Armed Forces Overseas, millions of persons
104	N16A	MC_N16A [1]	Population Aged 16 and Over, millions of persons
105	RWM@SUM	MC_MFGWGRT [1]	Average Annual Manufacturing Wages, nominal $

106	RWNM@SUM	MC_NMFGWGRT [1]	Average Annual Non-Manufacturing Wages, nominal $
		MC_COMMFLSP(1) [1]	Commercial Floor Space, Total, billion square feet
107	KAMUSE@SUM	MC_COMMFLSP(2) [1]	Commercial Floor Space, Amusement, billion square feet
108	KAUTO@SUM	MC_COMMFLSP(3) [1]	Commercial Floor Space, Automobile Sales, billion square feet
109	KDORM@SUM	MC_COMMFLSP(4) [1]	Commercial Floor Space, Dormitories, billion square feet
110	KEDUC@SUM	MC_COMMFLSP(5) [1]	Commercial Floor Space, Education, billion square feet
111	KHEALTH@SUM	MC_COMMFLSP(6) [1]	Commercial Floor Space, Health, billion square feet
112	KHOTEL@SUM	MC_COMMFLSP(7) [1]	Commercial Floor Space, Hotel, billion square feet
113	KMFG@SUM	MC_COMMFLSP(8) [1]	Commercial Floor Space, Manufacturing, billion square feet
114	KMISCNR@SUM	MC_COMMFLSP(9) [1]	Commercial Floor Space, Miscellaneous Non-Residential, billion square feet
115	KOFFICE@SUM	MC_COMMFLSP(10) [1]	Commercial Floor Space, Office, billion square feet
116	KPUB@SUM	MC_COMMFLSP(11) [1]	Commercial Floor Space, Public, billion square feet
117	KREL@SUM	MC_COMMFLSP(12) [1]	Commercial Floor Space, Religion, billion square feet
118	KSTORES@SUM	MC_COMMFLSP(13) [1]	Commercial Floor Space, Stores, billion square feet
119	KWARE@SUM	MC_COMMFLSP(14) [1]	Commercial Floor Space, Warehouse, billion square feet

[1] MACOUT Common Block Variables provided at the National and Census Division level; all others provided only at the National level.

Table A-3. MAM Interindustry Submodule Variable Description

MACOUT Common Block Name	Industrial Gross Output Variable Description (millions of fixed 92$)
MC_MFGO(1) [2]	Food & Kindred Products (SIC 20)
MC_MFGO(2) [2]	Tobacco Products (SIC 21)
MC_MFGO(3) [2]	Textile Mill Products (SIC 22)
MC_MFGO(4) [2]	Apparel & Other Textiles (SIC 23)
MC_MFGO(5) [2]	Lumber & Wood Products (SIC 24)
MC_MFGO(6) [2]	Furniture & Fixtures (SIC 25)
MC_MFGO(7) [2]	Paper & Allied Industries (SIC 26)
MC_MFGO(8) [2]	Printing & Publishing (SIC 27)
MC_MFGO(9) [2]	Inorganic Chemicals (SIC 281)
MC_MFGO(10) [2]	Organic Chemicals (SIC 286)
MC_MFGO(11) [2]	Plastic Materials & Synthetics (SIC 282)
MC_MFGO(12) [2]	Agricultural Chemicals (SIC 287)
MC_MFGO(13) [2]	Other Chemicals & Allied (SIC 28, nec)
MC_MFGO(14) [2]	Petroleum Refining (SIC 291)
MC_MFGO(15) [2]	Asphalt, Coal, & Miscellaneous Products (SIC 295, 299)
MC_MFGO(16) [2]	Rubber & Miscellaneous Plastic Products (SIC 30)
MC_MFGO(17) [2]	Leather & Leather Products (SIC 31)
MC_MFGO(18) [2]	Glass & Glass Products (SIC 321, 322, 323)
MC_MFGO(19) [2]	Cement, Hydraulic (SIC 324)
MC_MFGO(20) [2]	Other Stone, Clay, & Glass Products (SIC 32, nec)
MC_MFGO(21) [2]	Blast Furnace & Basic Steel (SIC 331)
MC_MFGO(22) [2]	Aluminum (SIC 3334, pt 3341, 3353-5, 3363, 3365)
MC_MFGO(23) [2]	Other Primary Metals (SIC 33, nec)
MC_MFGO(24) [2]	Fabricated Metal Products (SIC 34)
MC_MFGO(25) [2]	Industrial Machinery & Equipment (SIC 35)
MC_MFGO(26) [2]	Electronic & Other Electric Equipment (SIC 36)
MC_MFGO(27) [2]	Transportation Equipment (SIC 37)
MC_MFGO(28) [2]	Instruments & Related Products (SIC 38)
MC_MFGO(29) [2]	Miscellaneous Manufacturing Industries (SIC 39)

MC_MFGO(30) [2]	Agricultural Production, Crops (SIC 01)
MC_MFGO(31) [2]	Other Agricultural Production Including Livestock (SIC 02, 07, 08, 09)
MC_MFGO(32) [2]	Coal Mining (SIC 12)
MC_MFGO(33) [2]	Oil & Gas Extraction (SIC 13)
MC_MFGO(34) [2]	Metal & Other Mining (SIC 10, 14)
MC_MFGO(35) [2]	Construction (SIC 15, 16, 17)
MC_MFGO(36) [2]	Chemicals & Allied Products(SIC 28)
MC_MFGO(37) [2]	Petroleum Refining & Related Industries (SIC 29)
MC_MFGO(38) [2]	Stone, Clay, Glass, & Concrete Products (SIC 32)
MC_MFGO(39) [2]	Primary Metal Industries (SIC 33)
MC_NMFGO(1) [1]	Transportation Services (SIC 40, 41, 42, 43, 44, 45, 46, 47)
MC_NMFGO(2) [1]	Communications (SIC 48)
MC_NMFGO(3) [1]	Electric Utilities (SIC 491, part of 493)
MC_NMFGO(4) [1]	Gas Utilities (SIC 492, part of 493)
MC_NMFGO(5) [1]	Water & Sewer Services (SIC 494, 495, 496, 497, part of 493)
MC_NMFGO(6) [1]	Wholesale Trade (SIC 50,51)
MC_NMFGO(7) [1]	Retail Trade (SIC 52, 53, 54, 55, 56, 57, 59, 739)
MC_NMFGO(8) [1]	Finance, Insurance, Real Estate (SIC 60, 61, 62, 63, 65, 66, 153)
MC_NMFGO(9) [1]	Services (SIC 58, 70, 73, 75, 76, 78, 79, 80, 82, 83, 84, 86, 89)
MC_NMFGO(10) [1]	Government Enterprises (SIC part of 41, 431)
MC_NMFGO(11) [1]	Total Services Output (SIC 40 - 99)

[1] MACOUT Common Block Variables provided only at the National level

[2] MACOUT Common Block Variables provided at the National and Census Division level

Table A-4. Interindustry Growth Determined by NEMS Quantities

j	MACOUT Common Block Name	Interindustry Sector Definition	NEMS source
1	MC_MFGO(32)	Coal Mining (SIC 11, 12)	COALOUT Common Block: CQSBB - Total Coal Production
2	MC_MFGO(33)	Oil and Gas Extraction (SIC 13)	PMMOUT Common Block: RFQTDCRD - Total Crude Oil Production RFPQNGL - Total Natural Gas Plant Liquids Production OGPRDNG - Total Dry Natural Gas Production OGPRSUP - Supplemental Natural Gas Production
3	MC_MFGO(14)	Petroleum Refining (SIC 291)	PMMOUT Common Block: RFQPRDT - Total Petroleum Product Supplied PMMRPT Common Block: RFQPRDT - Total Imported Petroleum Products
4	MC_NMFGO(4)	Gas Utilities (SIC 492, part of 493)	PMMOUT Common Block: OGPRDNG - Total Dry Natural Gas Production
5	MC_NMFGO(3)	Electric Utilities (SIC 491, part of 493)	UEFDOUT Common Block: UGNTLNR - Total Electricity Generation

Table A-5. MAM Employment Submodule Variable Description

DRI-WEFA Variable Name	MACOUT Common Block Name	Variable Description (millions of persons)
EEA	MC_EMPNA(1) [2]	Total Non-Agricultural Employment
EC	MC_EMPNA(2) [2]	Construction (SIC 15-17) Employment
EGF	MC_EMPNA(3) [2]	Federal Government Employment
EFIR	MC_EMPNA(4) [2]	Finance, Insurance, and Real Estate (SIC 60-67)Employment
EMI	MC_EMPNA(5) [2]	Mining (SIC 10-14) Employment
ESV	MC_EMPNA(6) [2]	Services (SIC 70-89) Employment
EGSL	MC_EMPNA(7) [2]	State & Local Government Employment
ER	MC_EMPNA(8) [2]	Transportation, Communications, Public Utilities (SIC 40-49) Employment
ETR	MC_EMPNA(9) [2]	Retail Trade (SIC 52-59) Employment
ETW	MC_EMPNA(10) [2]	Wholesale Trade (SIC 50-51) Employment
E24	MC_EMPNA(11) [2]	Lumber & Wood Products (SIC 24) Employment
E25	MC_EMPNA(12) [2]	Furniture & Fixtures (SIC 25) Employment
E32	MC_EMPNA(13) [2]	Stone, Clay, & Glass (SIC 32) Employment
E33	MC_EMPNA(14) [2]	Primary Metals (SIC 33) Employment
E34	MC_EMPNA(15) [2]	Fabricated Metal Products (SIC 34) Employment
E35	MC_EMPNA(16) [2]	Industrial Machinery and Equipment (SIC 35) Employment
E36	MC_EMPNA(17) [2]	Electronic and other Electrical Equipment (SIC 36) Employment
E37	MC_EMPNA(18) [2]	Transportation Equipment (SIC 37) Employment
E38	MC_EMPNA(19) [2]	Instruments (SIC 38) Employment
E39	MC_EMPNA(20) [2]	Miscellaneous Manufacturing (SIC 39) Employment
E20	MC_EMPNA(21) [2]	Food & Kindred Products (SIC 20) Employment
E21	MC_EMPNA(22) [2]	Tobacco Products (SIC 21) Employment
E22	MC_EMPNA(23) [2]	Textile Mill Products (SIC 22) Employment
E23	MC_EMPNA(24) [2]	Apparel & Other Textile Products (SIC 23) Employment
E26	MC_EMPNA(25) [2]	Paper & Allied Products (SIC 26) Employment
E27	MC_EMPNA(26) [2]	Printing & Publishing (SIC 27) Employment
E28	MC_EMPNA(27) [2]	Chemicals & Allied Products (SIC 28) Employment
E29	MC_EMPNA(28) [2]	Petroleum & CoalProducts (SIC 29) Employment
E30	MC_EMPNA(29) [2]	Rubber & Miscellaneous Plastics Products (SIC 30) Employment
E31	MC_EMPNA(30) [2]	Leather & Leather Products (SIC 31) Employment
EAG	MC_EMPNA(31) [1]	Agricultural (SIC 01, 02, 07-09) Employment

[1] MACOUT Common Block Variables provided only at the National level

[2] MACOUT Common Block Variables provided at the National and Census Division level

Table A-6. MAM EVIEWS Driver Input Variables

i	DRI-WEFA Variable	DRI-WEFA Variable Definition	NEMS source
	&TXGF	Tax Revenue	<u>EMISSION Common Block:</u> EMREV(I) for I = 1 to 5 - Emission Revenue by Demand Sector
2	WPI051	Producer Price Index - Coal	<u>AMPBLK Common Block:</u> PCLEL - Coal Price to Electric Generators
3	WPI053	Producer Price Index - Gas Fuels	<u>NGTDMREP Common Block:</u> OGWPRNG - Natural Gas Wellhead Price
4	WPI054	Producer Price Index - Electric Power	<u>AMPBLK Common Block:</u> PELRS - Residential Purchased Electricity Price PELCM - Commercial Purchased Electricity Price PELIN - Industrial Purchased Electricity Price PELTR - Transportation Purchased Electricity Price
5	WPI055	Producer Price Index - Utility Natural Gas	<u>AMPBLK Common Block:</u> PNGRS - Residential Natural Gas Price PNGCM - Commercial Natural Gas Price PNGIN - Industrial Natural Gas Price PNGTR - Transportation Natural Gas Price PNGEL - Natural Gas Price to Electric Generators
6	WPI0561	Producer Price Index - Crude Petroleum	<u>INTOUT Common Block:</u> IT_WOP - World Oil Price

	PI057	Producer Price Index - Refined Petroleum Products	**<u>AMPBLK Common Block:</u>** PTPRS - Residential Total Petroleum Price PDSCM - Commercial Distillate Price PRSCM - Commercial Residual Fuel Price PDSIN - Industrial Distillate Price PRSIN - Industrial Residual Fuel Price PDSTR - Transportation Distillate Price PJFTR - Transportation Jet Fuel Price PMGTR - Transportation Motor Gasoline Price PRSTR - Transportation Residual Fuel Price

8	**DTFUELSALLB**	**Demand for All Fuels - All Sectors**	**<u>QBLK Common Block:</u>** **QTPAS - Petroleum Consumption, All Sectors** **QNGAS - Natural Gas Consumption, All Sectors** **QGPTR - Natural Gas Pipeline Consumption** **QLPIN - Lease and Plant Fuel Consumption** **QCLAS - Coal Consumption, All Sectors** **QMCIN - Metallurgical Coal Consumption, Industrial** **QCIIN - Net Coal Coke Imports, Industrial** **QUREL - Uranium Consumption, Electricity Generation** **QTRAS - Renewables Consumption, All Sectors** **QSTRS - Solar Thermal Consumption, Residential** **QSTCM - Solar Thermal Consumption, Commercial** **QEIEL - Net Electricity Imports** **QMETR - Methanol Consumption, Transportation** **QHYTR - Liquid Hydrogen Consumption, Transportation** **QTREL - Total Renewables, Electricity Generation** **QPCEL - Petroleum Coke, Electricity Generation** **<u>RESDREP Common Block:</u>** **QGERS - Geothermal Consumption, Residential**
9	**DENDUSE@COAL**	**End-Use Demand for Coal**	**<u>QBLK Common Block:</u>** **QMCIN - Metallurgical Coal Consumption, Industrial** **QCLAS - Coal Consumption, All Sectors** **QCLEL - Coal Consumption, Electricity Generation** **QCIIN - Net Coal Coke Imports, Industrial**

10	**DENDUSE@ELC**	**Electricity Sales to Ultimate Consumers**	**QBLK Common Block:** **QELAS - Purchased Electricity, All Sectors**
11	**DENDUSE@PET**	**End-Use Demand for Petroleum**	**QBLK Common Block:** **QDSAS - Distillate Consumption, All Sectors** **QDSEL - Distillate Consumption, Electricity Generation** **QKSAS - Kerosene Consumption, All Sectors** **QJFTR - Jet Fuel Consumption, Transportation** **QLGAS - Liquified Petroleum Gases, All Sectors** **QMGAS - Motor Gasoline Consumption, All Sectors** **QPFIN - Petrochemical Feedstocks, Industrial** **QRSAS - Residual Fuel Consumption, All Sectors** **QRSEL - Residual Fuel Cons., Electricity Generation** **QOTAS - Other Petroleum Consumption, All Sectors** **QSGIN - Still Gas Consumption, Industrial** **QPCIN - Petroleum Coke Consumption, Industrial** **QASIN - Asphalt and Road Oil Consumption, Industrial**
12	**DENDUSE@NG**	**End-Use Demand for Natural Gas**	**QBLK Common Block:** **QNGAS - Natural Gas Consumption, All Sectors** **QGPTR - Natural Gas Pipeline Consumption** **QLPIN - Lease and Plant Fuel Consumption** **QNGEL - Natural Gas Consumption, Electricity Gen.**
13	**WPI05**	**Producer Price Index - Fuels and Related Products and Power**	**Calculated from MCKCOMM inputs 2 through 7**

14	**PCWCNFUEL**	**Personal Consumption Deflator, Household Fuel Oil**	**PTPRS - Residential Price of Fuel Oil**
15	**PCWCNGAS**	**Personal Consumption Deflator, consumer gasoline and oil**	**PMGTR - Transportation price of gasoline** **PDSTR - Transportation price of diesel fuel**
16	**PCWCSHHOPE**	**Personal Consumption Deflator, household electricity**	**PELRS - Residential price of electricity**
17	**PCWCSHHOPG**	**Personal Consumption Deflator, household natural gas**	**PNGRS - Residential price of natural gas**
18	**CNFUEL**	**Consumption of household fuel oil**	**QTPRS - Residential consumption of heating fuel**
19	**CNGAS**	**Consumption of Consumer gasoline and oil**	**QMGTR - Transportation consumption of gasoline** **QDSTR - Transportation consumption of diesel fuel**
20	**CSHHOPE**	**Consumption of household electricity**	**QELRS - Residential consumption of electricity**
21	**CSHHOPG**	**Consumption of household natural gas**	**QNGRS - Residential consumption of natural gas**

22	**JQIND12**	**Production of coal mining**	**CQSSB - Production of coal**
23	**JQIND13**	**Production of oil and gas extraction**	**RFQTCRD - Production of crude oil** **RFPQNGL - Production of natural gas liquids** **OGPRDNG - Production of dry natural gas**
24	**QENG**	**Index of Domestic Energy Demand**	**Calculated from MCKCOMM inputs 9 through 12**

Table A-7. MAM Input and Output File Specification

Filename	**File Description**	**Input or Output**
MCPARMS	**Parameter file**	**Input**
MCBASE.WK1(LOW, MID, or HIGH)	**Macroeconomic (including Interindustry and Employment) variable file (scenario specific)**	**Input**
MCRGBAS(LOW, MID, or HIGH)	**Regional variable file (scenario specific)**	**Input**
MC_NATIONAL.WK1	**National variable solution results and baseline values, including percent changes from base**	**Output**
MC_EMPLOYMENT.WK1	**Employment variable solution results and baseline values**	**Output**
MC_INDUSTRIAL.WK1	**Industrial variable solution results and baseline values**	**Output**
MC_REGIONAL.WK1	**Regional variable solution results and baseline values**	**Output**
MC_COMMON.WK1	**Common block variables for all submodules, including National, Employment, Industrial and Regiional**	

Table A-8. MCBASE Input File Layout

i	**DRI-WEFA Name**	**MACOUT Common Block Name**	**Macroeconomic Variable Description**
1	CONS96C	MC_CONS96C	Personal Consumption Expenditures, Total, Billions of chained 96$
2	CD96C	MC_CD96C	Personal Consumption Expenditures, Durable Consumer Goods, Billions of chained 96$
3	CDMVAP96C	MC_CDMVAP96C	Consumption of Motor Vehicles and Parts, billions of chained 96$
4	CDFURN96C	MC_FURN96C	Consumption of Furniture, billions of chained 96$
5	CDCMPASW96C	MC_CDCMPASW96C	Consumption of Computers and Software, billions of chained 96$
6	CDFURN_CSW96C	MC_CDFURN_CSW96C	Consumption of Furniture, exc Computers and Software, billions of chained 96$
7	CDOTH96C	MC_CDOTH96C	Consumption of Other Consumer Durables, billions of chained 96$
8	CDOOPHT96C	MC_CDOOPHT96C	Consumption of Ophthalmic Products, billions of chained 96$
9	I96C	MC_I96C	Gross Private Domestic Investment, Total, billions of chained 96$
10	IFIX96C	MC_IFIX96C	Gross Private Fixed Investment, billions of chained 96$
11	IFIXNR96C	MC_IFIXNR96C	Gross Private Fixed Nonresidential Investment, billions of chained 96$
12	IPDENR96C	MC_IPDENR96C	Gross Nonresidential Investment in Equipment, billions of chained 96$
13	IPDENRLV96C	MC_IPDENRLV96C	Net Nonresidential Investment in Light Duty Vehicles, billions of chained 96$
14	IPDENREQC96C	MC_IPDENREQC96C	Gross Nonresidential Investment in Communications Equipment, billions of chained 96$
15	IPDENRMCP96C	MC_IPDENRMCP96C	Gross Nonresidential Investment in Computer Equipment, billions of chained 96$
16	IPDENRSW96C	MC_IPDENRSW96C	Gross Nonresidential Investment in Software, billions of chained 96$
17	IPDENROTHR96C	MC_IPDENROTHR96C	Gross Investment in Nonresidential Producers' Other Durable Equipment, billions of chained 96$
18	ICNR96C	MC_ICNR96C	Gross Nonresidential Investment in Structures, billions of chained 96 $
19	ICNRBAO96C	MC_ICNRBAO96C	Gross Investment in Nonresidential Structures, Buildings and Other, billions of chained 96$
20	ICNRMIAPET96C	MC_ICNRMIAPET96C	Gross Investment in Nonresidential Structures, Mining and Exploration, billions of chained 96$
21	ICNRPU96C	MC_ICNRPU96C	Gross Investment in Nonresidential Structures, Public Utilities, billions of chained 96$
22	IFIXR96C	MC_IFIXR96C	Gross Residential Fixed Investment, billions of chained 96$
23	ICR96C	MC_ICR96C	Gross Residential Investment, billions of chained 96$
24	IPDER96C	MC_IPDER96C	Gross Investment in Residential Equipment, billions of chained 96$
25	GDP96C	MC_GDP96C	Gross Domestic Product, billions of chained 96$
26	GDP96CFE	MC_GDP96CFE	Gross Domestic Product at full employment, billions of chained 96$
27	CONS96C	MC_CONS96C	Personal Consumption Expenditures, Total, billions of chained 96$

28	I96C	MC_I96C	Gross Private Investment, Total, billions of chained 96$
29	EX96C	MC_EX96C	Exports of Goods & Services, billions of chained 96$
30	M96C	MC_M96C	Imports of Goods & Services, billions of chained 96$
31	G96C	MC_G96C	Government Consumption Expenditures & Gross Investment, billions of chained 96$
32	CD96C	MC_CD96C	Personal Consumption Expenditures, Durable Consumer Goods, Billions of chained 96$
33	CN96C	MC_CN96C	Personal Consumption Expenditures, Nondurable Consumer Goods, Billions of chained 96$
34	CS96C	MC_CS96C	Personal Consumption Expenditures, Consumer Services, Billions of chained 96$
35	ICNR96C	MC_ICNR96C	Gross Nonresidential Investment in Structures, billions of chained 96 $
36	ICR96C	MC_ICR96C	Gross Residential Investment, billions of chained 96$
37	IPDENR96C	MC_IPDENR96C	Gross Nonresidential Investment in Equipment, billions of chained 96$
38	IPDER96C	MC_IPDER96C	Gross residential Investment in Equipment, billions of chained 96$
39	IFIX96C	MC_IFIX96C	Gross Private Fixed Investment, billions of chained 96$
40	IFIXNR96C	MC_IFIXNR96C	Gross Private Fixed Nonresidential Investment, billions of chained 96$
41	IFIXR96C	MC_IFIXR96C	Gross Private Fixed Residential Investment, billions of chained 96$
42	EX96CNIA0	MC_EX96CNIA0	Exports, Food Goods, Feeds, & Beverages, billions of chained 96$
43	EX96CNIA1	MC_EX9CNIA1	Exports, Industrial Supplies & Materials, billions of chained 96$
44	EX96CNIA2	MC_EX96CNIA2	Exports, Capital Goods exc autos, billions of chained 96$
45	EX96CNIA3	MC_EX96CNIA3	Exports, Automotive Vehicles, Engines & Parts, billions of chained 96$
46	EX96CNIA4	MC_EX96CNIA4	Exports, Consumer Goods except Automotive, billions of chained 96$
48	EXDAN96C	MC_EXDAN92C	Exports, Goods, billions of chained 96$
49	EXS96C	MC_EXS96C	Exports, Services, billions of chained 96$
50	M96CNIA0	MC_M96CNIA0	Imports, Food Goods, Feeds, and Beverages, billions of chained 96$
51	M96CNIA1	MC_M96NIA1	Imports, Industrial Supplies & Materials, billions of chained 96$
52	M96CNIA2	MC_M96CNIA2	Imports, Capital Goods excl. Autos, billions of chained 96$
53	M96CNIA3	MC_M96CNIA3	Imports, Automotive Vehicles, Engines & Parts, billions of chained 96$
54	M96CNIA4	MC_M96CNIA4	Imports, Consumer Goods except Automotive, billions of chained 96$
55	MS96C	MC_MS96C	Imports, Services, billions of chained 96$
56	INV96CCH	MC_INV96CCH	Change in Business Inventories, billions of chained 96$
57	GFML96C	MC_GFML96C	Federal Government Defense Expenditures on Goods and Services, billions of chained 96$
58	GDP	MC_GDP	Gross Domestic Product, billions of nominal $
59	CONS	MC_CONS	Personal Consumption Expenditures, Total, billions of nominal $
60	I	MC_I	Gross Private Domestic Investment, billions of nominal $
61	GNP96C	MC_GNP96C	Gross National Product, billions of chained 96$

62	PCWGDP	MC_PCWGDP	Chain-Type Price Index, GDP, 1996 = 1.0 (1987 = 1.0 in MC_COMMON)
63	RMGBS3NS	MC_RMGBS3NS	Discount Rate on 3-Month U.S. Treasury Bills
		MC_RLRMGBS3NS	Real Discount Rate on 3-Month U.S. Treasury Bills
64	RMMTGCCNS	MC_RMMTGCCNS	Conventional 30-Year Mortgage Commitment Rate
65	RMPUAANS	MC_RMPUAANS	Yield on AA Utility Bonds
		MC_RLRMPUAANS	Real Yield on AA Utility Bonds
66	REALRMGBLUS	MC_REALRMGBLUS	Real Average Yield on 10-Year U.S. Government Bonds, Constant Maturity
67	ECIWSP	MC_ECIWSP	Employment Cost Index, Wages & Salaries, Private Sector, June 1989 = 1.0
68	SQTRCARS	MC_SQTRCARS	Unit Sales of Automobiles, Total, millions of units
69	SQLV	MC_SQLV	Unit Sales of Light Duty Vehicles, Domestic, millions of units
70	SQDTRUCKSL	MC_SQDTRUCKSL	Truck Deliveries, Light Duty, millions of units
71	SQDTRUCKSHAM	MC_SQDTRUCKSHAM	Truck Deliveries, Heavy and Medium Duty, millions of units
72	RUC	MC_RUC	Unemployment Rate, All Civilian Workers
73	WPI	MC_WPI	Producer Price Index, All Commodities, 1982 = 1.0
74	WPI14	MC_WPI14	Producer Price Index, Transportation Equipment, 1982 = 1.0
75	WPI11	MC_WPI11	Producer Price Index, Machinery & Equipment, 1982 = 1.0
76	LC	MC_LC	Civilian Labor Force, millions of persons
77	RMFEDFUNDNS	MC_RMFEDFUNDNS	Effective Rate on Federal Funds
78	CPI	MC_CPI	Consumer Price Index (All Urban) - All Items, 1982-84 = 1.0
79	YD96C	MC_YD96C	Disposable Personal Income, billions of chained 96$
80	WSD	MC_WSD	Wage & Salary Disbursements, billions of nominal $
81	YP96C	MC_YP96C	Personal Income, billions of chained 96$
97	SHUMBL	MC_SHUMBL	Mobile Homes Shipments, millions of units
98	HUSTS1	MC_HUSTS1	Single-Family Housing Starts, Private including Farm, millions of units
99	HUSTS2A	MC_HUSTS2A [2]	Multi-Family Housing Starts, Private including Farm, millions of units
100	KQMH	MC_KQMH [2]	Stock of Mobile Homes, millions of units
101	KQHUSTS1	MC_KQHUSTS1 [2]	Stock of Single-Family Housing, millions of units
102	KQHUSTS2A	MC_KQHUSTS2A [2]	Stock of Multi-Family Housing, millions of units
103	N	MC_N [2]	Population Including Armed Forces Overseas, millions of persons
104	N16A	MC_N16A [2]	Population Aged 16 and Over, millions of persons
105	RWM@SUM	MC_MFGWGRT [2]	Average Annual Manufacturing Wages, nominal $
106	RWNM@SUM	MC_NMFGWGRT [2]	Average Annual Non-Manufacturing Wages, nominal $
		MC_COMMFLSP(1) [2]	Commercial Floor Space, Total, billion square feet
107	KAMUSE@SUM	MC_COMMFLSP(2) [2]	Commercial Floor Space, Amusement, billion square feet

108	KAUTO@SUM	MC_COMMFLSP(3) [2]	Commercial Floor Space, Automobile Sales, billion square feet
109	KDORM@SUM	MC_COMMFLSP(4) [2]	Commercial Floor Space, Dormitories, billion square feet
110	KEDUC@SUM	MC_COMMFLSP(5) [2]	Commercial Floor Space, Education, billion square feet
111	KHEALTH@SUM	MC_COMMFLSP(6) [2]	Commercial Floor Space, Health, billion square feet
112	KHOTEL@SUM	MC_COMMFLSP(7) [2]	Commercial Floor Space, Hotel, billion square feet
113	KMFG@SUM	MC_COMMFLSP(8) [2]	Commercial Floor Space, Manufacturing, billion square feet
114	KMISCNR@SUM	MC_COMMFLSP(9) [2]	Commercial Floor Space, Miscellaneous Non-Residential, billion square feet
115	KOFFICE@SUM	MC_COMMFLSP(10) [2]	Commercial Floor Space, Office, billion square feet
116	KPUB@SUM	MC_COMMFLSP(11) [2]	Commercial Floor Space, Public, billion square feet
117	KREL@SUM	MC_COMMFLSP(12) [2]	Commercial Floor Space, Religion, billion square feet
118	KSTORES@SUM	MC_COMMFLSP(13) [2]	Commercial Floor Space, Stores, billion square feet
119	KWARE@SUM	MC_COMMFLSP(14) [2]	Commercial Floor Space, Warehouse, billion square feet

120	EEA	Employment[3]	Total Non-Agricultural, millions of employees
121	EC	Employment[3]	Construction (SIC 15-17), millions of employees
122	EGF	Employment[3]	Federal Government, millions of employees
123	EFIR	Employment[3]	Finance, Insurance, and Real Estate (SIC 60-67), millions of employees
124	EMI	Employment[3]	Mining (SIC 10-14), millions of employees
125	ESV	Employment[3]	Services (SIC 70-89), millions of employees
126	EGSL	Employment[3]	State & Local Government, millions of employees
127	ER	Employment[3]	Transportation, Communications, Public Utilities (SIC 40-49), millions of employees
128	ETR	Employment[3]	Retail Trade (SIC 52-59), millions of employees
129	ETW	Employment[3]	Wholesale Trade (SIC 50-51), millions of employees
130	E24	Employment[3]	Lumber & Wood Products (SIC 24), millions of employees
131	E25	Employment[3]	Furniture & Fixtures (SIC 25), millions of employees
132	E32	Employment[3]	Stone, Clay, & Glass (SIC 32), millions of employees
133	E33	Employment[3]	Primary Metals (SIC 33), millions of employees
134	E34	Employment[3]	Fabricated Metal Products (SIC 34), millions of employees
135	E35	Employment[3]	Industrial Machinery and Equipment (SIC 35), millions of employees
136	E36	Employment[3]	Electronic and other Electrical Equipment (SIC 36), millions of employees
137	E37	Employment[3]	Transportation Equipment (SIC 37), millions of employees
138	E38	Employment[3]	Instruments (SIC 38), millions of employees
139	E39	Employment[3]	Miscellaneous Manufacturing (SIC 39), millions of employees
140	E20	Employment[3]	Food & Kindred Products (SIC 20), millions of employees
141	E21	Employment[3]	Tobacco Products (SIC 21), millions of employees
142	E22	Employment[3]	Textile Mill Products (SIC 22), millions of employees

143	E23	Employment[3]	Apparel & Other Textile Products (SIC 23), millions of employees
144	E26	Employment[3]	Paper & Allied Products (SIC 26), millions of employees
145	E27	Employment[3]	Printing & Publishing (SIC 27), millions of employees
146	E28	Employment[3]	Chemicals & Allied Products (SIC 28), millions of employees
147	E29	Employment[3]	Petroleum & CoalProducts (SIC 29), millions of employees
148	E30	Employment[3]	Rubber & Miscellaneous Plastics Products (SIC 30), millions of employees
149	E31	Employment[3]	Leather & Leather Products (SIC 31), millions of employees
151	Gross Output	PCIO[2]	Food & Kindred Products (SIC 20), millions of fixed 92$
152	Gross Output	PCIO[2]	Tobacco Products (SIC 21), millions of fixed 92$
153	Gross Output	PCIO[2]	Textile Mill Products (SIC 22), millions of fixed 92$
154	Gross Output	PCIO[2]	Apparel & Other Textiles (SIC 23), millions of fixed 92$
155	Gross Output	PCIO[2]	Lumber & Wood Products (SIC 24), millions of fixed 92$
156	Gross Output	PCIO[2]	Furniture & Fixtures (SIC 25), millions of fixed 92$
157	Gross Output	PCIO[2]	Paper & Allied Industries (SIC 26), millions of fixed 92$
158	Gross Output	PCIO[2]	Printing & Publishing (SIC 27), millions of fixed 92$
159	Gross Output	PCIO[2]	Inorganic Chemicals (SIC 281), millions of fixed 92$
160	Gross Output	PCIO[2]	Organic Chemicals (SIC 286), millions of fixed 92$
161	Gross Output	PCIO[2]	Plastic Materials & Synthetics (SIC 282), millions of fixed 92$
162	Gross Output	PCIO[2]	Agricultural Chemicals (SIC 287), millions of fixed 92$
163	Gross Output	PCIO[2]	Other Chemicals & Allied (SIC 28, nec), millions of fixed 92$
164	Gross Output	PCIO[2]	Petroleum Refining (SIC 291), millions of fixed 92$
165	Gross Output	PCIO[2]	Asphalt, Coal, & Miscellaneous Products (SIC 295, 299), millions of fixed 92$
166	Gross Output	PCIO[2]	Rubber & Miscellaneous Plastic Products (SIC 30), millions of fixed 92$
167	Gross Output	PCIO[2]	Leather & Leather Products (SIC 31), millions of fixed 92$
168	Gross Output	PCIO[2]	Glass & Glass Products (SIC 321, 322, 323), millions of fixed 92$
169	Gross Output	PCIO[2]	Cement, Hydraulic (SIC 324), millions of fixed 92$
170	Gross Output	PCIO[2]	Other Stone, Clay, & Glass Products (SIC 32, nec), millions of fixed 92$
171	Gross Output	PCIO[2]	Blast Furnace & Basic Steel (SIC 331), millions of fixed 92$
172	Gross Output	PCIO[2]	Aluminum (SIC 3334, pt 3341, 3353-5, 3363, 3365), millions of fixed 92$
173	Gross Output	PCIO[2]	Other Primary Metals (SIC 33, nec), millions of fixed 92$
174	Gross Output	PCIO[2]	Fabricated Metal Products (SIC 34), millions of fixed 92$
175	Gross Output	PCIO[2]	Industrial Machinery & Equipment (SIC 35), millions of fixed 92$
176	Gross Output	PCIO[2]	Electronic & Other Electric Equipment (SIC 36), millions of fixed 92$
177	Gross Output	PCIO[2]	Transportation Equipment (SIC 37), millions of fixed 92$
178	Gross Output	PCIO[2]	Instruments & Related Products (SIC 38), millions of fixed 92$
179	Gross Output	PCIO[2]	Miscellaneous Manufacturing Industries (SIC 39), millions of fixed 92$
180	Gross Output	PCIO[2]	Agricultural Production, Crops (SIC 01), millions of fixed 92$

181	Gross Output	PCIO[2]	Other Agricultural Production Including Livestock (SIC 02, 07, 08, 09), millions of fixed 92$
182	Gross Output	PCIO[2]	Coal Mining (SIC 12), millions of fixed 92$
183	Gross Output	PCIO[2]	Oil & Gas Extraction (SIC 13), millions of fixed 92$
184	Gross Output	PCIO[2]	Metal & Other Mining (SIC 10, 14), millions of fixed 92$
185	Gross Output	PCIO[2]	Construction (SIC 15, 16, 17), millions of fixed 92$
186	Gross Output	PCIO[2]	Transportation Services (SIC 40, 41, 42, 43, 44, 45, 46, 47), millions of fixed 92$
187	Gross Output	PCIO[2]	Communications (SIC 48), millions of fixed 92$
188	Gross Output	PCIO[2]	Electric Utilities (SIC 491, part of 493), millions of fixed 92$
189	Gross Output	PCIO[2]	Gas Utilities (SIC 492, part of 493), millions of fixed 92$
190	Gross Output	PCIO[2]	Water & Sewer Services (SIC 494, 495, 496, 497, part of 493), millions of fixed 92$
191	Gross Output	PCIO[2]	Wholesale Trade (SIC 50,51), millions of fixed 92$
192	Gross Output	PCIO[2]	Retail Trade (SIC 52, 53, 54, 55, 56, 57, 59, 739), millions of fixed 92$
193	Gross Output	PCIO[2]	Finance, Insurance, Real Estate (SIC 60, 61, 62, 63, 65, 66, 153), millions of fixed 92$
194	Gross Output	PCIO[2]	Services (SIC 58, 70, 73, 75, 76, 78, 79, 80, 82, 83, 84, 86, 89), millions of fixed 92$
195	Gross Output	PCIO[2]	Government Enterprises (SIC part of 41, 431), millions of fixed 92$
197	Employment	Employment[3]	Food & Kindred Products (SIC 20), millions of employees
198	Employment	Employment[3]	Tobacco Products (SIC 21), millions of employees
199	Employment	Employment[3]	Textile Mill Products (SIC 22), millions of employees
200	Employment	Employment[3]	Apparel & Other Textiles (SIC 23), millions of employees
201	Employment	Employment[3]	Lumber & Wood Products (SIC 24), millions of employees
202	Employment	Employment[3]	Furniture & Fixtures (SIC 25), millions of employees
203	Employment	Employment[3]	Paper & Allied Industries (SIC 26), millions of employees
204	Employment	Employment[3]	Printing & Publishing (SIC 27), millions of employees
205	Employment	Employment[3]	Inorganic Chemicals (SIC 281), millions of employees
206	Employment	Employment[3]	Organic Chemicals (SIC 286), millions of employees
207	Employment	Employment[3]	Plastic Materials & Synthetics (SIC 282), millions of employees
208	Employment	Employment[3]	Agricultural Chemicals (SIC 287), millions of employees
209	Employment	Employment[3]	Other Chemicals & Allied (SIC 28, nec), millions of employees
210	Employment	Employment[3]	Petroleum Refining (SIC 291), millions of employees
211	Employment	Employment[3]	Asphalt, Coal, & Miscellaneous Products (SIC 295, 299), millions of employees
212	Employment	Employment[3]	Rubber & Miscellaneous Plastic Products (SIC 30), millions of employees
213	Employment	Employment[3]	Leather & Leather Products (SIC 31), millions of employees
214	Employment	Employment[3]	Glass & Glass Products (SIC 321, 322, 323), millions of employees

215	Employment	Employment[3]	Cement, Hydraulic (SIC 324), millions of employees
216	Employment	Employment[3]	Other Stone, Clay, & Glass Products (SIC 32, nec), millions of employees
217	Employment	Employment[3]	Blast Furnace & Basic Steel (SIC 331), millions of employees
218	Employment	Employment[3]	Aluminum (SIC 3334, pt 3341, 3353-5, 3363, 3365), millions of employees
219	Employment	Employment[3]	Other Primary Metals (SIC 33, nec), millions of employees
220	Employment	Employment[3]	Fabricated Metal Products (SIC 34), millions of employees
221	Employment	Employment[3]	Industrial Machinery & Equipment (SIC 35), millions of employees
222	Employment	Employment[3]	Electronic & Other Electric Equipment (SIC 36), millions of employees
223	Employment	Employment[3]	Transportation Equipment (SIC 37), millions of employees
224	Employment	Employment[3]	Instruments & Related Products (SIC 38), millions of employees
225	Employment	Employment[3]	Miscellaneous Manufacturing Industries (SIC 39), millions of employees
226	Employment	Employment[3]	Agricultural Production, Crops (SIC 01), millions of employees
227	Employment	Employment[3]	Other Agricultural Production Including Livestock (SIC 02, 07, 08, 09), millions of employees
228	Employment	Employment[3]	Coal Mining (SIC 12), millions of employees
229	Employment	Employment[3]	Oil & Gas Extraction (SIC 13), millions of employees
230	Employment	Employment[3]	Metal & Other Mining (SIC 10, 14), millions of employees
231	Employment	Employment[3]	Construction (SIC 15, 16, 17), millions of employees
232	Employment	Employment[3]	Transportation Services (SIC 40, 41, 42, 43, 44, 45, 46, 47), millions of employees
233	Employment	Employment[3]	Communications (SIC 48), millions of employees
234	Employment	Employment[3]	Electric Utilities (SIC 491, part of 493), millions of employees
235	Employment	Employment[3]	Gas Utilities (SIC 492, part of 493), millions of employees
236	Employment	Employment[3]	Water & Sewer Services (SIC 494, 495, 496, 497, part of 493), millions of employees
237	Employment	Employment[3]	Wholesale Trade (SIC 50,51), millions of employees
238	Employment	Employment[3]	Retail Trade (SIC 52, 53, 54, 55, 56, 57, 59, 739), millions of employees
239	Employment	Employment[3]	Finance, Insurance, Real Estate (SIC 60, 61, 62, 63, 65, 66, 153), millions of employees
240	Employment	Employment[3]	Services (SIC 58, 70, 73, 75, 76, 78, 79, 80, 82, 83, 84, 86, 89), millions of employees
241	Employment	Employment[3]	Federal Government, millions of employees
242	Employment	Employment[3]	State & Local Government, millions of employees

[1] Macroeconomic: DRI-WEFA U.S. Quarterly Macroeconomic Model

[2] PCIO: DRI-WEFA Input-Output Model for the Personal Computer

[3] Employment: DRI-WEFA Econometric Model of Employment by Industry

[4] Regional: DRI-WEFA Regional Model for the Personal Computer

Table A-9. MAM Variables Used by Other NEMS Modules

MCBASE Row Number	DRI-WEFA Name	MACOUT Common Block Name	Macroeconomic Variable Description	Referencing NEMS Module
84	GFML96C	MC_GFML96C	Federal Government Purchases, Defense, billions of chained 96$	TRAN
75	EXDAN96C	MC_EXDAN96C	Exports, Goods, billions of chained 96$	TRAN
53	GDP96C	MC_GDP96C	Gross Domestic Product, billions of chained 96$	RENEW TRAN
57	EX96C	MC_EX96C	Exports of Goods & Services, billions of chained 96$	TRAN
58	M96C	MC_M96C	Imports of Goods & Services, billions of chained 96$	TRAN
88	GNP96C	MC_GNP96C	Gross National Product, billions of chained 96$	TRAN
89	PCWGDP	MC_PCWGDP	Chain-Type Price Index, GDP, 1996 = 1.0 (1987 = 1.0 in MACOUT)	COMM EPM IND NGHIST NGPTM NGTDM REFETH REFINE RESD TRAN UEFP ULDSM WELLAK WELLEOR WELLOFF
90	RMGBS3NS	MC_RMGBS3NS	Discount Rate on 3-Month U.S. Treasury Bills	UEFP
92	RMPUAANS	MC_RMPUAANS	Yield on AA Utility Bonds	NGPTM NGTDM UEFP
		MC_RLRMPUAANS	Real Yield on AA Utility Bonds	COALCPS WELLOGS
93	REALRMGBLUS	MC_REALRMGBLUS	Real Average Yield on 10-Year U.S. Government Bonds, Constant Maturity	COMM NGTDM
94	ECIWSP	MC_ECIWSP	Employment Cost Index, Wages & Salaries, Private Sector, June 1989 = 1.0	NGTDM UEFP
95	SQTRCARS	MC_SQTRCARS	Unit Sales of Automobiles, Total, millions of units	TRAN
97	SQDTRUCKSL	MC_SQDTRUCKSL	Truck Deliveries, Light Duty, millions of units	TRAN
100	WPI	MC_WPI	Producer Price Index, All Commodities, 1982 = 1.0	UEFP

101	WPI11	MC_WPI11	Producer Price Index, Machinery & Equipment, 1982 = 1.0	UEFP
102	WPI14	MC_WPI14	Producer Price Index, Transportation Equipment	COALCDS COALCPS
105	CPI	MC_CPI	Consumer Price Index (All Urban) - All Items, 1982-84 = 1.0	NGTDM TRAN
106	YD96C	MC_YD96C	Disposable Personal Income, billions of chained 96$	COMM HEM TRAN
109	SHUMBL	MC_SHUMBL	Mobile Homes Shipments, millions of units	RESD
110	HUSTS1	MC_HUSTS1	Single-Family Housing Starts, Private including Farm, millions of units	RESD
111	HUSTS2A	MC_HUSTS2A	Multi-Family Housing Starts, Private including Farm, millions of units	RESD
115	N	MC_N	Population Including Armed Forces Overseas, millions of persons	COALCPS COMM RESD TRAN TRANFRT
116	N16A	MC_N16A	Population Aged 16 and Over, millions of persons	RESD TRAN
118	RWNM@SUM	MC_NMFGWGRT	Average Annual Non-Manufacturing Wages, nominal $	COALCPS
Located in MC_REGIONAL.WK1, an output file	Commercial Floorspace	MC_COMMFLSP	Commercial Floor Space by Type of Building, billion square feet	COMM
149-183	Gross Output	MC_MFGO	Gross Output by Manufacturing (SIC 20-39) Sector, millions of fixed 92$	IND TRAN TRANFRT
184-193	Gross Output	MC_NMFGO	Gross Output by Non-Manufacturing (Agriculture, Mining, Construction) Sector, millions of fixed 92$	TRAN TRANFRT
119-148, 197-242	Employment	MC_EMPNA	Employment by Industrial (SIC 20-39, Agriculture, Mining, Construction) Sector, millions of employees	IND COMM

NEMS Module Descriptions:

COALCPS	Coal Production Module
COMM	Commercial Sector Demand Module
EPM	Future Emission Policy Module
HEM	Household Expenditure Model
IND	Industrial Sector Demand Module

NGHIST	Natural Gas Interstate Transmission Module Historical Processing Code
NGPTM	Natural Gas Transmission & Distribution Tariff Module
NGTDM	Natural Gas Transmission & Distribution Module
REFETH	Ethanol Code - Separating for Petroleum Marketing Module
REFINE	Refinery (Petroleum Marketing) Module
RENEW	Renewables Module
RESD	Residential Sector Demand Module
TRAN	Transportation Sector Demand Module
TRANFRT	Freight Portion of Transportation Module
UEFP	Electricity Market Module Financial Planning Routines
ULDSM	Electricity Market Module Demand Side Management Routines
WELLAK	Oil & Gas Production, Alaskas
WELLEOR	Oil & Gas Production, Enhanced Oil Recovery
WELLOFF	Oil & Gas Production, Offshore
WELLOGS	Oil & Gas Production, Main Module

Appendix B. Mathematical Description

Introduction

Appendix B provides a mathematical description of equations, transformations, and other computations for the National, Interindustry (including the Growth Industry Component of the Interindustry Submodule), Employment, Regional and Commercial Floorspace Submodules of the MAM used to generate the AEO2002 production runs of the NEMS system.

The National Submodule

The National Submodule of the MAM uses the Eviews version of the DRI-WEFA U.S. Quarterly Macroeconomic Model and is used in the AEO2002 production runs of NEMS to provide each of the energy supply, demand, and conversion submodules with key macroeconomic variable forecasts. There is now a direct link between the NEMS model and the DRI-WEFA macroeconomic model. This replaces the kernel regression (a nonparametric estimation technique) model representation of Standard and Poor's DRI Quarterly Macroeconomic Model previously found in the National Submodule of MAM.

Included in the National Submodule is a direct link routine that converts NEMS energy price and quantity variables into concepts required by DRI-WEFA model. These concepts are described in Table A-6 in Appendix A of this model documentation. Before calling the DRI-WEFA model, MAM calculates the starting levels of the NEMS energy drivers and the levels of those same energy drivers with every successive NEMS cycle. These drivers are then passed to the Eviews program where it is converted to quarterly frequency that is required by the DRI-WEFA model. The DRI-

WEFA energy variables will show the same percentage changes from the initial starting values as the NEMS energy variables. Eviews then extracts the needed macroeconomic variables to the annual frequency, which NEMS requires.

Developing direct links from NEMS to the DRI-WEFA Quarterly Macroeconomic Model allows greater user flexibility and precludes the lengthy process required to estimate either response surface or kernel regression database, which requires many case-specific simulations of the underlying DRI-WEFA model.

The Interindustry Submodule

The baseline forecast of sectoral gross output is first developed using the DRI-WEFA PCIO Model. The Interindustry Submodule of MAM calculates changes of sectoral gross output from baseline levels based on changes in macroeconomic final demand components that feed into the macroeconomic model calculation of generated output by sector. The change in generated output by sector is then used to drive consistent changes in industrial gross output within the Interindustry Submodule.

The Growth Industry Submodule

The description in the preceding section applies to all the industrial gross output sectors except the energy supply sectors. Industrial Gross Output for the Petroleum Refining, Coal Mining, Oil and Gas Extraction, Electric Utilities, and Gas Utilities sectors are all benchmarked in DRI-WEFA historical years, but change in rates determined by selected NEMS energy supply and conversion modules. Figure 4 in Chapter 3 of the main text of this report illustrates the flow of the Growth Industry Submodule. Table A-4 also describes the NEMS variables used to calculate MCINDGROW, the growth rate for each energy supply sector. The solution output, ESIND, for these sectors is calculated as:

$$ESIND_{i,CURIYR} = (MACINDGROW_{j,CURIYR} + 1.0) * ESIND_{i,(CURIYR-1)} \qquad \textbf{(B-1)}$$

The Employment Submodule

The baseline forecast of employment by sector is derived using the DRI-WEFA Employment Model to create an employment baseline. The Employment Submodule calculates the employment impacts of altered energy market conditions based on the following causal relationships. When energy prices change, the level and composition of macroeconomic final demands are affected. In turn, the level and composition of interindustry gross outputs required to satisfy the new final demands are changed. Finally, faced with new demands for their products, industries will adjust the number of workers employed. The Employment Submodule will show the same percentage change as the gross output changes calculated in the Interindustry Submodule.

The Regional Submodule

The Regional Submodule of the MAM apportions the national totals computed in the National, Interindustry, and Employment Submodules between the nine Census Divisions. The first step is to calculate the national aggregates by looping through the EBREG regional levels contained in MCRGBAS:

$$EBREGSUM_{i,\,CURIYR} = EBREGSUM_{i,\,CURIYR} + EBREG_{i,\,r,\,CURIYR} \qquad \textbf{(B-2)}$$

Next, regional shares are calculated:

$$REGSHRS_{r,\,i,\,CURIYR} = EBREG_{i,\,r,\,CURIYR} / EBREGSUM_{i,\,CURIYR} \qquad \textbf{(B-3)}$$

The resulting shares are applied to the National Submodule (including Employment) values to arrive at the regional levels:

$$ESMACREG_{r,\,i,\,CURIYR} = ESMACREG_{11,\,i,\,CURIYR} \\ *REGSHRS_{r,\,i,\,CURIYR} \qquad \textbf{(B-4)}$$

and to the Interindustry Submodule values to arrive at the regional levels:

$$ESIND_{r,\,j,\,CURIYR} = ESIND_{11,\,j,\,CURIYR} \\ REGSHRS_{r,\,i,\,CURIYR} \qquad \textbf{(B-5)}$$

The Commercial Floorspace Submodule

New to the 2002 Annual Energy Outlook is a commercial floorspace forecast done with a model independent of the Regional submodule of the Macroeconomic Activity Module. The COMFLR submodule of MAM contains 140 equations of which 117 (13 commercial floorspace types in each of 9 Census Divisions) are estimated using historical data reaching back into the seventies. The remaining twenty-three equations are identities that aggregate floorspace by Division (9 Divisions), across region by floorspace type (13 types) and across all regions for a national total. The submodule forecasts thirteen floorspace types in each of the nine Census Division regions. The model forecasts thousand square feet of commercial floorspace at a quarterly interval. Since commercial floorspace is a stock measure, the fourth quarter solution is provided to the NEMS common block as the reported annual floorspace forecast.

Regional level, commercial floorspace at time t is a function of a time trend and of lags of own floorspace; aggregate, regional, commercial floorspace; interest rates adjusted for regional inflation, regional, real disposable income on a per capita basis and regional population. The general form of the estimated commercial floorspace equations is:

$$Commflrsp_{i,k,t} = a_{i,k} + b_{i,k}*trend + b_{i,k,j}*Commflrsp_{i,k,t-j} + b_{i,k}*Commflrsp_{i,t-j}$$
$$+ b_{i,k}*realrate_{i,t-j} + b_{i,k}*realinc_{i,t-j} + b_{i,k}*pop_{i,t-j}$$

$$Commflrsp_{i,t} = \Sigma Commflrsp_{i,k,t}$$

where:

i = 1 to 9 Census Divisions

k = 1 to 13 Commercial Floorspace Types

t = time

j = lags of time t

$a_{i,k}$ = estimated constant for commercial floorspace k in Census Division i equation

$b_{i,k}$ = estimated coefficient for explanatory variable in commercial floorspace k in Census Division i equation

trend = time

$Commflrsp_{i,k,t-j}$ = lags of own commercial floorspace

$Commflrsp_{i,t-j}$ = lags of regional, aggregate commercial floorspace

$realrate_{i,t-j}$ = short-term interest rate adjusted for regional inflation

$realinc_{i,t-j}$ = regional, real disposable income on a per capita basis

$pop_{i,t-j}$ = regional population aged 16 and over

There is an estimated equation for each of the thirteen commercial floorspace types, k, in each of the nine Census Divisions, i. The thirteen commercial floorspace types are:

1. Stores – stores and restaurants
2. Warehouse – manufacturing and wholesale trade, public and federally-owned warehouses
3. Office – private, federal, and state and local offices
4. Automotive – auto service and parking garages
5. Manufacturing

6. Education – primary/secondary and higher education
7. Health – hospitals and nursing homes
8. Public – federal and state and local
9. Religious
10. Amusement
11. Miscellaneous, non-residential – transportation related and all other not elsewhere classified
12. Hotel – hotels and motels
13. Dormitories – educational and federally-owned (primarily military)

The real rate of interest is constructed using the nominal discount rate on 3-month Treasury bills and the all-urban consumer price index. DRI-WEFA supplies the data for both series. The 3-month Treasury bill rate is from DRI-WEFA's Quarterly Macroeconomic Model and is quarterly beginning in 1970. Its model mnemonic is RMGBS3NS. This nominal interest rate is not a measure of interest rates at the Census Division level. Regional measures of inflation are used to deflate the nominal interest rate and thereby construct a real rate of interest. DRI-WEFA's regional measure of prices comes from their Regional model. Its mnemonic is CPI. The historical, all-urban consumer price index is quarterly beginning in 1975 and is available for all Census Division regions.

The general specification for the real, short-term rate of interest is:

$$Real\_RMGBS3NS_{i,t} = RMGBS3NS_t - ((CPI_{i,t}\{1\}/CPI_{i,t}\{5\})-1.)*100.$$

where:

i = 1 to 9 Census Divisions
t = time
$Real\_RMGBS3NS_{i,t}$ = rate of short-term interest adjusted for regional inflation
$RMGBS3NS_t$ = nominal discount rate on 3-month Treasury bills

$CPI_{i,t}$ = regional, all-urban consumer price index

The regional, real disposable income per capita is constructed using regional, real disposable income and regional population (those aged 16 and over.) Data Resources Inc. supplies the data for both series and both come from their Regional model. Their mnemonics are YD96C and NR16A. Real disposable income is measured in billions of chained 1996 dollars. It is available regionally beginning in 1975 for all Census Divisions but Mountain and Pacific. Real disposable income for the Mountain and Pacific Census Divisions begins in 1985. As mentioned, the measure of population used also comes from DRI-WEFA's Regional model. The historical population for those aged 16 and over is quarterly beginning in 1971 for all Census Divisions except Mountain and Pacific. Population for the Mountain and Pacific Census Divisions begins in 1975. The general specification for the regional, real, disposable income per capita is:

$$PerCapita\_YD96C_{i,t} = YD96C_{i,t}/NR16A_{i,t}$$

where:

i = 1 to 9 Census Divisions
t = time
$PerCapita\_YD96C_{i,t}$ = regional, real disposable income per capita
$YD96C_{i,t}$ = regional, real disposable income in billions of chained 1996 dollars
$NR16A_{i,t}$ = regional population aged 16 and over

In general, the period of historical data available for equation estimation is the same across Census Divisions. That range is from the first quarter of 1975 to the last quarter of 2000. The presence of lagged right-hand side variables reduces that amount of data. As mentioned earlier; quarterly, commercial floorspace data begins at the start of 1970. It is the explanatory variables and not commercial floorspace or the lag structure that restricts the amount of data available for equation estimation. Time series for both real disposable income and the all-urban consumer price index begins in the first quarter of 1975. The available data for population is not a constraint. It begins in the first quarter of 1971. The exceptions are the Mountain and Pacific Census Divisions. Limiting the estimation range for these two Census Divisions is real disposable income. It begins in the first quarter of 1985. There is also less population data as compared to the other Census Divisions. Population for Mountain and Pacific Census Divisions begins in the first quarter of 1975. Data for the consumer price index for the Mountain and Pacific Census Divisions begins in 1975 just like that for all other Census Divisions.

All equation estimation and hypothesis tests were done using WinRATS-32, version 5.0. Ordinary least squares was used to estimate the equations. The Lagrange multiplier technique was used to test for the absence of serially correlated residuals. Cochrane-Orcutt method of estimation was used, when necessary, for correcting for serially correlated errors. In-sample, dynamic forecasts were done as a general check of each estimated equation's behavior.

The nominal interest rate, consumer price index, real disposable income and population are all exogenous to the commercial floorspace model. During a NEMS simulation, MAM's DRTLINK submodule supplies the commercial floorspace model with the nominal interest rate forecast. The MAM's REGIONAL submodule supplies the forecasts for the all-urban consumer price index, real disposable income and population at the Census Division level. These forecasts are conditioned on assumptions about energy prices and quantities supplied by the other Module's in NEMS. NEMS is an annual model; and, as mentioned earlier, the commercial floorspace model is quarterly. The annual interest rate, consumer price index, real disposable income and population forecasts are expanded to a quarterly frequency by making each quarter's value equal to the annual value. The resulting commercial floorspace forecast is quarterly and is compressed by returning the fourth quarter value to the NEMS common block.

Appendix C. Bibliography

Introduction

This Appendix provides a bibliography of sources from the literature used in the theoretical and analytical design, development, implementation, and evaluation of MAM. The references supplied here are supplemented by additional detail including page citations, in the body of this report.

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Appendix D. Model Abstract

Model Name:

Macroeconomic Activity Module of the National Energy Modeling System

Model Acronym:

MAM

Description:

MAM is comprised of five Submodules: National, Interindustry, Employment, Regional and Commercial Floorspace. The National Submodule uses the Eviews version of the proprietary Quarterly Macroeconomic Model of the U.S. Economy developed by DRI-WEFA, a Global Insight Company. The Quarterly Macroeconomic Model is a 1,200 equation econometric specification that forecasts macroeconomic driver variables at the national level of detail.

The baseline forecast of sectoral gross output is first developed using the DRI-WEFA PCIO Model. The Interindustry Submodule of MAM calculates changes of sectoral gross output from baseline levels based on changes in macroeconomic final demand components that feed into the macroeconomic model calculation of generated output by sector. The change in generated output by sector is then used to drive consistent changes in industrial gross output within the Interindustry Submodule.

The baseline forecast of employment by sector is derived using the DRI-WEFA Employment Model. The Employment Submodule calculates the employment impacts of altered energy market conditions based changes in sectoral output.

The Regional Submodule consists of a set of shares at the nine Census Division level of detail developed from simulations of DRI-WEFA's Quarterly Macroeconomic Model, PCIO Model, Employment Model, and Regional Model. The regional shares included as the Regional Submodule of MAM are used to disaggregate the national results generated by the National, Interindustry, and Employment Submodules of MAM to the nine Census Division level of detail.

The Commercial Floorspace Model forecasts thirteen floorspace types in each of the nine Census Division regions. The model is driven by regional disposable income per capita, regional population and interest rates adjusted for region inflation.

Purpose of the Model:

MAM links the National Energy Modeling System (NEMS) to the rest of the economy by providing industrial sector activity and macroeconomic inputs to the energy modules of NEMS. Macroeconomic variables such as GDP, disposable income, aggregate prices, interest rates, and employment drive energy demands and are important determinants of energy prices and quantities. Conversely, changes in energy supplies and prices impact GDP, prices, interest rates, and other macroeconomic variables. MAM responds to changes in energy supplies and prices to generate forecasts of approximately 120 macroeconomic variables for use in various energy modules within NEMS.

Most Recent Model Update:

September 2001

Part of Another Model?

National Energy Modeling System (NEMS).

Model Interfaces:

MAM provides sectoral macroeconomic driver variables including housing starts, commercial floorspace, industrial gross output, light duty vehicle sales, and disposable income projections to the

NEMS Residential Sector, Commercial Sector, Industrial Sector, and Transportation Sector Demand Modules. MAM provides financial indicators such as aggregate prices and interest rates to both the demand and supply modules of NEMS.

Official Model Representative:

Ron Earley, Economist
Office of Integrated Analysis and Forecasting
International Economic and Greenhouse Gases Division
(202) 586-1398

Documentation:

Model Documentation Report: Macroeconomic Activity Module (MAM) of the National Energy Modeling System, December 2001.

Energy System Described:

Domestic macroeconomic sector.

Coverage:

- Geographic: Nine Census Divisions.
- Time Unit/Frequency: Annual, 1990 through 2020
- Products: Forecasts of domestic macroeconomic driver variables, at the national, interindustry, and nine Census Division levels of detail.
- Economic Sectors: National macroeconomic activity.

Modeling Features:

- Model Structure: MAM is composed of five Submodules: National, Interindustry, Employment, Regional and Commercial Floorspace. The five Submodules are executed sequentially in the order presented, and subsequent Submodules build upon the results of previously-executed Submodules.

- Modeling Techniques: MAM uses large econometric proprietary models, plus a Commercial Floorspace Model developed by the Energy Information Administration. The Regional Submodule of MAM is composed of shares developed from simulations of large econometric macroeconomic, interindustry, employment, and regional models.

- Special Features: A direct link exists between NEMS and the DRI-WEFA Quarterly Macroeconomic Model of the U.S. Economy which has been converted to operate in the Eviews system.

Non-DOE Input Sources:

DRI-WEFA input data from the DRI-WEFA U. S. Quarterly Macroeconomic Model, the DRI-WEFA PCIO Model, the DRI-WEFA Employment Model, and the DRI-WEFA Regional Model, plus data on commercial floorspace acquired from F.W. Dodge Statistics and Forecasting Group, Building Stock Database.

DOE Input Sources:

MAM relies upon the DRI-WEFA Input data to generate the baseline growth path. Alternative growth paths are developed based on alternative economic driver variable growth path assumptions. DOE data is not used to develop the MAM.

Independent Expert Reviews Conducted:

None.

Status of Evaluation Efforts by Sponsor:

None.