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Update Information

This edition of the Macroeconomic Activity Module (MAM)–Model Documentation 2022 reflects changes made to the MAM over the past four years for the *Annual Energy Outlook* 2019 through 2022. These changes include:

- Updates to industrial and employment historical data
- New regional industry and employment model
- Industry and employment start year changed based on data availability
- Employment model aggregation changed
- Addition of renewable energy and energy trade variables to the U.S. model

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Introduction

The National Energy Modeling System (NEMS) is a comprehensive, mid-term energy projection and policy analysis tool that EIA uses. The NEMS projects energy supply, demand, prices, and environmental emissions by region, given assumptions about the economy, international markets, and energy policies. The Macroeconomic Activity Module (MAM) links the NEMS to the economy by providing projections of economic driver variables for the supply, demand, and conversion modules of the NEMS. The MAM's baseline economic projection contains the initial economic assumptions used in the NEMS to help determine energy demand and supply. The MAM can also provide the NEMS with alternative economic assumptions representing a range of uncertainty about economic growth. Different assumptions regarding the path of world oil prices or of the penetration of new technologies can also be modeled in the MAM. The resulting economic impacts of such assumptions are inputs to the remaining supply and demand modules of the NEMS (Table B14 in Appendix B on page 127). Outside of the *Annual Energy Outlook* (AEO) setting, the MAM represents a system of linked models that can assess the potential impacts of changes in energy events on the economy or of policy proposals as specified by a non-EIA requestor. These economic impacts are the result of assumptions about energy events prompted by policy proposals built into the NEMS. The linked modules of the NEMS then iterate to a solution.

This report documents the objectives and analytical approach of the MAM that is used to develop the *Annual Energy Outlook* for 2022 (AEO2022). It serves as a reference document providing a description of the MAM used for the AEO2022 production runs for model analysts, users, and the public. It also facilitates continuity in model development by providing documentation from which energy analysts can undertake model enhancement and modifications. This documentation report is divided into two separate components.

Part A presents the structural models that make up the MAM, including:

- IHS Markit's model of the U.S. economy
- Our models of industrial output and of employment by industry
- Our models of the regional economies

Part B focuses on the MAM's interface with the NEMS. This section identifies the set of model levers and simulation rules used to operate the system. It also discusses three types of integrated simulations carried out with the NEMS. This section views the MAM from the perspective of a programmer, focusing on the ties that link the various models together to form the MAM and how the MAM communicates with the NEMS.

Appendices A and B provide detailed information on variable listings and sectoral definitions.

Appendix C provides a detailed listing of the equations for the regional models.

Part A. Macroeconomic Activity Module (MAM) of the National Energy Modeling System

1. Modeling system overview

Economic activity driving the National Energy Modeling System (NEMS) is determined by an economic modeling system comprised of three sets of models:

- IHS Markit's model of the U.S. economy
- EIA's industrial output and employment by industry models
- EIA's regional models

IHS Markit's model of the U.S. economy is the same model used by IHS Markit to produce its economic projections for the company's monthly assessment of the U.S. economy. The IHS Markit U.S. model used for the AEO2022 is the US2021A version. EIA's Industrial Output and Employment by Industry Models have been tailored to provide the industrial output and employment by industry detail required by the NEMS modeling system. EIA's regional models consist of models of economic activity, industrial output, employment by industry and commercial floor space. The first two models were developed during 2019 to prepare the AEO2018 and are updated annually. The regional models were last re-estimated for the AEO2010, except for the commercial floor space model, which was re-estimated for the AEO2016.

All of the MAM models are linked, which provides a fully integrated approach to estimating economic activity at the national, industrial, and regional levels. IHS Markit's model of the U.S. economy determines the national economy's growth path and the final demand mix. Our Industrial Output Model ensures that supply by the energy industry is consistent with the final demands (consumption, investment, government spending, exports, and imports) calculated in the U.S. model. Industrial output is the key driver of the employment estimation in our Employment by Industry model. The Employment by Industry projection also uses aggregate hours per week and productivity trends found in the U.S. model. The Employment by Industry projection is aligned with the aggregate employment estimates in the U.S. model. Key inputs to our regional models include:

- Projections of national output
- Employment by industry
- Population
- National income
- Housing

Our regional models then calculate levels of industrial output, employment by industry, population, incomes, and housing activity for each of the nine census divisions. The sum of each of these concepts across the nine census divisions is aligned with the national totals estimated by the U.S. model. Together, these models of the U.S. economy, industrial output, employment by industry, and regional economic activity constitute the Macroeconomic Activity Module (MAM) of the National Energy Modeling System (NEMS).

Before the MAM can execute its suite of models, it requires exogenous assumptions regarding energy prices, consumption, and domestic production. Over 70 energy prices and quantities are extracted from the output of the demand and supply modules of the NEMS. The MAM needs transformations of the exogenous assumptions to map these inputs from the NEMS into more aggregated concepts in the MAM. After the appropriate transformations are done, the U.S., Industrial Output, Employment by Industry, and Regional Models execute in sequence to produce an estimate of economic activity at the national, industrial, and regional levels. We draw the economic driver variables from the projections, which are then passed to the supply, demand, and conversion modules of the NEMS (Table B14, Appendix B, p. 120). The NEMS reacts to the new economic activity assumptions, and it passes the estimates of energy prices and quantities based on these new economic assumptions back to the MAM. A NEMS *cycle* is complete once all of the modules of the NEMS solve. Cycles continue repeating until the NEMS iterates to a stable solution.

The NEMS determines projections in the MAM for a few industrial output and employment by industry concepts. The MAM's results for industrial output of the five energy-related sectors are based on growth rates extracted from the appropriate modules in the NEMS. We apply the growth rates to the last historical value of the appropriate series in the MAM's Industrial Output Model (Table B4 in Appendix B on page 109) in output of:

- Petroleum refining
- Coal mining
- Oil
- Natural gas extraction
- Electric utilities
- Natural gas utilities

IHS Markit's Model of the U.S. Economy

Key Inputs

- National population by age cohort
- Total factor productivity
- Federal tax rates
- Nominal expenditures
- Money supply
- Energy prices and quantities
- GDP of trading partners

Key Outputs

- Final demands (consumption, investment, government purchases, exports, imports)
- Inflation
- Foreign exchange and interest rates
- Incomes
- Employment
- Federal, state, and local government revenues and expenditures
- Balance of payments

EIA's Industrial Output Model

Key Inputs

- Final demands
- Prices and productivity measures from IHS Markit's model of the U.S. economy
- Input-output coefficient matrices

Key Outputs

- Real output value (defined by value of shipments or revenue) for 58 industrial and service sectors

EIA's Employment by Industry Model

Key Inputs

- Industrial outputs from the industrial output model
- Capital service cost determinants
- Productivity measures
- Total employment from IHS Markit's model of the U.S. economy

Key Outputs

- Employment for 39 industrial and service sectors

EIA's Regional Economic Activity Model

Key Inputs

- National GDP
- Wages
- Incomes
- Population
- Housing activity and prices from IHS Markit's model of the U.S. economy
- State population estimates and projections from the U.S. Census Bureau

Key Outputs

- Wages and salaries
- Personal income
- Disposable income
- Population
- Housing activity for the nine census divisions

EIA's Regional Industrial Output and Employment by Industry Models

Key Inputs

- National output and employment by sector from the Industrial Output and Employment by Industry models
- Regional shares

Key Outputs

- Output values for 48 industrial sectors and employment for 39 industrial output and service sectors for the nine census divisions

EIA's Regional Commercial Floor Space Model

Key Inputs

- GDP
- Consumer spending
- Employment
- Private non-residential investment
- Interest rates
- Productivity
- Personal disposable income
- Population
- Lagged values of the dependent variable

Key Outputs

- Commercial floor space in rates of growth for 13 commercial floor space types in each of the nine census divisions.

The Appendices to this report include further detail on each of these models.

2. IHS Markit's Model of the U.S. Economy

The Model's Theoretical Position

Econometric models built in the 1950s and 1960s were largely Keynesian income-expenditure systems that assumed a closed domestic economy. High computation costs involving statistical estimation and model manipulation, along with the underdeveloped state of macroeconomic theory, limited the size of the models and the richness of the linkages of spending to financial conditions, inflation, and international developments. Since that time, however, computer costs have fallen; macroeconomic theory has also benefited from five decades of postwar data observation and from the intellectual attention of many eminent economists.

An Econometric Dynamic Equilibrium Growth Model

IHS Markit's model of the U.S. economy strives to incorporate the best insights of many theoretical approaches to the business cycle: Keynesian, neoclassical, monetarist, supply-side, and rational expectations. In addition, IHS Markit's model of the U.S. economy embodies the major properties of the long-term growth models presented by James Tobin, Robert Solow, Edmund Phelps, and others. This structure guarantees that short-run, cyclical developments will converge to a robust, long-run equilibrium.

In growth models, the expansion rates of technical progress, the labor force, and the capital stock, both physical capital and human capital, determine the productive potential of an economy. Both technical progress and the capital stock are governed by investment, which, in turn, must be in balance with post-tax capital costs, available savings, and the capacity requirements of current spending. As a result, monetary and fiscal policies will influence both the short- and the long-term characteristics of such an economy through their impacts on national saving and investment.

A modern model of output, prices, and financial conditions is melded with the growth model to present detailed, short-run dynamics of the economy. In specific goods markets, the interactions of a set of supply and demand relations jointly determine spending, production, and price levels. Typically, 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 hours, energy usage, and the capital stocks of business equipment and structures with government infrastructure. The *total factor productivity* of this composite of tangible inputs is driven by expenditures on research and development that produce technological progress.

Prices adjust in response to short-run gaps between current production and supply potential and to changes in the cost of inputs. Wages adjust to labor supply-demand gaps (indicated by a demographically adjusted unemployment rate), current and expected inflation (with a unit long-run elasticity), productivity, tax rates, and minimum wage legislation. The supply of labor responds positively to the perceived availability of jobs, to the after-tax wage level, and to the growth and age-gender mix of the population. Demand for labor is keyed to the level of output in the economy and to the productivity of labor, capital, and energy. Because the capital stock does not change much in the short run, a higher level of output requires more employment and energy inputs. Such increases are not necessarily equal to the percentage increase in output because of the improved efficiencies typically

achieved during an upturn. Tempering the whole process of wage and price determination is the exchange rate; a rise signals prospective losses of jobs and markets unless costs and prices are reduced.

For financial markets, the model predicts exchange rates, interest rates, stock prices, loans, and investments interactively with the preceding GDP and inflation variables. The Federal Reserve sets the supply of reserves in the banking system and the fractional reserve requirements for deposits. Private sector demands to hold deposits are driven by national income, expected inflation, and the deposit interest yield relative to the yields offered on alternative investments. Banks and other thrift institutions, in turn, set deposit yields based on the market yields of their investment opportunities with comparable maturities and on the intensity of their need to expand reserves to meet legal requirements. In other words, the contrast between the supply and demand for reserves sets the critical short-term interest rate for interbank transactions, the federal funds rate. Other interest rates are keyed to this rate, expected inflation, Treasury borrowing requirements, and sectoral credit demand intensities.

The old tradition in macroeconomic model simulations of exogenous fiscal policy changes was to hold the Federal Reserve's supply of reserves constant at baseline levels. Although this approach makes static analysis easier in the classroom, it sometimes creates unrealistic policy analyses when a dynamic model is appropriate. In IHS Markit's model of the U.S. economy, *monetary policy* is defined by a set of targets, instruments, and regular behavioral linkages between targets and instruments. The model user can choose to define unchanged monetary policy as unchanged reserves or as an unchanged reaction function in which interest rates or reserves are changed in response to changes in policy concerns such as the price level and the unemployment rate.

Monetarist aspects

The model pays due attention to valid lessons of monetarism by carefully representing the diverse portfolio aspects of money demand and by capturing the central bank's role in long-term inflationary trends.

The private sector may demand money balances as one portfolio choice among transaction media (currency, checkable deposits), investment media (bonds, stocks, short-term securities), and durable assets (homes, cars, equipment, structures). Given this range of choices, each asset's implicit and explicit yield must, therefore, match expected inflation, offset perceived risk, and respond to the scarcity of real savings. Money balances provide benefits by facilitating spending transactions and can be expected to rise nearly proportionately with transactions requirements unless the yield of an alternative asset changes.

Now that even demand deposit yields can float, to a limited extent, in response to changes in Treasury bill rates, money demand no longer shifts quite as sharply when market rates change. Nevertheless, the velocity of circulation (the ratio of nominal spending to money demand) is still far from stable during a cycle of monetary expansion or contraction. So, the simple monetarist link from money growth to price inflation or nominal spending is considered invalid as a rigid short-run proposition.

Equally important, as long-run growth models demonstrate, induced changes in capital formation can also invalidate a naive long-run identity between monetary growth and price increases. Greater demand for physical capital investment can enhance the economy's supply potential in the event of more rapid money creation or new fiscal policies. If simultaneous, countervailing influences deny an expansion of the economy's real potential, the model will translate all money growth into a proportionate increase in prices rather than in physical output.

Supply-side economics

Since 1980, supply-side political economists have pointed out that the economy's growth potential is sensitive to the policy environment. They focused on potential labor supply, capital spending, and savings impacts of tax rate changes. IHS Markit's model of the U.S. economy embodies supply-side hypotheses to the extent supportable by empirical evidence embodied in the available data. The empirical evidence is considerable in the many areas that supply-side hypotheses share with long-run growth models. These features, however, have been fundamental aspects of the model since 1976.

Rational expectations

As the rational expectations school has pointed out, much of economic decision-making is forward looking. For example, the decision to buy a car or a home is not only a question of current affordability, but also one of timing. The delay of a purchase until interest rates or prices decline has become particularly common since the mid-1970s, when both inflation and interest rates were very high and volatile. Consumer sentiment surveys, such as those conducted by the University of Michigan Survey Research Center, clearly confirm this speculative element in spending behavior.

However, households have shown that they base their expectations, to a large extent, on their past experiences: they believe that the best guide to the future is an extrapolation of recent economic conditions and the changes in those conditions. Consumer sentiment about whether this is a "good time to buy" can, therefore, be successfully modeled as a function of recent levels and changes in employment, interest rates, inflation, and inflation expectations. Similarly, inflation expectations (influencing financial conditions) and market strength expectations (influencing inventory and capital spending decisions) can be modeled as functions of recent rates of price and spending increases.

This largely retrospective approach is not, of course, wholly satisfactory to pure adherents of the rational expectations doctrine. In particular, this group argues that announcing macroeconomic policy changes would significantly influence expectations of inflation or growth prior to any realized change in prices or spending. If an increase in government expenditures is announced, the argument purports, expectations of higher taxes to finance the spending might lead to lower consumer or business spending in spite of temporarily higher incomes from the initial government spending stimulus. A rational expectations theorist would thus argue that multiplier effects will tend to be smaller and more short-lived than a mainstream economist would expect.

These propositions are subject to empirical evaluation. IHS Markit's conclusions are that expectations do play a significant role in private sector spending and investment decisions; but, until change has occurred in the economy, there is very little room for significant changes how households perceive change before it actually occurs. The rational expectations school thus correctly emphasizes a previously

understated element of decision-making but exaggerates its significance for economic policy-making and model building.

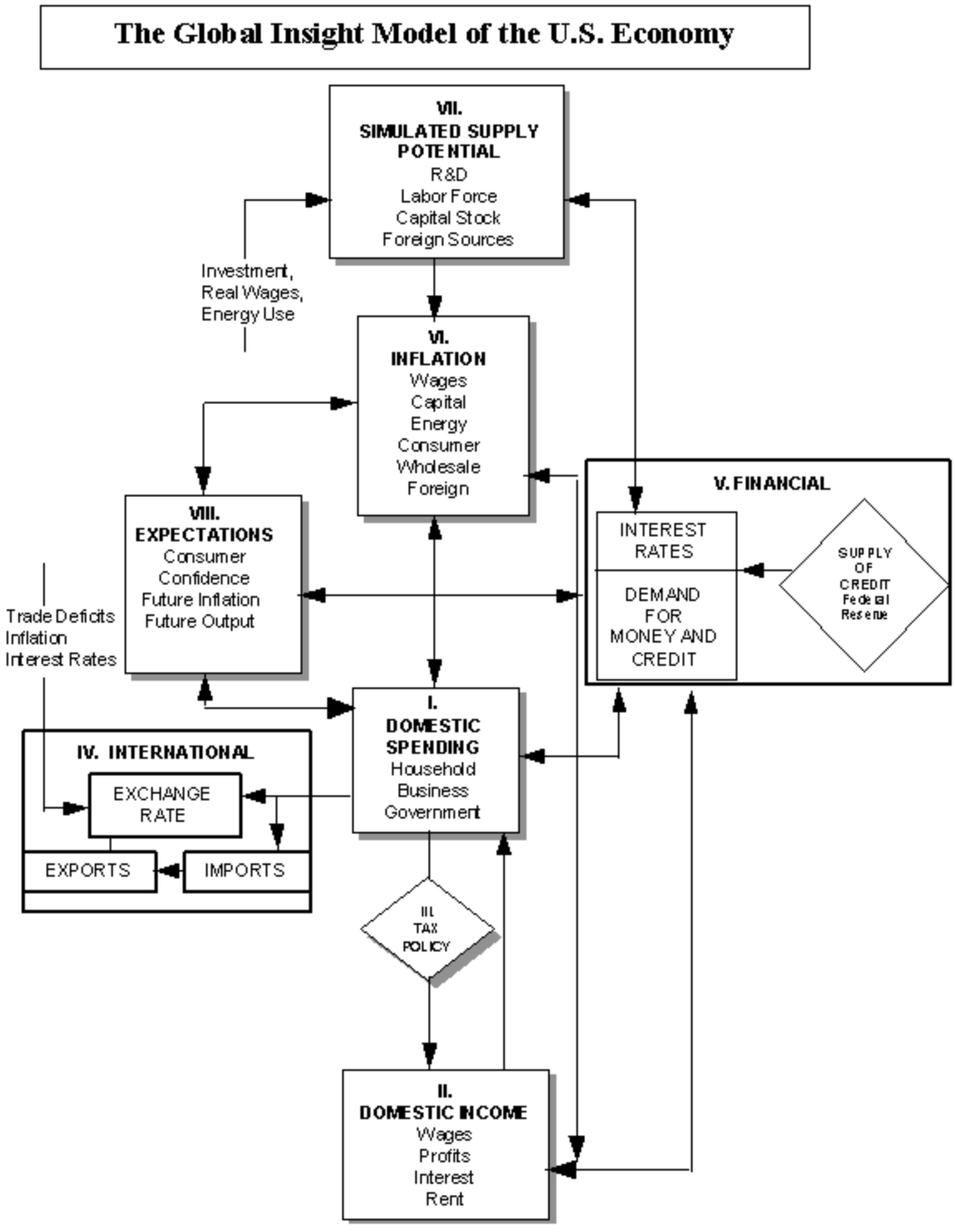
IHS Markit's model of the U.S. economy allows a choice in this matter. On the one hand, the user can simply accept IHS Markit's judgments and let the model translate policy initiatives into initial changes in the economy, simultaneous or delayed changes in expectations, and subsequent changes in the economy. On the other hand, the user can manipulate the clearly identified expectations variables in the model, that is, consumer sentiment, and inflation expectations. For example, if the user believes that fear of higher taxes would subdue spending; the user could reduce the consumer sentiment index.

Theory as a constraint

The conceptual basis of each equation in IHS Markit's model of the U.S. economy was thoroughly worked out before the regression analysis was initiated. The list of explanatory variables includes carefully selected demographic and financial inputs. Each estimated coefficient was then thoroughly tested to be certain that it met the tests of modern theory and business practice. This attention to equation specification and coefficient results has eliminated the *short circuits* that can occur in evaluating a derivative risk or an alternative policy scenario. Because each equation will stand up to a thorough inspection, IHS Markit's model is a reliable analytical tool and can be used without excessive iterations. The model is not a black box: it functions like a personal computer spreadsheet in which each interactive cell has a carefully computed, theoretically consistent entry and so performs logical computations simultaneously.

Major sectors

IHS Markit's model of the U.S. economy captures the full simultaneity of the U.S. economy, projecting over 1,700 concepts spanning final demands, aggregate supply, prices, incomes, international trade, industrial detail, interest rates, and financial flows. The chart below summarizes the structure of the eight interactive sectors (in Roman numerals). The following discussion presents the logic of each sector and significant interactions with other sectors.


The Global Insight Model of the U.S. Economy
VII.
SIMULATED SUPPLY POTENTIAL
R&D
Labor Force
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EXPORTS
IMPORTS
III.
TAX POLICY
II.
DOMESTIC INCOME
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Profits
Interest
Rent

Spending—consumer

The domestic spending (I), income (II), and tax policy (III) sectors model the central circular flow of behavior as measured by the national income and product accounts. If the rest of the model were frozen, these blocks would produce a Keynesian system similar to the models pioneered by Tinbergen and Klein, except that neoclassical price factors have been imbedded in the investment and other primary demand equations.

Consumer spending on durable goods is divided into nine categories:

- Light vehicles
- Used automobiles
- Motor-vehicle parts
- Other vehicles
- Computers
- Software
- Other household equipment and furnishings
- Ophthalmic and orthopedic products
- Other

Spending on non-durable goods is divided into nine categories:

- Three food categories
- Clothing and shoes
- Gasoline and oil
- Fuel oil and coal
- Tobacco
- Drugs
- Other.

Spending on services is divided into 16 categories:

- Housing
- Six household operation subcategories
- Four transportation categories
- Medical care
- Recreation
- Two personal business service categories
- Other services (Table A1 in Appendix A on page 76)

In nearly all cases, real consumption expenditures are motivated by real income and the consumer price of a particular category relative to the prices of other consumer goods. Durable and semi-durable goods are also especially sensitive to current financing costs and consumer speculation on whether it is a *good time to buy*. The University of Michigan Survey of Consumer Sentiment monitors this last influence with the index itself modeled as a function of current and lagged values of inflation, unemployment, and the prime rate.

Spending—business investment

Business spending includes nine fixed investment categories for equipment and seven for construction (Table A2, Appendix A, p. 64):

- 4 information processing equipment categories
- 1 industrial equipment category
- 3 transportation equipment categories
- 1 other producers' durable equipment category
- 4 building categories
- 1 mines and wells category
- 2 two public utility structures categories

Spending components of equipment and business structures (non-utility, non-mining) are determined by each of their effective post-tax capital costs, capacity utilization, and replacement needs. The cost terms are sophisticated blends of post-tax debt and equity financing costs (offset by expected capital gains) and the purchase price of the investment good (offset by possible tax credits and depreciation-related tax benefits). This updates the well-known work of Dale Jorgenson, Robert Hall, and Charles Bischoff.

Given any cost or financing environment, the need to expand capacity is monitored by recent growth in national goods output weighted by the capital intensity of such production. Public utility structure expenditures are motivated by similar concepts except that the output terms are restricted to utility output rather than total national goods output. Net investment in mining and petroleum structures responds to movements in real domestic oil prices and to oil and natural gas production.

Inventory demand is the most erratic component of GDP, reflecting the pro-cyclical, speculative nature of the private sector, which accumulates during booms and is drawn down during downturns. The forces that drive the five non-farm inventory categories are changes in spending, short-term interest rates and expected inflation, surges in imports, capacity utilization, and the speed of vendor deliveries. Unexpected increases in demand lead to an immediate draw down of stocks that are then rebuilt over time; the reverse naturally holds for sudden reductions in final demand. Inventory demands are sensitive to the cost of holding the stock, measured by such terms as interest costs adjusted for expected price increases and by variables monitoring the presence of bottlenecks. The cost of a bottleneck that slows delivery times is lost sales: an inventory spiral can, therefore, be set in motion when all firms accelerate their accumulation during a period of strong growth but then try to deplete excessive inventories when the peak is past.

Spending—residential investment

The residential investment sector of the model includes two housing starts (single and multifamily starts) and three housing sales categories (new and existing single-family sales and new single-family units for sale). Housing starts and sales, in turn, drive investment demand in five GDP account categories (Table A3, Appendix A, p. 65):

- Single-family housing
- Multifamily housing
- Improvements

- Other residential structure
- Residential equipment

Residential construction is typically the first sector to contract in a recession and the first to rebound in a recovery. Moreover, the magnitude of the building cycle plays a large role in the subsequent macroeconomic cycles. The housing sector of IHS Markit's model of the U.S. economy explains new construction as a decision primarily based on the after-tax cost of home ownership relative to disposable income. This cost is estimated as the product of the average new home price adjusted for changes in quality and the mortgage rate, plus operating costs, property taxes, and an amortized down payment. *Lever variables* allow the model user to specify the extent to which mortgage interest payments, property taxes, and depreciation allowances (for rental properties) produce tax deductions that reduce the effective cost.

The equations also include a careful specification of demographic forces. After estimating changes in the likelihood of specific age-gender groups to form independent households, the resulting *headship rates* are multiplied by corresponding population statistics to estimate the trend expansion of single- and multifamily households. The housing equations are then specified to explain current starts relative to the increase in trend households over the past year, plus pent-up demand and replacement needs. Essentially, the model is analyzing the share of new construction in an expanding housing market. The primary factors in determining this share are housing affordability, consumer confidence, and the weather. Actual construction spending in the GDP accounts is the value of construction *put-in-place* in each period after the start of construction (with a lag of up to six quarters in the case of multifamily units), plus residential improvements and brokerage fees.

Spending—government

The last sector of domestic demand for goods and services, the government, is largely exogenous (user determined) at the federal level and endogenous (equation determined) at the state and local level. The user sets the real level of federal non-defense and defense purchases (for compensation, consumption of fixed capital, Commodity Credit Corporation inventory change, other consumption, and gross investment), medical and non-medical transfer payments, and medical and non-medical grants to state and local governments. The model calculates the nominal values through multiplication by the relevant estimated prices. Transfers to foreigners, wage accruals, and subsidies (agricultural, housing, and other) are also specified by the user but in nominal dollars. One category of federal government spending—net interest payments—is determined within the model because of its dependence on the model's financial and tax sectors. Net federal interest payments are determined by the level of privately held federal debt, short and long-term interest rates, and the maturity of the debt (Table A4, Appendix A, p. 66).

The presence of a large and growing deficit imposes no constraint on federal spending. This contrasts sharply with the state and local sector, where legal requirements for balanced budgets mean that declining surpluses or emerging deficits produce both tax increases and reductions in spending growth. State and local purchases (for compensation, consumption of fixed capital, other consumption, and construction) are also driven by the level of federal grants (due to the matching requirements of many programs), population growth, and trend increases in personal income (Table A5, Appendix A, p. 67).

Income

Domestic spending, adjusted for trade flows, defines the economy's value-added or gross national product (GNP) and gross domestic product (GDP). Because all value-added must accrue to some sector of the economy, the expenditure measure of GNP (GDP plus net exports of factor services) also determines the nation's gross income. The distribution of income among households, business, and government is determined in Sectors II and III of the model.

Pre-tax income categories include private and government wages, corporate profits, interest, rent, and entrepreneurial returns. Each pre-tax income category except corporate profits is determined by some combination of wages, prices, interest rates, debt levels, and capacity utilization or unemployment rates. In some cases, such as wage income, these are identities based on previously calculated wage rates, employment, and hours per week.

Profits are logically the most volatile component of GNP on the income side. When national spending changes rapidly, the contractual arrangements for labor, borrowed funds and energy imply that the return to equity holders is a residual that will soar in a boom and collapse in a recession. The model reflects this by calculating wage, interest, and rental income as thoroughly reliable near-identities (for example, wages equal average earnings multiplied by hours worked) and then subtracting each non-profit item from national income to solve for profits (Tables A6 and A7, Appendix A, pgs. 81 and 82).

Taxes

Because post-tax rather than pre-tax incomes drive expenditures, each income category must be taxed at an appropriate rate, so the model tracks personal, corporate, payroll, and excise taxes separately. Users may set federal tax rates; tax revenues are then simultaneously calculated as the product of the rate and the associated pre-tax income components. However, the model automatically adjusts the effective average personal tax rate for variations in inflation and income per household and the effective average corporate rate for credits earned on equipment, utility structures, and research and development. Substitutions or additions of *flat* taxes and value-added taxes for existing taxes are accomplished with specific tax rates and new definitions of tax bases. As appropriate, these are aggregated into personal, corporate, or excise tax totals.

State and local corporate profits and social insurance (payroll) tax rates are exogenous in the model, but personal income and excise taxes are fully endogenous: the U.S. model makes reasonable adjustments automatically to press the sector toward the legally required approximate budget balance. The average personal tax rate rises with income and falls with the government-operating surplus. Property and sales taxes provide the bulk of state excise revenue and reflect changes in oil and natural gas production, gasoline purchases and retail sales, as well as revenue requirements. The feedback from expenditures to taxes and taxes to expenditures works quite well in reproducing both the secular growth of the state and local sector and its cyclical volatility (Table A8, Appendix A, p. 70).

International

The international sector (IV) is a critical, fully simultaneous block that can either add or divert strength from the central circular flow of domestic income and spending. Depending on the prices of foreign output, the U.S. exchange rate, and competing domestic prices, imports capture varying shares of domestic demand.

Depending on similar variables and the level of world gross domestic product, exports can add to domestic spending on U.S. production. The exchange rate responds to international differences in inflation, interest rates, trade deficits, and capital flows between the United States and other countries. IHS Markit's U.S. Economic Service and the World Service collaborate in determining internally consistent trade prices and volumes, interest rates, and financial flows to create projections.

Eight categories of goods and one of services are modeled separately for both imports and exports, with one additional goods category for oil imports (Table A9, Appendix A, p. 71). For example, export and import detail for business machines is included as a natural counterpart to the office equipment component of producers' durable equipment spending. The business machines detail allows more accurate analysis because computers are rapidly declining in effective quality-adjusted prices relative to all other goods and because such equipment is rising rapidly in prominence as businesses push ahead with new production and information processing technologies.

Investment income flows are also explicitly modeled. The current stream of large account deficits incurred by the United States has important implications for the U.S. investment income balance. As current account deficits accumulate, the U.S. net international investment position and the U.S. investment income balance deteriorate. U.S. foreign assets and liabilities are, therefore, included in the model, and the current account deficit determines the path of the net investment position.

The reactions of overseas prices, interest rates, and GDP to U.S. development are robust and automatic. For the depreciation of the dollar, for example, U.S. activity may expand, reducing foreign activity, and U.S. inflation may rise while the rate in other countries slows.

Financial

Using a detailed financial sector (V) and interest rate and wealth effects in the spending equations recognizes the importance of credit conditions on the business cycle and on the long-run growth prospects for the economy.

Interest rates, the key output of this sector, are modeled as a term structure, pivoting off the federal funds rate. As noted earlier, the model gives the user the flexibility to use the supply of reserves as the key monetary policy instrument, reflecting the Federal Reserve's open market purchases or sales of Treasury securities, or to use a reaction function as the policy instrument. If the supply of reserves is chosen as the policy instrument, the federal funds rate depends on the balance between the demand and supply of reserves to the banking system. Banks and other thrift institutions demand reserves to meet the reserve requirements on their deposits and the associated (exogenous) fractional reserve requirements. The private sector, in turn, demands deposits of various types, depending on current yields, income, and expected inflation.

If the reaction function is chosen as the monetary policy instrument, the federal funds rate is determined in response to changes in policy concerns such as inflation and unemployment. The reaction function recognizes that monetary policy seeks to stabilize prices (or to sustain a low inflation rate) and to keep the unemployment rate as close to the natural rate as is consistent with the price objective. A scenario designed to display the impact of a fiscal policy change in the context of unchanged monetary policy is arguably more realistic when unchanged or traditional reactions to economic cycles are recognized than when the supply of reserves is left unchanged.

Longer-term interest rates are driven by shorter-term rates as well as factors affecting the slope of the yield curve. In IHS Markit's model of the U.S. economy, such factors include inflation expectations, government borrowing requirements, and corporate financing needs. The expected real rate of return varies over time and across the spectrum of maturities. An important goal of the financial sector model is to both capture the persistent elements of the term structure and to interpret changes in this structure. Twenty-four interest rates are covered to meet client needs regarding investment and financial allocation strategies (Table A10, Appendix A, p. 72).

Inflation

Inflation (VI) is modeled as a carefully controlled, interactive process involving wages, prices, and market conditions. Equations embodying a near accelerationist point of view produce substantial secondary inflation effects from any changing factor such as a change in wage demands or a rise in foreign oil prices. Unless the Federal Reserve expands the supply of credit, real liquidity is reduced by any such shock. Given the real-financial interactions described above, this reduced liquidity can significantly reduce growth. The process also works in reverse: a spending shock can significantly change wage-price prospects and then have important secondary impacts on financial conditions. Inspection of the simulation properties of IHS Markit's model of the U.S. economy, including full interaction among real demands, inflation, and financial conditions, confirms that the model has moved toward a central position in the controversy between fiscalists and monetarists, and in the debates among neoclassicists, institutionalists and rational expectationists.

The principal domestic cost influences are labor compensation, non-farm productivity (output per hour), and foreign input costs. Foreign input costs are driven by the exchange rate, the price of oil, and foreign wholesale price inflation. Excise taxes paid by the producer are an additional cost fully fed into the pricing decision. These cost influences drive each of the 19 industry-specific producer price indexes, combined with a demand pressure indicator and appropriately weighted composites of the other 18 producer price indexes. In other words, the inflation rate of each industry price index is the reliably weighted sum of the inflation rates of labor, energy, imported goods, and domestic intermediate goods plus a variable markup reflecting the intensity of capacity utilization or the presence of bottlenecks. If the economy is in balance--with unemployment near 5%, manufacturing capacity utilization steady near 80 to 85%, and foreign influences neutral--then prices will rise in line with costs and neither will show signs of acceleration or deceleration.

Supply

The first principle of the market economy is that prices and output are determined simultaneously by the factors underlying both demand and supply. As noted above, the *supply-siders* have not been neglected in IHS Markit's model of the U.S. economy; indeed, substantial emphasis on the supply side of the economy (VII) was incorporated as early as 1976. In IHS Markit's model of the U.S. economy, aggregate supply is estimated by a Cobb-Douglas production function that combines factor input growth and improvements in total factor productivity. Factor input equals a weighted average of labor, business fixed capital, public infrastructure, and energy provided by the energy sector. Based on each factor's historical share of total input costs, the elasticity of potential output with respect to labor is 0.65 (that is, a 1% increase in the labor supply increases potential GDP 0.65%), the business capital elasticity is 0.26, the infrastructure elasticity is 0.025, and the energy elasticity is 0.07. Factor supplies are defined by estimates of the full employment labor force, the full employment capital stock, end-use energy demand, and the stock of infrastructure. To avoid double-counting energy input, the labor and capital inputs are both adjusted to deduct estimates of the labor and capital that produce energy. Potential GDP is the sum of the aggregate supply concept derived from the production function, less net energy imports, plus housing services and the compensation of government employees. Total factor productivity depends on the stock of research and development capital and trend technological change.

Taxation and other government policies influence labor supply and all investment decisions, thereby linking tax changes to changes in potential GDP. Expanding potential GDP first reduces prices and then reduces credit costs, spurring demand. Demand rises until it becomes equal with potential output. Therefore, the growth of aggregate supply is the fundamental constraint on the long-term growth of demand. Inflation, created by demand that exceeds potential GDP or by a supply-side shock or excise tax increase, raises credit costs and weakens consumer sentiment, slowing aggregate demand.

Expectations

The contributions to the model of the U.S. economy and its simulation properties of the rational expectations school are as rich as the data will support. Expectations (Sector VIII) affect several expenditure categories in IHS Markit's model of the U.S. economy, but the principle nuance relates to the entire spectrum of interest rates. Shifts in price expectations or the expected capital needs of the government are captured through price expectations and budget deficit terms. Price expectations affect the level of rates throughout the maturity spectrum, and budget deficit terms affect intermediate and long-term rates, which affects the shape of the yield curve. On the expenditure side, inflationary expectations affect consumption through consumer sentiment, and growth expectations affect business investment.

3. EIA's Industrial Output and Employment by Industry Models

Industrial Output Model overview

The Industrial Output Model is a stochastic model of activity for 58 industries and service sectors in the United States. The model estimates the real value of shipments, or revenue, as a measure of output for each sector. The output level generated in the Industrial Output Model reflects a level of domestic production that is consistent with the economic expenditures generated in IHS Markit's model of the U.S. economy. The economic expenditure categories driving the Industrial Output Model are available in Appendix A (Table A11, p. 73). The nonmanufacturing and manufacturing industries modeled in the Industrial Output and Employment Models are also available in Appendix A, along with the codes for each industry as used by IHS Markit, the North American Industry Classification System (NAICS), and NEMS (Table A12, p. 75).

The industrial and service sectors are defined according to NAICS codes. The industry details follow the manufacturing industries as reported by the Department of Commerce in its monthly *Manufacturers' Shipments, Inventories, and Orders* survey. Details are mostly three or four-digit NAICS aggregations with some disaggregation beyond four digits. The nonmanufacturing industries and the service sectors are two-, three-, or four-digit NAICS aggregations. The real value of shipments is based in 2012 dollars, which is compatible with the 2012-based final demands from the model of the U.S. economy.

The behavioral equations of the model translate macroeconomic estimates from IHS Markit's model of the U.S. economy into demand by industry. All other model concepts are projected by statistical equations and identities.

The model projections are at a quarterly frequency. Historical data supporting the model are, for the most part, quarterly series released by various government agencies, typically within a few months of the observation. All data, unless otherwise specified, are seasonally adjusted at annual rates.

Revenue/output for manufacturing industries

Industry revenues are measured in billions of 2012 constant dollars and are available for each of the manufacturing industries in the model. The historical series are the Bureau of Economic Analysis's (BEA) quarterly GDP by industry. The base year of industry revenues is consistent with the economic variables in the Macroeconomic Model.

Constant-dollar revenue by industry is modeled as a function of production based on activity levels in both final demand markets and industries to which it sells, as well as on cyclical, trend, and expectations variables.

The functional form of the estimator of the ratio of revenues to output, as well as the specific cyclical variables used, may vary by industry. The general form of the estimator is given by

$$\log\left(\frac{R_{ind}}{D_{ind}}\right) = f\left(log\left(\frac{R_{ind,t-j}}{D_{ind,t-j}}\right), x_1, \dots, x_j,\ g(t)\right),$$

where

R_{ind} = constant dollar revenue for industry ind;

D_{ind} = production for industry ind;

$x_1, \ldots, x_j$ = variables selected for industry ind; and

$g(t)$ = trend term.

Revenue/output for nonmanufacturing industries/services

For nonmanufacturing industries and service sectors, sales revenue is the main activity indicator. Historical data are collected primarily from the Bureau of Labor Statistics and BEA. The common criteria for the data are that conceptually they should be as close as possible to the measure of value of production or total gross output, rather than value added, and the current dollar measure is roughly equivalent to revenue.

Estimates of the revenue to output ratios for nonmanufacturing industries are calculated from equations of the same form as those used for manufacturing industries:

$$\log\left(\frac{R_{ind}}{D_{ind}}\right) = f\left(log\left(\frac{R_{ind,t-j}}{D_{ind,t-j}}\right), x_1, \ldots, x_j, \ g(t)\right),$$

where

R_{ind} = constant dollar revenue for industry ind;

D_{ind} = production for industry ind;

$x_1, \ldots, x_j$ variables selected for industry ind; and

$g(t)$ = trend term.

Aggregation to the NEMS sectors

The sectoral classification in the MAM is more aggregate than IHS Markit's classification; it is made up of 48 industrial sectors and 10 service sectors. Of the 48 industrial sectors, 41 are manufacturing sectors and 7 are nonmanufacturing industrial sectors. Five of the sectors are energy sectors. For these energy sectors, production estimates are available from other NEMS modules, and their projected growth rates are applied to the historical data in place of the MAM's model estimate.

One of the main users of the output values is the NEMS's Industrial Demand Module (IDM). In that module, the 48 industries are further aggregated into 26 categories. The MAM maintains 58 industries and their corresponding IDM categories. The concordance between IHS Markit's codes and the 58 industries is available in Appendix A (Table A12, p. 75).

Table 1. Industry categories for the Macroeconomic Activity Module and their corresponding Industrial Demand Module categories

NEMS Macroeconomic Activity Module	NEMS Industrial Demand Module
Manufacturing industries	
Food products (sum of next four)	Food products
Grain and oil seed milling	NA
Dairy products	NA
Animal slaughter and seafood products	NA
Other food products	NA
Beverage and tobacco products	Balance of manufacturing
Textile, apparel, and leather	Balance of manufacturing
Wood products	Wood products
Furniture and related products	Balance of manufacturing
Paper products (sum of the next three)	Paper and allied products
Pulp and paper mills	NA
Paperboard containers	NA
Other paper products	NA
Printing	Balance of manufacturing
Basic inorganic chemicals	Inorganic chemicals
Basic organic chemicals	Organic chemicals
Ethanol	NA
Resins and synthetics	Resins
Agricultural chemicals	Agricultural chemicals
Other chemical products (sum of next four)	Balance of manufacturing
Pharma products	NA
Paints products	NA
Soaps and cleaning products	NA
Other chemical products	NA
Petroleum refining*	Petroleum refining
Other petroleum and coal products	Balance of manufacturing
Plastics and rubber products	Plastics and rubber products
Glass and glass products	Glass and glass products
Flat glass	NA
Cement manufacturing	Cement
Lime manufacturing	Lime
Other non-metallic mineral products	Balance of manufacturing
Iron and steel products	Iron and steel
Alumina and aluminum products	Aluminum
Other primary metals	Balance of manufacturing
Fabricated metal products	Fabricated metal products
Machinery	Machinery

Table 1. Industry categories for the Macroeconomic Activity Module and their corresponding Industrial Demand Module categories

NEMS Macroeconomic Activity Module	NEMS Industrial Demand Module
Computers and electronic products	Computer and electronic products
Transportation equipment	Transportation equipment
Appliance and electrical equipment	Electrical equip., appliances and components
Miscellaneous manufacturing	Balance of manufacturing
Nonmanufacturing industries	
Crop production	Agriculture production – crops
Animal production	Agriculture production – animals
Other agriculture	Other agriculture including Forestry
Coal mining *	Coal mining
Oil and natural gas extraction and support activities *	Oil and natural gas extraction
Other mining and quarrying	Metal and other non-metallic mining
Construction	Construction
Services	
Transportation and warehousing	NA
Broadcasting and telecommunications	NA
Electric power generation and distribution *	NA
Natural gas distribution *	NA
Water, sewage, and related systems	NA
Wholesale trade	NA
Retail trade	NA
Finance and insurance, real estate	NA
Other services	NA
Public administration	NA

* Energy sector projections from other NEMS modules

Employment by Industry Model overview

The Employment by Industry Model represents 39 industries and service sectors in the United States (see Table A12 in Appendix A on page 88), which is consistent with the projection of non-farm employment (EEA) from the Macroeconomic Model. Employment is determined by GDP-level drivers and variables affecting output per hour. Private employment is computed from total hours worked in private nonfarm establishments and average work week for nonfarm business. Detailed employment in the industry sector equations of the Macroeconomic Model is constrained to add up to that result. Employment in manufacturing durables and non-durables have their own reconciliation processes to ensure each is consistent with manufacturing employment, productivity, and output. Government employment is determined by real government wages and salaries and is not constrained by reconciliation.

4. EIA's regional models

Overview

NEMS demand modules need economic concepts lower than the national level. The level of regional detail is defined by the nine census divisions:

- New England (NENG)
- Middle Atlantic (MATL)
- South Atlantic (SATL)
- East North Central (ENC)
- East South Central (ESC)
- West North Central (WNC)
- West South Central (WSC)
- Mountain (MTN)
- Pacific (PAC)

We developed a suite of regional models that project for the three concepts by census division:

- Macroeconomic variables—population, economic activity, prices, and wages
- Industry variables—output and employment by sector
- Building variables—residential housing starts and commercial floor space rates of growth

The regional models are downstream models in the Macroeconomic Activity Module (MAM), which means that they run after the national models run. The MAM doesn't have an option to revise the national estimates based on the regional results. Instead, an alignment process is introduced to calibrate the regional calculations so that the sum of the regional estimates equals the corresponding national estimate, if the national model computes the latter. We adopted this *top-down* approach because only selected macroeconomic variables are covered in the regional models and because the national variables are explanatory variables. Without a complete regional economic framework, it is not possible to adopt a *bottom-up* approach for selected variables.

You can find detailed descriptions of the variables in Tables A13–A15 in Appendix A on pages 91 through 94.

Appendix C contains detailed structural forms and coefficients for the regional models.

Macroeconomic variables

The following macroeconomic concepts are projected for each of the nine census divisions:

- Population
- Real gross state product
- Real personal disposable income
- Personal income tax
- Personal income tax rate
- Personal income
- Wage and salary disbursements
- Manufacturing and nonmanufacturing wages
- Consumer price index

Estimates of the two population variables are based on population projections published by the U.S. Census Bureau. The other variables are calculated in the regional macroeconomic model. The regional model is a quarterly model with historical data beginning as early as 1970. It uses inputs from the U.S. Macroeconomic Model and supplies outputs to the regional industrial output and employment models. You can find model equations in Appendix C1 of Appendix C, beginning on page 132.

Population

Projections of the population series are exogenous to the NEMS. For the AEO2022, the source of the historical population data is the U.S. Census Bureau. IHS Markit's March 2010 projection is the source of the regional population shares. To get census division population projections, the February 2010 regional share is applied to the IHS Markit's November 2021 national population projection.

Gross state product

The MAM projects gross regional product in real per capita terms. The equations are in log form. Each of the nine census divisions has an estimated equation. Explanatory variables include lags of state-level and domestic national-level gross product. The general form of the gross regional product equations is

$$\Delta\log\left[\frac{GSPRZNP_d(t)}{GDPRZNP(t)}\right] = b1_d * \log\left[\frac{GSPRZNP_d(t-1)}{GDPRZNP(t-1)}\right]$$
$$+ b2_d * @movav\left[\log\left(\frac{GSPRZNP_d(t-1)}{GDPRZNP(t-1)}\right), 3\right],$$

where

d = 1 to 9 census divisions;

$b1_d, b2_d$ = estimated coefficients for the explanatory variables in the equation for gross regional product, for region d;

$GDPRZNP(t)$ = real per capita gross domestic product for quarter t, in billions of 2012 dollars, national; and

$GSPRZNP_d(t)$ = real per capita gross regional product for quarter t, in billions of 2012 dollars, for region d.

$@movavg$ is a lagged moving average operator defined by

$$@movavg(x_{-j,k}) = \frac{\sum_{l=j}^{k+j-1} x_{t-l}}{k}.$$

Historical data for real gross state product comes from the Bureau of Economic Analysis. The real gross domestic product data comes from IHS Markit's model of the U.S. economy. Quarterly gross domestic product is available for 1959 and later years, in billions of 2012 dollars. IHS Markit uses real gross domestic product data from the Bureau of Economic Analysis. The equations were estimated using least squares. The sample range was from 1990 to 2020. The sample includes more than 100 observations.

Income and taxes

Regional disposable income is in real terms and is estimated by allocating the national projection to the census divisions using shares. Each of the nine census divisions has an equation. The general form of the real disposable income equations is

$$YPDR_d(t) = YPDR(t) * \frac{YPDR\_IHSGI_d(t)}{\sum_{d=1}^{9} YPDR\_IHSGI_d(t)},$$

where

d = 1 to 9 census divisions;

$YPDR_d(t)$ = real disposable income for quarter t, in billions of 2012 dollars, for region d;

$YPDR\_IHSGI_d(t)$ = IHS Markit projection of real disposable income for quarter t, in billions of 2012 dollars, for region d;

$YPDR(t)$ = real disposable income for quarter t, in billions of 2012 dollars, national;

Nominal personal disposable income is personal income minus taxes. Regional nominal personal disposable income is computed by allocating the national projection to the census divisions using shares.

$$YPD_d(t) = YPD(t) * \frac{YPD\_IHSGI_d(t)}{\sum_{d=1}^{9} YPD\_IHSGI_d(t)},$$

where

d = 1 to 9 census divisions;

$YPD_d(t)$ = personal disposable income for quarter t, in billions of dollars, for region d.

$YPD\_IHSGI_d(t)$ = IHS Markit projection of personal disposable income for quarter t, in billions of dollars, for region d.

$YPD(t)$ = personal disposable income for quarter t, in billions of dollars, national;

Personal income is the sum of wage and salary disbursements by government and by the private sector plus income from other sources. Regional nominal personal income is computed by allocating the national projection to the census divisions using shares.

$$YP_d(t) = YP(t) * \frac{YP\_IHSGI_d(t)}{\sum_{d=1}^{9} YP\_IHSGI_d(t)},$$

where

d = 1 to 9 census divisions;

$YP_d(t)$ = personal income for quarter t, in billions of dollars, for region d;

$YP\_IHSGI_d(t)$ = IHS Markit projection of personal income for quarter t, in billions of dollars, for region d; and

$YP(t)$ = personal income for quarter t, in billions of dollars, national.

Other personal income (non-wage and non-salary) is the difference between personal income and total wage and salary disbursements. This is computed for each of the census divisions.

$$YPOTH_d(t) = YP_d(t) - YPCOMPWSD_d(t),$$

where

d = census division (1 through 9);

$YPOTH_d(t)$ = other personal income for quarter t, in billions of dollars, for region d.

$YP_d(t)$ = personal income for quarter t, in billions of dollars, for region d.

$YPCOMPWSD_d$ = total wage and salary disbursements in billions of dollars, for region d;

The Bureau of Economic Analysis (BEA) provides quarterly historical income data at the regional level for 1970 and subsequent years. Nominal income series, measured in billions of dollars, are adjusted to reflect real income in billions of 2012 dollars. IHS Markit's model of the U.S. economy extends the national-level BEA series back to 1959, in both current and 2012 dollars, on a quarterly basis.

Personal income tax is the difference between personal and disposable incomes. IHS Markit's model of the U.S. economy provides quarterly national-level data on personal and disposable incomes in billions of dollars for 1959 and subsequent years. These income estimates are based on BEA data. The personal tax rate is the share of personal income paid in taxes. The model uses BEA's personal and disposable

income figures, at the national and census division levels, to compute historical national and regional tax rates. Quarterly historical data are available for 1970 and subsequent years.

The model computes tax rates at the national level.

$$TAX(t) = YP(t) - YPD(t),$$

$$TAXRATE(t) = \frac{TAX(t)}{YP(t)},$$

where

d = census division (1 to 9);

TAX = personal income tax, in billions of dollars, national;

$TAXRATE$ = personal income tax rate, as a proportion, national;

YP = personal income, in billions of dollars, national;

YPD = disposable income, in billions of dollars, national;

Wage and salary disbursements

The model computes total, private, and government salary disbursements at the census division level by allocating the national wage and salary disbursements using shares. Wage and salary disbursements are measured in billions of dollars.

$$YPDCOMPWSD_d(t) = YPDCOMPWSD(t) * \frac{YPDCOMPWSD\_IHSGI_d(t)}{\sum_{d=1}^{9} YPDCOMPWSD\_IHSGI_d(t)},$$

$$YPDCOMPWSDP_d(t) = YPDCOMPWSDP(t) * \frac{YPDCOMPWSDP\_IHSGI_d(t)}{\sum_{d=1}^{9} YPDCOMPWSDP\_IHSGI_d(t)},$$

$$YPDCOMPWSDG_d(t) = YPDCOMPWSDG(t) * \frac{YPDCOMPWSDG\_IHSGI_d(t)}{\sum_{d=1}^{9} YPDCOMPWSDG\_IHSGI_d(t)},$$

where

d = census division (1 to 9);

$YPCOMPWSD_d$ = total wage and salary disbursements in billions of dollars, for region d;

$YPCOMPWSD\_IHSGI_d$ = IHS Markit projection of total wage and salary disbursements in billions of dollars, for region d;

$YPCOMPWSD$ = total wage and salary disbursements in billions of dollars, national;

$YPCOMPWSDG_d$ = government wage and salary disbursements in billions of dollars, for region d;

$YPCOMPWSDG\_IHSGI_d$ = IHS Markit projection of government wage and salary disbursements in billions of dollars, for region d;

$YPCOMPWSDG$ = government wage and salary disbursements in billions of dollars, national d;

$YPCOMPWSDP_d$ = private wage and salary disbursements in billions of dollars, for region d;

$YPCOMPWSDP\_IHSGI_d$ = IHS Markit projection of private wage and salary disbursements in billions of dollars, for region d; and

$YPCOMPWSDP$ = private wage and salary disbursements in billions of dollars, national.

Quarterly data on wage and salary disbursements for all census divisions are available from the BEA for 1970 and subsequent years. The model uses quarterly national wage and salary disbursements data from IHS Markit's model of the U.S. economy. These data are available for all quarters beginning with 1959.

The Bureau of Labor Statistics (BLS) publishes the Employment Cost Index (ECI) as well as data on hours worked. The EIA regional model uses these quarterly data as provided by the IHS Markit's model of the U.S. economy. The ECI data series begins with the first quarter of 1975, and the data series on hours worked in non-farm establishments begins in 1964.

Refer to the previous section, *Gross State Product*, on page 33 for the description of regional and national populations.

Manufacturing and nonmanufacturing wages

The model projects regional average annual manufacturing wages in nominal terms. The regional estimation equations use a first difference log formulation with the private sector wage and the salary employment cost index as an explanatory variable. The general form of the average annual manufacturing wages equations is

$$\Delta \log(RWM_d(t)) = b1_d * \Delta \log(JECIWSP(t)),$$

where

d = census division (1 to 9);

$b1_d$ = estimated regression coefficient for the explanatory variable in the equation for average annual manufacturing wages, for region d;

$JECIWSP(t)$ = employment cost index, private sector wages and salaries, index – December 2005 = 1.0, national;

$RWM_d(t)$ = average annual manufacturing wages, in thousands of dollars, for region d; and

Δ = first difference operator, i.e., $\Delta x_t = x_t - x_{t-1}$, where t is the reference year.

The historical average annual manufacturing wage estimates are computed from BEA's quarterly manufacturing wage data, which are available by census division for 1970 and subsequent years. The employment cost index for private sector wages and salaries comes from IHS Markit's model of the U.S. economy. The historical employment cost index is quarterly beginning in 1975 and is an index with December 2005 = 1.0.

For nonmanufacturing wages, the model uses data from the same sources used for manufacturing wages, and the equation is analogous:

$$\Delta \log(RWNM_d(t)) = b1_d * \Delta \log(JECIWSP(t)),$$

where

d = census division (1 to 9);

$b1_d$ = estimated regression coefficient for the explanatory variable in the equation for average annual manufacturing wages, for region d;

$JECIWSP(t)$ = employment cost index, private sector wages and salaries, index – December 2005 = 1.0, national;

$RWNM_d(t)$ = average annual nonmanufacturing wages, in thousands of dollars, for region d; and

Δ = first difference operator, i.e., $\Delta x_t = x_t - x_{t-1}$, where t is the reference year.

Consumer price index

For each census division, the model estimates a Consumer Price Index (CPI) by applying a regional share to the national CPI. The base year for the index is 1982–84 = 1.0.

$$CPI_d(t) = CPI(t) * \frac{CPI\_IHSGI_d(t)}{\sum_{d=1}^{9} CPI\_IHSGI_d(t)},$$

where

d = census division (1 to 9);

$CPI_d(t)$ = estimated CPI (all urban consumers, base = 1982–84) for census division for region d;

$CPI\_IHSGI_d(t)$ = IHS Markit projection of estimated CPI (all urban consumers, base = 1982–84) for census division for region d; and

$CPI(t)$ = national CPI (all urban consumers, base = 1982–84).

The source for the regional and national consumer price index is IHS Markit. The historical national index is quarterly beginning in 1959, and the average of the index from 1982 to 1984 is 1.0. The historical

regional index is quarterly beginning in 1982, and the average of the index from 1982 to 1984 is 1.0. IHS Markit's source for the national consumer price index is the Bureau of Labor Statistics.

Industry variables

The industry block of the Regional Model estimates values of 48 industrial output sectors and of 27 employment by industry sectors as well as 12 service sectors for each of the nine census divisions. Table A14 in Appendix A on page 85 lists the descriptions of the sectors and the corresponding NAICS codes.

Historical value of shipments and employment data for the manufacturing sectors are from the Economic Census databases, Annual Survey of Manufacturing databases, and the Bureau of Labor Statistics. As for the nonmanufacturing and service sectors, we use gross state product and employment data from the BEA (http://www.bea.gov/regional/rims/) to supplement the value of output and employment data from the Economic Census, which covers all sectors.

Output

We purchase regional output shares from IHS Markit and apply them to the national-level real output values in constant 2012 dollars from the national industry model. Sectoral price information at the region level are not available to us.

$$RealOutputValue_{x,d}(t) = RealOutputValue_{x,national}(t) * Share_{x,d}(t),$$

where

d = census division (1 to 9); and

x = industrial or service sector

The start year for estimation is 1997. Historical data for all equations ends in 2017. In general, each census division has twenty years of data.

Employment

We purchase regional employment shares from IHS Markit and apply them to the national-level employment values in the national employment model.

$$Employment_{x,d}(t) = Employment_{x,national}(t) * Share_{x,d}(t),$$

where

d = census division (1 to 9); and

x = industrial or service sector

The start year for estimation is 1997. Historical data for all equations ends in 2021.

Building variables

Other regional variables required by the NEMS Demand Modules are housing starts and commercial floor space rates of growth.

Housing Starts:

- Single-Family Housing Starts
- Multifamily Housing Starts
- Mobile Home Shipments

Commercial floor space (rates of growth) types:

- Stores–stores and restaurants
- Warehouse–manufacturing and wholesale trade, public and federally owned warehouses
- Office–private, federal, and state and local offices
- Automotive– auto service and parking garages
- Manufacturing
- Education – primary/secondary and higher education
- Health – hospitals and nursing homes
- Public – federal and state and local
- Religious
- Amusement
- Miscellaneous, non-residential–transportation related and all other not elsewhere classified
- Hotel–hotels and motels
- Dormitories–educational and federally owned (primarily military)

Housing starts

The regional residential housing projection for single and multifamily housing starts and for mobile home shipments are done using shares supplied by the NEMS's Residential Module team. The shares are derived from annual changes in regional population relative to the national population. Population estimates are exogenous to the MAM models. Starts and shipments are measured in millions of units. Beginning in 2002, each census division has an annual share value for single and for multifamily housing starts as well as for mobile home shipments. We apply the shares to the respective national total from IHS Markit's model of the U.S. economy. Historical data for housing starts and manufactured housing shipments are quarterly and begin in 1959. The U.S. Census Bureau is IHS Markit's source for single-family starts and manufactured housing shipments. IHS Markit constructs estimates of multifamily housing starts. Because the frequency of the shares is annual but IHS Markit's model of the U.S. economy and our regional models are quarterly, the shares are converted to a quarterly frequency.

Commercial floor space

The Commercial Floor space model of the MAM contains 170 equations, and 117 of those equations (corresponding to the 13 commercial floor space types in each of nine census division levels) project growth in national floor space stocks using historical data beginning in 1970. The remaining 53 equations are definitional. Of these equations, 36 sum to census division totals or to aggregates required by other NEMS modules. The final 17 equations sum to national totals by floor space type plus aggregates required by other NEMS modules.

The Commercial Floor Space model calculates the growth in the stocks of 13 floor space types in each of the nine census divisions. The units are rates of growth in the stock of commercial floor space, and the frequency is annual. The annual growth rates in the stocks are written to the NEMS common block as

the reported annual floor space estimate. You can find the model equations in Appendix C2 of Appendix C on page 136.

The commercial floor space model is a growth rate model. The endogenous variable is the second difference in the log of the stock of commercial floor space in thousands of square feet by floor space type. The explanatory variables include lagged values of growth in commercial floor space stocks, trends of growth in own commercial floor space stocks, real gross domestic product, consumption of goods and services, private non-residential fixed investment, interest rates, productivity, personal disposable income, and population. The general form of the estimated commercial floor space equations is as follows.

$$\Delta(\Delta\log(COMFLRSTK_i(t))) = intercept_i$$
$$+b1_i * \Delta(\Delta\log(COMFLRSTK(t-1))),$$
$$+b2_i * (\Delta log(COMFLRSTKTREND_i(t)) - \Delta\log(COMFLRSTK_i(t-1)))$$
$$+b3_i * \Delta log\left(\frac{CONSR(t)}{NP16A(t)}\right)$$
$$+b4_i * \Delta log\left(\frac{GDPR(t)}{NP16A(t)}\right)$$
$$+b5_i * \Delta log\left(\frac{IFNRER(t)}{NP16A(t)}\right)$$
$$+b6_i * \Delta log(JQPCMHFE(t))$$
$$+b7_i * \Delta log(RMCORPAAA(t))$$
$$+b8_i * \Delta log(YPDR(t)/NP16A(t))$$

where

i = commercial floor space type (1 to 13);

$COMFLRSTK_i(t)$ = stock of commercial floor space type i for quarter t; in thousands of square feet, national;

$COMFLRSTKTREND_i(t)$ = long-term trend of stock of commercial floor space type i for quarter t; in thousands of square feet, national;

$CONSR(t)$ = real consumer spending on all goods and services for quarter t, in billions of chained 2012 dollars, national;

$GDPR(t)$ = real gross domestic product for quarter t, in billions of chained 2012 dollars, national;

$IFNRER(t)$ = private fixed nonresidential investment for quarter t, in billions of chained 2012 dollars, national;

$JQPCMHFE(t)$ = full-employment productivity in nonfarm business for quarter t, index - 2012 = 100, national;

$NP16A(t)$ = population aged 16 and over for quarter t, millions of persons, national;

$RMCORPAAA(t)$ = yield on AAA-rated corporate bonds for quarter t; in percent per annum, national;

$YPDR(t)$ = disposable income for quarter t, in billions of chained 2012 dollars, national; and

Δ = first difference operator, i.e., $\Delta x_t = x_t - x_{t-1}$, where t is the reference year.

Part B. The MAM interface with the NEMS

5. Integrated simulations using the MAM

This section first describes the types of integrated simulations of the Macroeconomic Activity Module (MAM) within the National Energy Modeling System (NEMS). It then briefly lays out the setup of the models constituting the MAM and the aspects that are common to all of the simulations. As indicated above, the set of models runs in a recursive manner. Our version of IHS Markit's model of the U.S. economy, the Macroeconomic Model, provides estimates of over 1700 concepts spanning final demands, aggregate supply, prices, incomes, international trade, industrial detail, interest rates, and financial flows.

The Industrial Output Model takes the final demand projections from the Macroeconomic Model as inputs and projects output for 58 industries, covering the entire economy, at the three-, and sometimes four-, digit NAICS code levels. The Employment Model projects employment levels for 39 industries, based on the output projections from the Industrial Output Model, national wage rates, productivity trends, and average workweek trends from the Macroeconomic Model. The Regional Model allocates the national totals of output and employment to the nine census divisions. The Commercial Floor Space Model calculates growth in regional floors pace, by census division, for 13 commercial floor space types.

Integrated simulations of alternative energy conditions or events

The integrated NEMS projections center on estimating the state of the energy-economic system given a set of alternative energy conditions. Typically, the projections fall into the following five types of integrated NEMS simulations:

- Reference case projection
- Alternative world oil prices
- Changes in or proposed energy fees or emissions permits
- Proposed changes in Combined Average Fuel Economy (CAFE) standards or technology assumptions
- Alternative macroeconomic growth cases

In these integrated NEMS simulations, estimated values for over 240 macroeconomic and demographic variables from MAM are passed to NEMS. After making any transformations required by the simulation, the modules of NEMS solve for demand, supply, and prices of energy over the projection period. These energy prices and quantities are then returned to MAM and a new calculation, Scenario 1, is solved in the MAM's U.S., Industrial Output, Employment by Industry, Regional, and Commercial Models.

Reference projection

Developing the MAM's Reference case is an iterative process that requires many integrated simulations of the NEMS before global convergence is attained. Before the first integrated run can be done, we create a baseline for the U.S. Model. We modify IHS Markit's model of the U.S. economy so that it includes our assumption about the path of the world oil price. The results of this model solution become the preliminary baseline, Scenario 0, of the Macroeconomic Model.

At this point, the MAM is included in integrated simulations of the NEMS. Energy market conditions, as supplied by the modules of the NEMS, are assumptions exogenous to the Macroeconomic Model. The Macroeconomic Model is simulated using these assumptions. The resulting projection is labeled *Scenario 1* in the EViews workfile. The MAM is a collection of models, and the Macroeconomic Model is the first to execute. The Industrial Output and Employment by Industry Models are solved sequentially at the national level using the Macroeconomic Model results. Simulations of regional models of economic activity, housing starts, commercial floor space, industrial output, and employment by industry then follow.

Once all the models of the MAM are solved, a subset of the projection is written to the global data structure so that the modules of NEMS can react to these new economic assumptions (Table B14, Appendix B, p. 120). This process is one *cycle* of the NEMS. Cycles are repeated until convergence factors are satisfied. At some point, following many runs of the NEMS, the Reference case is frozen. The *Scenario 1* solution in the U.S. Model then becomes the final baseline used as the starting point for analyzing policy proposals and changes in energy markets. These results are reported in the AEO as the Reference case.

Clean Energy Standards

Clean Energy Standards require that a certain percentage of electricity generation is produced by clean energy sources, but the definition of these clean sources varies among studies. Imposing standards that utilities must use may result in a fuel mix that deviates from a market-based solution. Clean Energy Standards are not assumed in the Reference case or in any other case in the *Annual Energy Outlook*.

Investment in more expensive generation technologies is required with no underlying increase in total generation capability. Resources that would not have otherwise been used if the standards were not imposed must be allocated to fund these technologies. Aggregate supply should be lower because electricity is now being produced by higher-cost techniques. These techniques use more resources, reducing the resources available to produce other goods and services.

The key equation of aggregate supply is a concept of non-housing, non-government GDP. The drivers of this aggregate supply concept are non-energy capital stock, non-energy potential labor hours, energy usage, and trend total factor productivity. The Macroeconomic Model does not capture all of the inherent costs when energy is produced by higher-cost methods, which may not be totally captured by increased energy costs. In this instance, labor and capital are diverted to producing more expensive energy sources so that less *non-energy* labor and capital are used to produce other goods and services.

The Electricity Market Module in the National Energy Modeling System (NEMS) has estimates of the incremental investment needed to generate the required clean energy. The increase in investment represents the amount of resource costs diverted from the rest of the economy. To represent these costs, potential aggregate supply is decreased by the change in investment, and then the amount by which trend productivity would have to be reduced to yield that reduced aggregate supply is computed.

Annual estimates of expense and capital payments are available in the Electricity Market Module. These estimates include:

- Installed capacity
- Transmission
- Retrofits
- Fixed operations and maintenance
- Capital additions
- Nonfuel variable operations and maintenance
- Fuel expenses
- Purchased power
- RPS credit expenses

Costs of installed capacity, transmission, and retrofits are summed up. The change in investment is then computed using the appropriate Reference case levels. Non-housing, non-government GDP (aggregate supply) is adjusted by the amount of the changed investment for the *Annual Energy Outlook* case. The trend factor productivity is then altered to yield the reduced aggregate supply.

Alternative world oil prices

Crude oil prices are determined in the international market and are influenced by production decisions in OPEC and non-OPEC nations. Two simulations are normally performed with the reference projection for the AEO. These simulations are based on a High World Oil Price case and a Low World Oil Price case. These high and low prices are based on different assumptions about the world's liquids market. For each of these cases, the MAM starts from the Reference case, as explained above, and passes the values of the required macro variables to the modules of NEMS. The NEMS reacts to the alternative world oil price and various measures of economic activity. A new set of energy variables, including new oil prices, are passed back to the MAM, which then solves its series of models again.

Changes in or proposed energy taxes or emission permits

This class of simulations levies taxes on an energy sector. It could be a per-unit tax (x-cents per gallon) or an ad-valorem tax (x% of revenues). It could be a tax on a fuel by type or on emissions by type. When taxes are levied on an industry, energy prices are expected to rise in proportion to the tax. These taxes, if collected by the federal government, will change the budget deficit relative to the baseline. Because these taxes are not levied to raise revenue, although raising revenue has also been considered in previous years, assumptions are made as to how these revenues are returned to the economy. Generally, three alternative schemes are implemented:

- We assume that taxes are retained within the business sector (grandfathered).
- Revenues can be returned to households.
- A fraction of the revenues can be returned to the households and the remaining fraction is retained within the business sector.

In practice, these alternative schemes have also included spending on government research and development projects as well as transfers to help ameliorate the impacts of the tax.

The grandfathered case is easiest to implement because the revenues stay in the business sector. Like in all simulations, reference scenario values for macroeconomic and demographic variables are passed to

the NEMS. Increases in or introductions of new energy taxes raise energy prices and reduce production and consumption in the NEMS, which returns the newly estimated values to the MAM. The increase in federal revenues resulting from energy taxes is also returned to the MAM. In this case, the business sector retains all tax revenues.

In the case where revenues are returned to the consumers, the increased revenues are subtracted from corporate profits before taxes (ZB) by increasing federal excise tax accruals, other than for a value added tax (TXIMGFOTH), through the add factor associated with it (TXIMGFOTH_A). Second, the add factor associated with federal personal tax receipts (TXPGF_A) is reduced by the same amount as the increase in the excise tax. Essentially, these two procedures imply that the federal government takes the energy tax revenues away from the business sector as a lump sum amount and then returns them to consumers in the form of a lump sum.

In the case where a portion of the tax revenue is allowed to stay in the business sector and the remaining amount is returned to consumers, the add factor for TXIMGFOTH is increased by the amount that has to be returned to the consumers. Then, the add factor for TXPGF is reduced by the same amount.

Proposed changes in CAFE standards

This class of simulations is based on changing (increasing) the combined average fuel economy of new, light-duty vehicles relative to the baseline CAFE standards. Increases in the CAFE standards are associated with an increase in the cost of producing new, light-duty vehicles, which are calculated by the Transportation Module of the NEMS. This increased cost is passed to the MAM. The additional cost per new, light-duty vehicle is added to the Reference case average price of new, light-duty vehicles (PLVAVG).

Once the MAM solves its series of models using the new assumption, it writes its new projection to the global data structure. The other modules of the NEMS read the new MAM and CAFE assumptions and recalculate their projections. The resulting new energy prices and quantities, along with the incremental cost for new, light-duty vehicles, are returned to the MAM. The MAM uses the newly estimated energy market assumptions to solve again. This process continues until the NEMS projection converges.

Model levers and simulation rules

IHS Markit provides a series of levers and simulation tools in its model of the U.S. economy that permit changes in key assumptions.

Energy prices and quantities

The projected values for energy prices and quantities appearing in the Macroeconomic Model are exogenous assumptions provided by the supply and demand modules of the NEMS. The production and end-use demand of energy is measured in quadrillion British thermal units. Similarly, projections of output for five energy-related industries are determined by the NEMS. The estimated values of the following energy variables are exogenous to the MAM and are determined in the supply and demand modules of the NEMS:

Production of energy

ENDUSEPCCOAL = Coal share of electric utility fuel use

ENDUSEPCNG = Natural gas share of electric utility fuel use

ENDUSEPCPET = Petroleum share of electric utility fuel use

ENGDOMBIO = Domestic production of energy from biomass, quadrillion British thermal units

ENGDOMCOAL = Domestic production of energy from coal, quadrillion British thermal units

ENDDOMNG =Domestic production of energy from natural gas, quadrillion British thermal units

ENGDOMOO = Domestic production of energy from other fuels, quadrillion British thermal units

ENGDOMPET = Domestic production of energy from petroleum, quadrillion British thermal units

ENGRESIDUAL = Inventory change and statistical discrepancy

Trade in energy

ENGEXPBIO = Export of biofuels, quadrillion British thermal units

ENGEXPCOAL = Export of coal, quadrillion British thermal units

ENGEXPNG = Export of natural gas, quadrillion British thermal units

ENGEXPOO = Export of other fuels, quadrillion British thermal units

ENGEXPPET = Export of petroleum, quadrillion British thermal units

ENGIMPBIO = Import of biofuels, quadrillion British thermal units

ENGIMPCOAL = Import of coal, quadrillion British thermal units

ENGIMPNG = Import of natural gas, quadrillion British thermal units

ENGIMPOO = Import of other fuels quadrillion British thermal units

ENGIMPPET = Import of petroleum, quadrillion British thermal units

End-use demand for energy

DALLFUELSBIO = Total demand for biofuels, quadrillion British thermal units

DALLFUELSCOAL = Total demand for coal, quadrillion British thermal units

DALLFUELSNG = Total demand for natural gas, quadrillion British thermal units

DALLFUELSOO = Total demand for other fuels, quadrillion British thermal units

DALLFUELSPET = Total demand for petroleum, quadrillion British thermal units

DENDUBIO = End-use demand for biofuels, quadrillion British thermal units

DENDUCOAL = End-use demand for coal (excludes electricity generation), quadrillion British thermal units

DENDUELC = Sales of electricity to ultimate consumers, quadrillion British thermal units

DENDUNG = End-use demand for natural gas, quadrillion British thermal units

DENDUPET = End-use demand for petroleum, quadrillion British thermal units

Consumer spending on energy

CNEFAOR = Real consumer spending on fuel oil and other fuels, billion 2012 dollars

CNEGAOR = Real consumer spending on motor vehicle fuels, lubricants and fuels, billion 2012 dollars

CSVUER = Real consumer spending on electricity, billion 2012 dollars

CSVUGR = Real consumer spending on natural gas, billion 2012 dollars

QGASASF = Highway consumption of gasoline and special fuels, billions of gallons

Prices of energy

JPCNEFAO = Chained price index, consumer fuel oil and coal, 2012=100

JPCNEGAO = Chained price index, consumer gasoline and oil, 2012=100

JPCSVUE = Chained price index, household electricity, 2012=100

JPCSVUG = Chained price index, household natural gas, 2012=100

PNGHH = Henry Hub spot market price of natural gas, dollars per million British thermal units

POILIMP = Weighted average price of imported crude received in refinery inventories, dollars per barrel

POILWTI = Average price of West Texas Intermediate crude oil, dollars per barrel

WPI051 = Producer price index coal, 1982=1.0

WPI053 = Producer price index, industrial natural gas, 1982=1.0

WPI054 = Producer price index, electric power, 1982=1.0

WPI055 = Producer price index, utility natural gas, 1982=1.0

WPI0561 = Producer price index, crude petroleum, 1982=1.0

WPI057 = Producer price index, refined petroleum products, 1982=1.0

WPI0574 = Producer price index, residual petroleum fuels, 1982=1.0

Industrial production indexes

IPSG211A3 = Industrial production index oil and natural gas extraction and support activities, 2012=100

IPSN2121 = Industrial production index coal mining, 2012=100

Industrial output

Though the output projections of the following energy-related industries are endogenously determined in the MAM's Industrial Output Model, its values are overwritten. The MAM's final results are computed by applying the growth rates from the NEMS projections to the last historical data point in the MAM's Industrial Output Model.

RR2121 = Real output of coal mining

RR211 and RR213 = Real output of oil and natural gas extraction and support activities

RR32411 = Real output of petroleum refining

RR2211 = Real output of electric utilities

RR2212 = Real output of gas utilities

Fiscal policy assumptions

Unless mentioned otherwise, the MAM retains IHS Markit's default settings for fiscal policy levers and assumptions.

Federal purchases

Real federal government spending for each spending category is an exogenous input in the model. The price deflator associated with each of the goods categories reflects goods inflation in the private sector of the economy. Price deflators associated with the federal wage categories (JPGFMLCWSS and JPGFOCWSS) are closely tied to legislated pay increases; this pay increase concept explains 70%–80% of the inflation in government wages, and wage inflation in the private sector of the economy explains the remainder.

The determination of federal government pay increases (GFMLPAY and GFOPAY) is controlled by model lever GFPAYLEV. If GFPAYLEV is set to 1, federal government pay increases are specified exogenously by the model user (they should supply values for exogenous variables GFMLPAYEXO and GFOPAYEXO that are annual percentage pay increases for the two categories, respectively). If GFPAYLEV is set to 0, federal government pay increases are modeled to rise with inflation as indicated by the chained price index of consumer purchases (JPC). The default value for GFPAYLEV is 1.0.

Federal transfer payments

The model lever JSSLEV allows users to simulate congressional decisions to trim (negative annual percentage rate) or augment (positive annual percentage rate) the cost-of-living adjustment (COLA) on social security payments (YPTRFGFSISS), based on CPI inflation. For example, setting the lever value to 1 increases the social security COLA by 1%. The default value for JSSLEV is 0.

Personal income tax rates

Tax rates in the model are largely exogenous at the federal level and endogenous at the state and local level. However, the model lever TXINFLEV allows the user to raise personal income tax rates if consumer prices rise. If TXINFLEV is set to 0, changes in the federal personal income tax rate (RTXPGF) are controlled through the add factor RTXPGF_A. If TXINFLEV is set to 1, the tax rate is indexed to CPI inflation. The default value for TXINFLEV is 1. The add factor RTXPGF_A can be used to target search the full employment federal budget surplus (NETSAVGFFE).

Monetary policy assumptions

The model lever RMFFLEV gives the user the flexibility to use the reserves as the key monetary policy instrument, reflecting the Federal Reserve's open market purchases or sales of Treasury securities or of using a reaction function as the policy instrument. If RMFFLEV is set to 0, the model uses non-borrowed reserves as the monetary policy instrument and the federal funds rate is determined by the balance between the demand and supply of reserves existing in the banking system (equation RMFFRES). The Federal Reserve does not engage in an active policy to stabilize the economy. The federal funds rate is determined by the demand for federal funds existing in the banking system. If the lever is set to 1, the model uses a Federal Reserve reaction function. This equation is an econometrically estimated equation that models the past behavior of the Federal Reserve in setting the federal funds rate in response to

changes in inflation and unemployment (equation RMFFRCT). Therefore, the Federal Reserve focuses on interest rates that trade off changes in inflation and the unemployment rate.

In the baseline projection of IHS Markit's model of the U.S. economy, both the RMFFRES equation and the RMFFRCT equation yield the same federal funds rate projection. Setting the lever at any value will not alter these baseline projections. For policy simulations, setting the value anywhere between 0 and 1 reflects the model user's view about the degree of active monetary policy undertaken by the Federal Reserve.

Foreign assumptions

In general, IHS Markit's default values are used, with some exceptions.

Interest rates

The long-term government bond yield in rest-of-world industrial economies (RMGBLMTP) is exogenous and equal to its baseline value *RMGBLMTPB* if the model lever *RMGBLMTPLEV* is set to 0. If *RMGBLMTPLEV* is set to 1, this rate changes by the same amount as the rate on the 10-year U.S. Treasury note. If the assumption is that international monetary policy coordination between the United States and the other major industrial economies occurs, then *RMGBLMTPLEV* should be set to 1. The default value for this lever is 0, which indicates that the interest rate differential between the United States and the rest-of-world industrial economies may differ.

Foreign prices

Export and import demands are highly sensitive to changes in U.S. prices relative to foreign prices. Although U.S. prices are modeled in considerable detail with a high level of sophistication, the prices of our major trading partners are largely exogenous assumptions. At times, policy or event-related simulations can cause relative (U.S./foreign) prices to deviate significantly from baseline when foreign prices are fixed, causing trade volumes to respond strongly. In the case of a carbon tax that affects our major trading partners to equal degrees, for example, relative prices should not change. Simple simulation rules have been added to the model to allow foreign price movement relative to baseline levels.

Producer prices and relative prices

The model lever TRADEPLEV allows users to negate any changes in relative prices on export and import demands. When TRADEPLEV is set to 1, export and import demands are determined by foreign output demand and relative (U.S./trading partner) prices. When TRADEPLEV is set to 0, relative prices are assumed to remain at baseline levels; export and import demands change from baseline levels only in response to changes in output, not relative prices. The default value for TRADEPLEV is 1.

The producer price index for the rest of the industrialized world (WPIWMTP) is both the key determining factor for import prices and the key foreign price index driving the U.S. exchange rate with industrialized

countries. *WPIWMTP* is determined by one of two simulation rules based on the value of the model lever *WPIWLEV*. If *WPIWLEV* is set to 0, foreign producer prices are changed relative to baseline levels with:

- Changes in imported oil prices (JPMGPET)
- U.S. merchandise export prices (JPXGXCPP)
- Exchange rates (JEXCHMTP)
- Foreign economic activity (JGDPMTPR and JGDPOITPR)

If *WPIWLEV* is set to 1, foreign producer prices move in line with U.S. merchandise export prices. The default value for *WPIWLEV* is 0.

Exchange rates

IHS Markit's model of the U.S. economy has two nominal exchange rates. These rates are *JEXCHMTP* and *JEXCHOITP* and are defined as trade-weighted exchange rates (in U.S. $) for industrialized countries and for developing countries, respectively. In the MAM, these variables are set exogenously to their baseline projected values for all simulations.

Foreign GDP

The Macroeconomic Model has two foreign real GDP variables. These variables are real GDP in the rest of the industrialized world (JGDPMTPR) and real GDP in developing countries (JGDPOITPR). If the model levers corresponding to *JGDPMTPR* and *JGDDPOITPR* (JGDPMTPRLEV and JGDPOITPRLEV, respectively) are set to 0, the values of the GDP variables are exogenous. When *JGDPMTPRLEV* and *JGDPOITPRLEV* levers equal 1, both foreign real GDP concepts change in the same proportion as the changes in U.S. real GDP. The default values for *JGDPMTPRLEV* and *JGDPOITPRLEV* are 0. In the MAM, these levers are set to 0.5 for all simulations.

Flowcharts of MAM

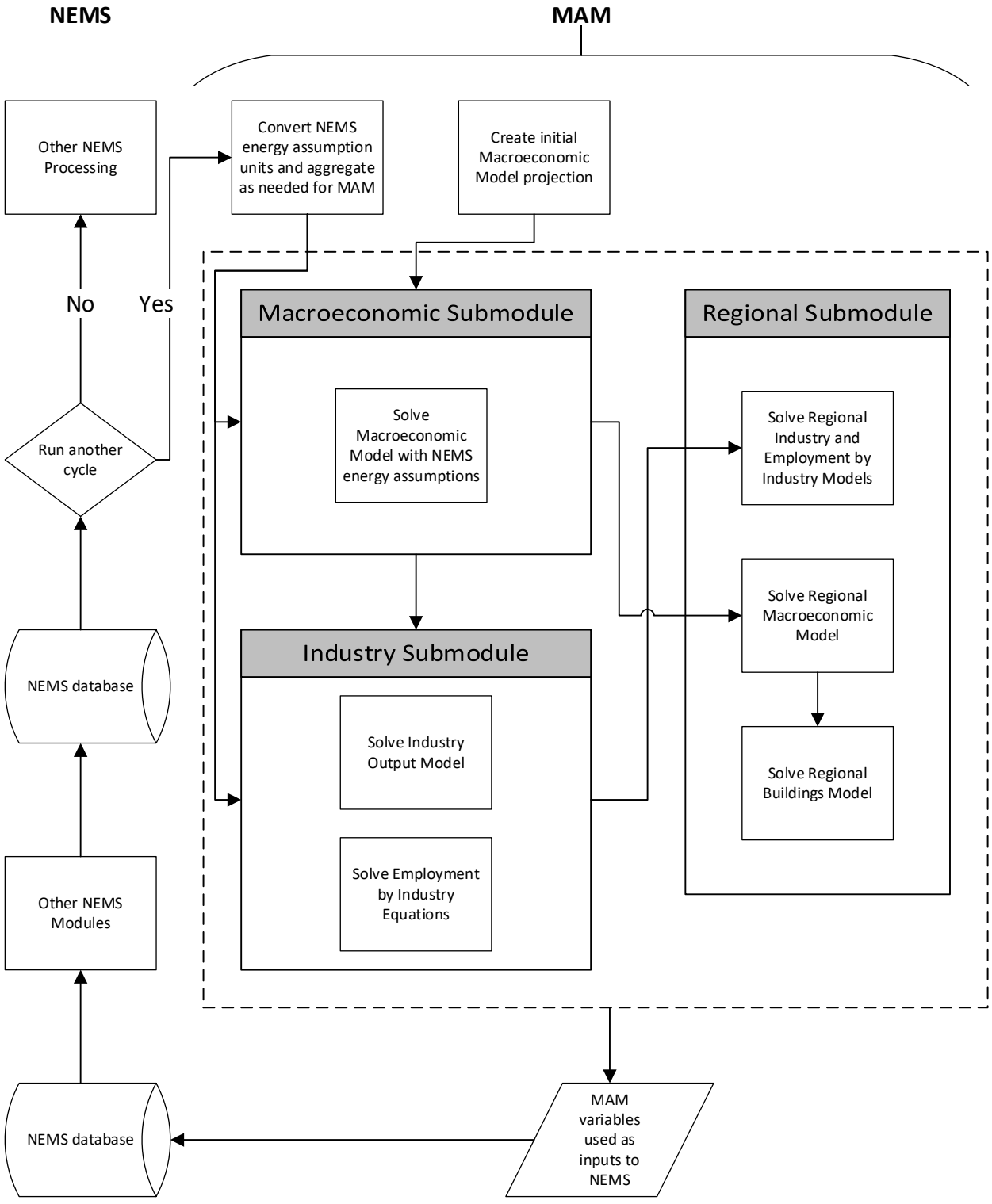
The following seven flowcharts show the flow of information from the NEMS to the MAM and how the energy data and economic information are passed among the components of the MAM. These flowcharts identify the tasks performed by each of the MAM's models and may not necessarily follow the actual programming sequence, which is covered in the next section, along with another set of flowcharts presenting the programming steps and subroutines.

Figure 1 summarizes the entire NEMS-MAM integrated system. The remaining six figures focus on the various models contained in the Macroeconomic, Industrial Output, Employment, and Regional Models of the MAM. In each model, a reference economic projection, created using the structural models described in Part A, was linked to the NEMS to start the system.

The MAM is a feedback system that modifies the Reference case based on assumed changes in energy events or policies. This approach is applied to all NEMS runs, including the Reference and sensitivity cases of the AEO. Alternative NEMS values of energy prices and quantities are first transformed into concepts compatible with those in the MAM models. The growth rates of these alternative NEMS series are applied to the most recent historical data values to create new energy projections. These new series are put into the MAM as predetermined variables, and a new case is run.

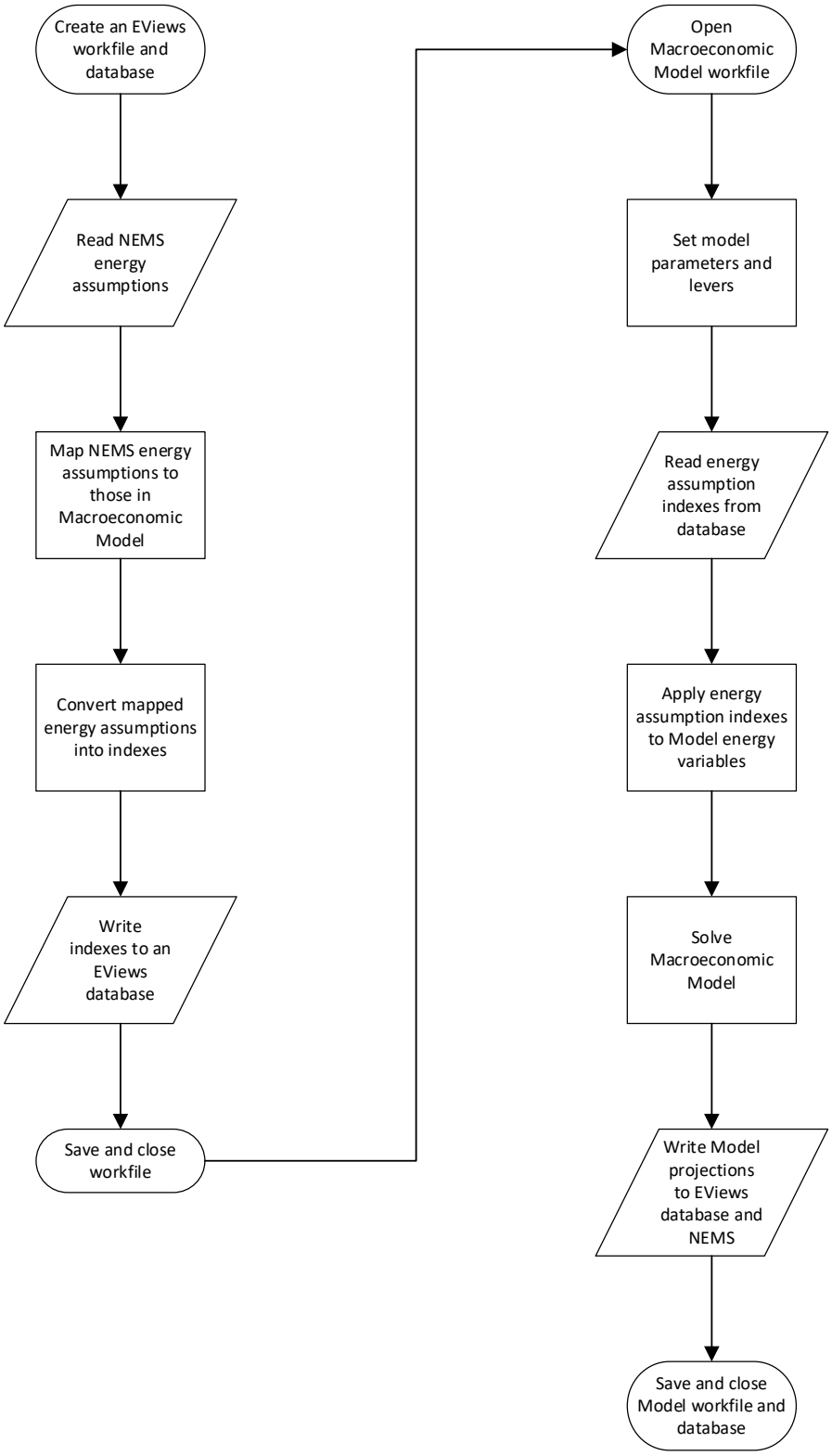
The models in the MAM are run sequentially. The Macroeconomic Model is the first to run with the new energy market assumptions. It is followed by the Industrial Output and Employment Models, and finally by the Regional Models. The downstream models in the MAM use the projections generated by the models further upstream as predetermined variables. The MAM does not have a feedback loop. That is, the estimate of an upstream model is not affected by the results of a downstream model in the same NEMS cycle. When one cycle of the MAM is complete, the projection is written to the global data structure of the NEMS for use by other models. Subsequent energy market estimates from the NEMS are returned to the MAM, if model convergence criteria are not satisfied.

Figure 1. Macroeconomic Activity Module (MAM) flow of the National Energy Modeling System (NEMS)



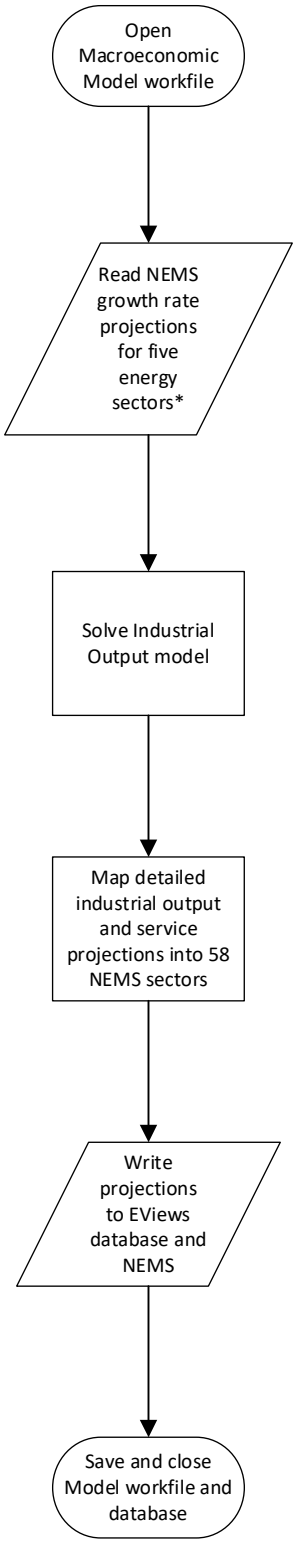
Data source: U.S. Energy Information Administration

Figure 2. Macroeconomic Model flow of the National Energy Modeling System (NEMS)



Data source: U.S. Energy Information Administration

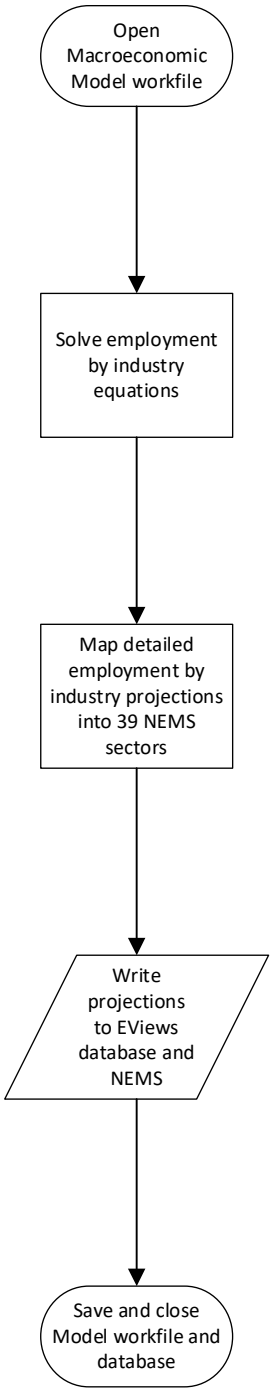
Figure 3. Industry Model of the National Energy Modeling System (NEMS)



*Five NEMS energy production sectors:
Coal mining
Oil and gas extraction
Petroleum refining
Electric utilities
Gas utilities

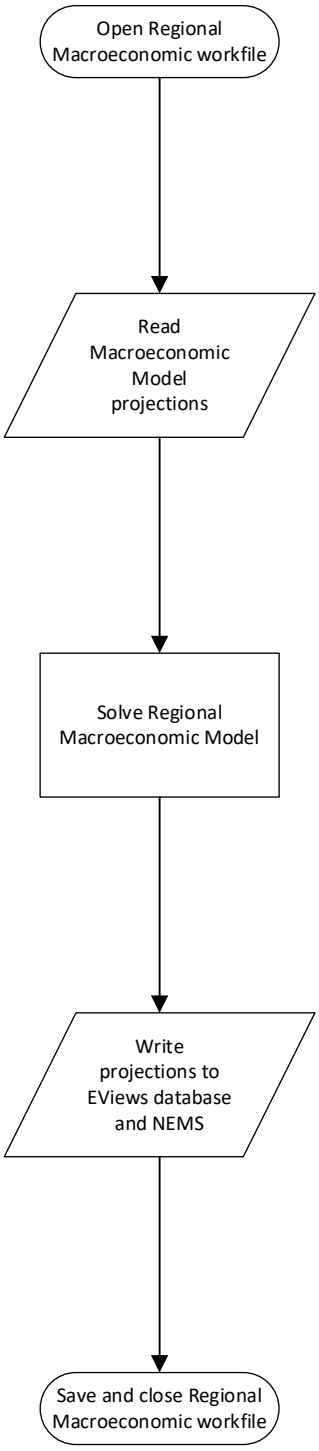
Data source: U.S. Energy Information Administration

Figure 4. Employment by Industry Model of the National Energy Modeling System (NEMS)



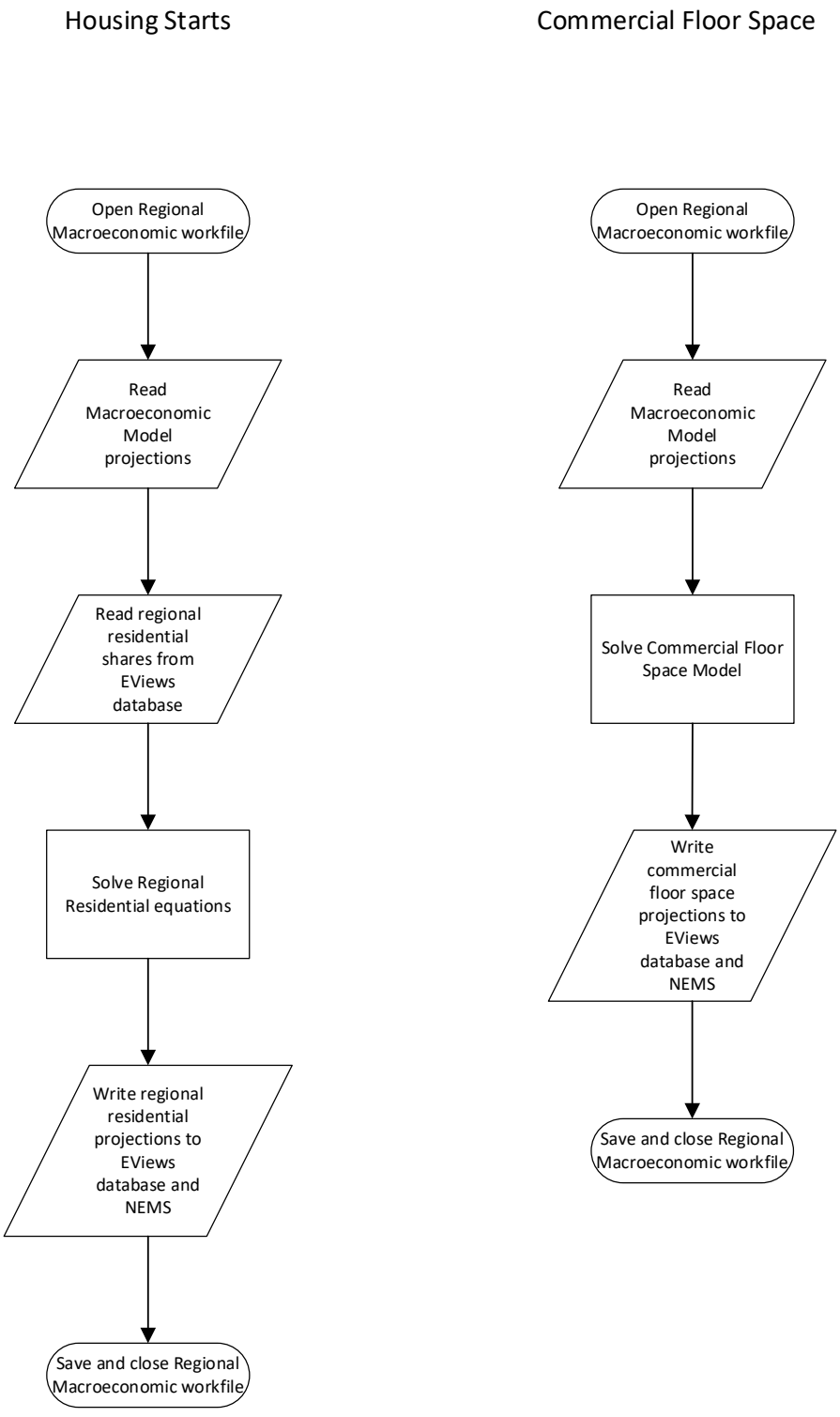
Data source: U.S. Energy Information Administration

Figure 5. Regional Macroeconomic Model of the National Energy Modeling System (NEMS)



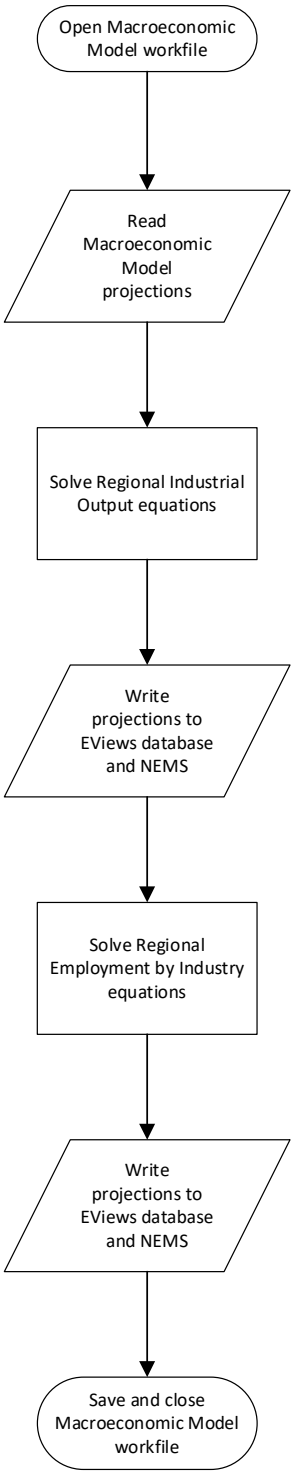
Data source: U.S. Energy Information Administration

Figure 6. Regional Buildings Model of the National Energy Modeling System (NEMS)



Data source: U.S. Energy Information Administration

Figure 7. Regional Industry and Employment by Industry Equations of the National Energy Modeling System (NEMS)



Data source: U.S. Energy Information Administration

6. Operation of MAM within NEMS

The Macroeconomic Activity Module (MAM) is one of a number of source files (also known as modules) that, after compiled and linked, compose the National Energy Modeling System (NEMS) executable. The MAM consists of nine subroutines used to read inputs, compute and apply shocks to the MAM models, run the model simulations, and write out the resulting projection. Figure 8 shows the flow of control within the MAM.

MAC subroutine

All of the activities in the MAM are directed by the MAC subroutine, the driver subroutine. In addition to making calls on the remaining eight subroutines in the MAM, the MAC subroutine has two tasks of its own. It writes the MC_ENERGY output text file of the NEMS energy prices and quantities that are the exogenous assumptions to the models in the MAM. This text file includes aggregates and components used to compute the prices and quantities. The values of the NEMS energy prices and quantities contained in the text file are read from the global data structure. The MAC subroutine's second task is to write the MAM results to the global data structure for the remaining NEMS modules and the NEMS report writer to use. Once this second task is complete, the MAC subroutine returns program control to the NEMS.

READMAC subroutine

The MAC subroutine functions as the driver within MAM and calls all the remaining subroutines. The first subroutine called is READMAC. Figure 9 shows the flow of control within READMAC. This subroutine is called once per run in the first iteration of the first year of a NEMS run. The READMAC subroutine opens and reads the contents of one input file, a text file of the MAM parameter settings named MCPARMS (Table B2, Appendix B, p. 86).

DRTLINK subroutine

DRTLINK is the second subroutine the MAC calls and is responsible for executing IHS Markit's model of the U.S. economy and EIA's national and regional models. Like the READMAC subroutine, the DRTLINK subroutine executes only in the first iteration of the first year of a NEMS run. Figure 10 shows the flow of control within DRTLINK.

When the modeler does not want the estimation of the other NEMS modules affected by a change from the MAM's reference values, the presence of feedback is controlled with the NEMS parameter MACFDBK. When the feedback switch is set to zero, the DRTLINK subroutine is not called. The value of the MACFDBK parameter is set in the NEMS scenario descriptor file (Table B2 in Appendix B on page 99).

Much of what the DRTLINK subroutine does is prepare to execute IHS Markit's national model and EIA's national and regional models within EViews. The programming in the subroutine begins by mapping the NEMS energy prices and quantities read from NEMS to comparable variables in IHS Markit's model of the U.S. economy (Table B3, Appendix B, p. 88). The DRTLINK then builds an EViews program file called DRIVERS. The DRIVERS program file contains instructions written in the EViews programming language. The commands in this program:

- Import exogenous assumptions
- Temporarily alter the model structure

- Simulate IHS Markit's model of the U.S. economy and EIA's models
- Export the projections

Program control is temporarily transferred to EViews as it executes the commands in the DRIVERS program file. The resulting model projections are written to the following eight output files:

- **EPMAC.CSV**—level of national economic activity, industrial output, and employment
- **MC_COMMFLR.CSV**—rates of growth of the stocks of commercial floor space by census division (Table B11, Appendix B, p. 115)
- **MC_DETAIL.CSV**—level of energy detail used as assumptions in the MAM
- **MC_REGEMP.CSV**—level of employment by census division (Table B12, Appendix B, p. 116)
- **MC_REGIO.CSV**—level of industrial output by census division (Table B13, Appendix B, p. 118)
- **MC_REGMAC.CSV**—level of economic activity by census division (Table B10, Appendix B, p. 114)
- **MC_VEHICLES.CSV**—national level of light truck sales by sales class (Table B8, Appendix B, p. 109)
- **MC_XTABS.CSV**—level of national economic activity in more detail

Once EViews completes execution of the DRIVERS program, the subroutine takes four additional steps:

1. Control is returned to the DRTLINK subroutine.
2. The DRTLINK subroutine reads the results contained in each of the text files listed above.
3. Control is returned to the MAC subroutine.
4. The MAC subroutine calls its third subroutine, INDUSTSUB.

INDUSTSUB subroutine

The INDUSTSUB subroutine operates in a manner similar to that described for the MAC subroutine. Figure 11 diagrams the flow of control within INDUSTSUB. Projections cover 48 categories of industrial output and 10 categories of services. These projected levels are written to both the EPMAC and MC_INDUSTRIAL text files (Table B6, Appendix B, p. 105).

In the MAM, data for the five NEMS energy industries are overwritten by NEMS projections:

- Petroleum refining
- Coal mining
- Oil and natural gas extraction
- Electric utilities
- Natural Gas utilities

The MAM computes annual growth rates using NEMS's projections of energy prices and quantities. Each of the growth rates is dynamically applied, beginning with an initial historical value. The resulting time series becomes the industrial output projection for the five energy industries.

REGIONSUB subroutine

REGIONSUB, the fourth subroutine called by the MAC subroutine, reads regional projections later written to NEMS and the MC_REGIONAL text file (Table B9, Appendix B, p. 110).

EMPLOYMENT subroutine

The fifth subroutine called by the MAC subroutine is named EMPLOYMENT. This subroutine works just like the INDUSTSUB subroutine. Estimated levels coming from IHS Markit's employment equations by

industry are written to the EPMAC output text file. The resulting projections are for 27 categories of industrial employment and 12 categories of service employment.

COMFLR subroutine

Figure 14 shows the flow of control within COMFLR, the sixth subroutine called by the MAC subroutine. The COMFLR subroutine copies and aggregates the EViews model results, preparing them for output to NEMS and to the MC_REGIONAL text file (Table B9, Appendix B, p. 110).

TRANC subroutine

Figure 15 shows the flow of control within TRANC, the seventh subroutine called by the MAC subroutine. This subroutine copies light-truck unit sales projections, preparing them for output to NEMS. Light trucks are vehicles with gross vehicle-weight ratings of 14,000 pounds (lbs.) or less. Equations added to IHS Markit's model of the U.S. economy allocate total light-truck sales, in thousands of vehicles, to the following size classes:

- Unit Sales of Class 1 Light Trucks, 0 to 6,000 lbs.
- Unit Sales of Class 2 Light Trucks, 6,001 to 10,000 lbs.
- Unit Sales of Class 3 Light Trucks, 10,001 to 14,000 lbs.

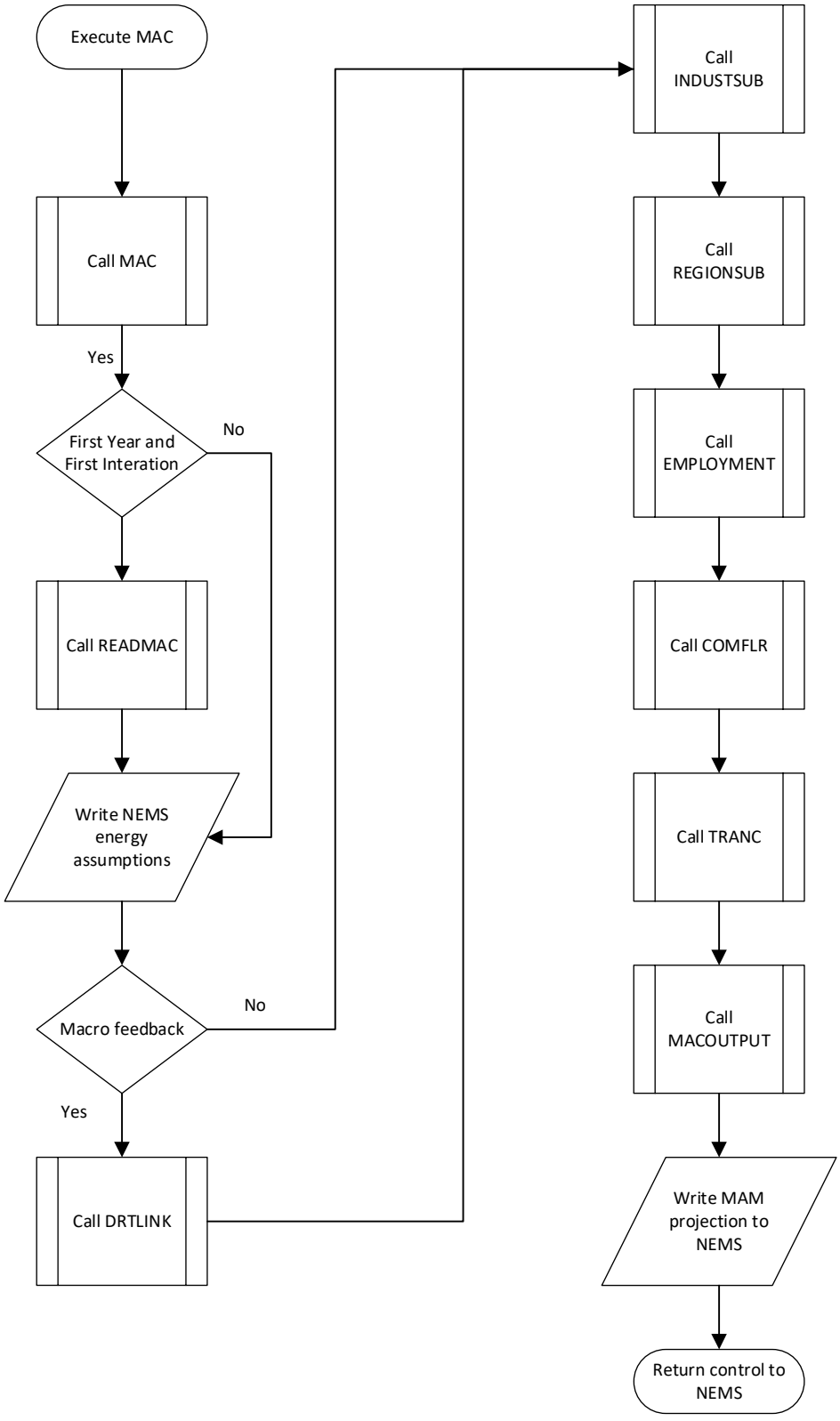
MACOUTPUT subroutine

After the TRANC subroutine executes, program control is returned to the MAC subroutine, which writes all of the MAM projections to NEMS for other modules to use, including the report writer. The MAC subroutine then calls the final MAM subroutine, MACOUTPUT. Figure 16 shows the flow of control within MACOUTPUT. The MACOUTPUT subroutine records the activities of the MAM for a NEMS run in the following five output text files:

- **MC_COMMON**—Contains projected values of variables written to NEMS from IHS Markit's model of the U.S. economy and EIA's regional models. These estimates include economic activity, industrial output, employment by industry, and growth of stocks of commercial floor space. Table B14 in Appendix B on page 127 indicates the MAM variables used by other NEMS modules.
- **MC_REGIONAL**—Contains the projected values of the regional variables by census division as well as for EIA's regional models of economic activity, industrial output, and employment by industry. Table B9 in Appendix B on page 117 lists the contents of the MC_REGIONAL text file.
- **MC_INDUSTRIAL**—Contains the projection of industrial output for 48 manufacturing and nonmanufacturing industries at the census division level as well as for the United States. This file also contains a U.S. estimate for each of the 10 services. Table B6 in Appendix B on page 112 lists the contents of the MC_INDUSTRIAL text file.
- **MC_EMPLOYMENT**—Contains the employment projections from the Employment Model for the 39 manufacturing and service industries. Table B7 in Appendix B on page 114 lists the contents of the MC_EMPLOYMENT text file.
- **MC_NATIONAL**—Contains the projection of macroeconomic variables. The estimation is completed by using IHS Markit's model of the U.S. economy. Table B5 in Appendix B on page 110 lists the contents of the MC_NATIONAL text file.

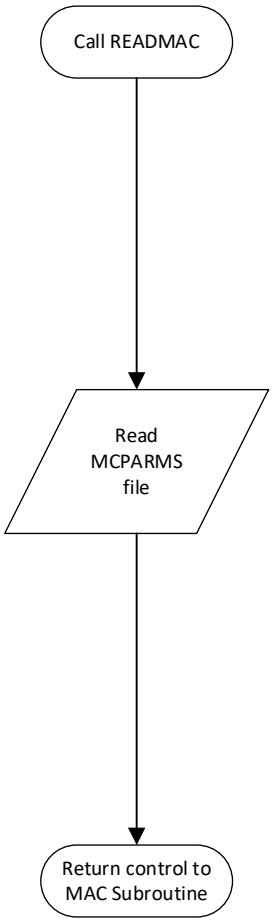
Once the last text file is written, program control is returned to the MAC subroutine, which, in turn, returns program control to NEMS.

Figure 8. Flow of control within MAM of the National Energy Modeling System (NEMS)



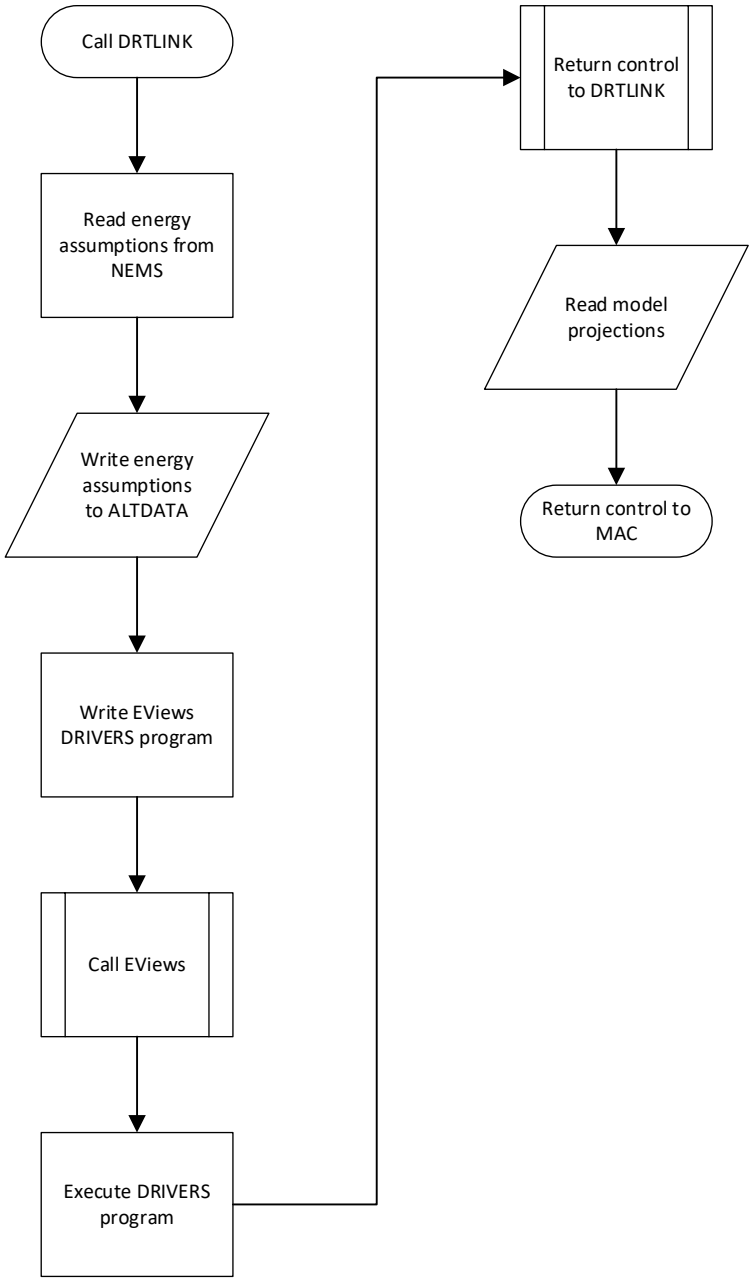
Data source: U.S. Energy Information Administration

Figure 9. Subroutine READMAC of the National Energy Modeling System (NEMS)



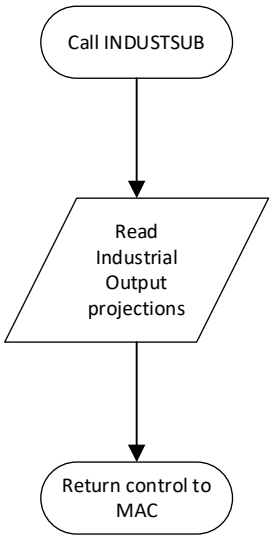
Data source: U.S. Energy Information Administration

Figure 10. Subroutine DRTLINK of the National Energy Modeling System (NEMS)



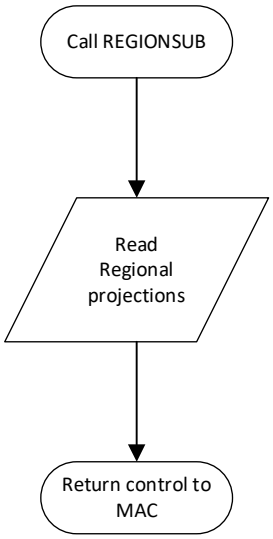
Data source: U.S. Energy Information Administration

Figure 11. Subroutine INDUSTSUB of the National Energy Modeling System (NEMS)



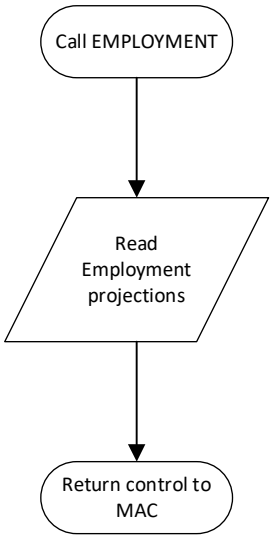
Data source: U.S. Energy Information Administration

Figure 12. Subroutine REGIONSUB of the National Energy Modeling System



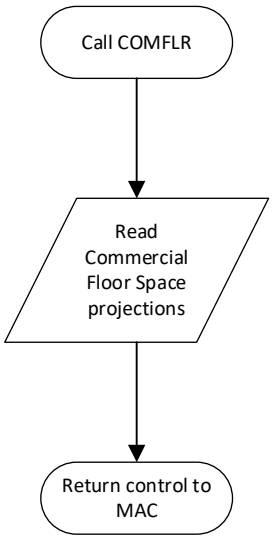
Data source: U.S. Energy Information Administration

Figure 13. Subroutine EMPLOYMENT of the National Energy Modeling System (NEMS)



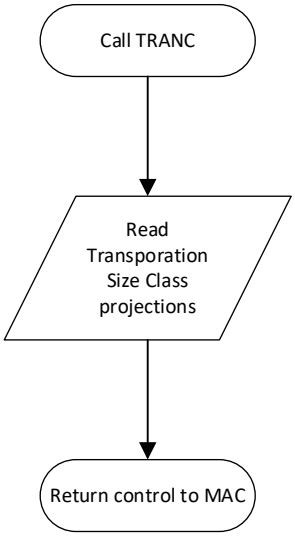
Data source: U.S. Energy Information Administration

Figure 14. Subroutine COMFLR of the National Energy Modeling System (NEMS)



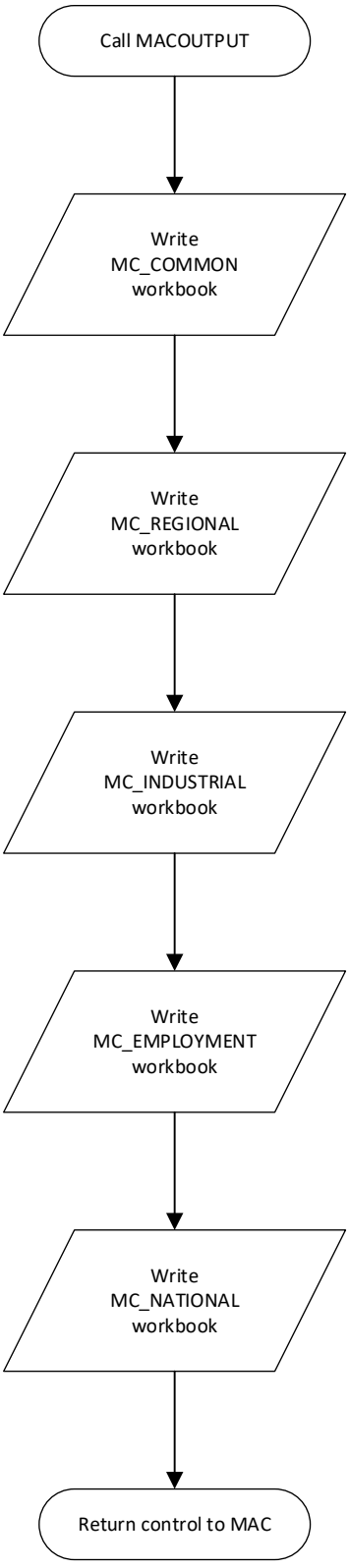
Data source: U.S. Energy Information Administration

Figure 15. Subroutine TRANC of the National Energy Modeling System (NEMS)



Data source: U.S. Energy Information Administration

Figure 16. Subroutine MACOUTPUT of the National Energy Modeling System (NEMS)



Data source: U.S. Energy Information Administration

Appendix A: Variables and Classifications in MAM Models

Macroeconomic Model detail

Table A1. Real personal consumption from the National Energy Modeling System (NEMS)

Personal consumption expenditures	**CONSR**
Durables	**CDR**
Motor vehicles and parts	CDMVR
Light vehicles	CDMVNR
Tires, tubes, accessories, and parts	CDMVPAR
Used automobiles	CDMVPUNAR
Furniture and appliances	CDFHER
Computers and software	CDRECIPR
Computers	CDRECIPPCR
Software	CDRECIPCSR
Other durable goods	CDOR
Medical devises	CDOTAER
Other recreational goods	CDRECOR
All other	CDOOR
Nondurables	**CNR**
Food	CNFR
Clothing and shoes	CNCSR
Gasoline and motor oil	CNEGAOR
Fuel oil and coal	CNEFAOR
Other nondurables	CNOR
Tobacco products	CNOTOBR
Prescription and over-the-counter drugs	CNOPMPR
All other	CNOOR
Services	**CSVR**
Housing	CSVHR
Gas	CSVUGR
Electricity	CSVUER
Telecommunications	CSVOCTR
Water and sewer	CSVUWASR
Transportation	CSVTSR
Motor vehicle leases	CSVTSMVOLSR
Other user-operated transportation	CSVTSMVXLSR
Purchased local transportation	CSVTSPUBLR
Purchased intercity transportation	CSVTSPUBOR
Medical care	CSVHCR
Recreation	CSVRECR
Accommodations	CSVACR
Food services	CSVFR
Personal business services	CSVFAINSR
Financial services charges, fees, and commissions	CSVFINFEER
Financial services furnished free	CSVFINFREER
Insurance	CSVINSR
Other services	CSVOOR

Data source: U.S. Energy Information Administration

Table A2. Real business investment from the National Energy Modeling System (NEMS)

Real private fixed nonresidential investment	**IFNRER**
Investment in nonresidential equipment	**IFNREER**
Industrial equipment	IFNREEINDR
Information processing equipment	IFNREEIPR
Computer equipment	IFNREEIPCCR
Communications equipment	IFNREEIPCTR
Other information processing equipment	IFNREEIPOR
Other equipment	IFNREEOR
Transportation equipment	IFNREETR
Real net sales of used light trucks	IFMVPUNTLR
Aircraft	IFNREETACR
Light vehicles	IFNREETLVADJR
Other transportation equipment	IFNREETOR
Investment in intellectual property products	**IFNREIPR**
Entertainment, literary, and artistic originals	IFNREIPELAR
Research and development	IFNREIPRDR
Software	IFNREIPSR
Investment in nonresidential structures including mines	**IFNRESR**
Mines and wells	IFNRESMIR
Miscellaneous nonresidential facilities	IFNRESOTHR
Communications structures	IFNRESPCR
Utilities other than communications structures	IFNRESPUOR
Nonresidential, non-farm buildings	IFNRESXFR
Other nonresidential buildings	IFNRESBOTHR
Commercial buildings	IFNRESCMLR
Industrial facilities	IFNRESMFGR
Inventory investment (change in real stock of inventories)	**IIR**
Nonfarm inventories	**IINFR**
Manufacturing	IIMR
Wholesale trade	IIWR
Retail trade	IIRTR
Retail inventories	INVRTR
Miscellaneous	IIMISCR
Construction, mining, and utilities	IICMIUR
Other business	IIOR
Farm inventories	**IIFR**

Data source: U.S. Energy Information Administration

Table A3. Real residential investment of the National Energy Modeling System (NEMS)

Housing starts including mobile homes	**HUS**
Housing starts	HUSPS
Single-family starts	HUSPS1
Multifamily starts	HUSPS2A
Mobile home shipments	HUSMFG
Housing sales	
New single-family homes for sale	HU1NFSALE
New single-family home sales	HU1NSOLD
Total existing home sales	HUESOLD
Sales of existing single-family homes	HU1ESOLD
Existing condos and co-ops sales	HUCCESOLD
Real private fixed residential investment	**IFRER**
Structures	IFRESR
Permanent site structures	IFRESPER
Single-family houses	IFRESPESFR
Multifamily structures	IFRESPEMFR
Other residential structures	IFRESOR
Manufactured homes	IFRESOMFGR
Improvements	IFRESOIMPR
Other structures	IFRESOOR
Equipment	IFREER
Nominal costs of housing	**IFNRESBOTHR**
Average sales price of existing single-family homes	PHU1EAVGNS
Median sales price of existing single-family homes	PHU1EMEDNS
Average sales price of a new 2005-style single-family home	PHU1NAVG96NS
Average sales price of new single-family homes	PHU1NAVGNS
Median sales price of new single-family homes	PHU1NMEDNS
Commitment rate on conventional 30-year mortgage – all lenders	RMMTG30CON

Data source: U.S. Energy Information Administration

Table A4. Key federal government expenditures of the National Energy Modeling System (NEMS)

Federal purchases of goods and services (real)	**GFR**
Defense	**GFMLR**
Consumption	GFMLCR
Personnel outlays	GFMLCWSSR
Consumption of fixed capital	GFMLCKFR
Other	GFMLCOR
Gross investment	GFMLGIR
Nondefense	**GFOR**
Consumption	GFOCR
Personnel outlays	GFOCWSSR
Consumption of fixed capital	GFOCKFR
Commodity Credit Corporation inventory change	GFOCINTNCCR
Other	GFOCOR
Gross investment	GFOGIR
Interest, dividends, transfer payments, subsidies, and accruals:	**IFRER**
Federal net interest payments	**INTNETGF**
Federal transfer payments	**TRFGF**
Transfers to resident persons	YPTRFGF
Non-cyclical component	YPTRFGFFE
Medicare payments	YPTRFGFSIHI
Social security payments	YPTRFGFSISS
Other	YPTRFGFFEO
Cyclical component	YPTRFGFO
Federal social benefits to rest of the world	TRFGFSIRW
Other federal transfer payments	TRFGFO
Grants-in-aid to state and local governments	GFAIDSL
Medicaid grants	GFAIDSLSSMED
Other	GFAIDSLO
Transfers to rest of the world	TRFGFORW
Subsidies	**SUBGF**
Agricultural programs	SUBGFAG
Housing subsidies	SUBGFHSNG
Other federal subsidies	SUBGFOTH

Data source: U.S. Energy Information Administration

Table A5. Key state and local government expenditure variables of the National Energy Modeling System (NEMS)

State and local purchases of goods and services (real)	**GSLR**
Consumption	**GSLCR**
Personnel outlays	GSLCWSSR
Consumption of fixed capital	GSLCKFR
All else	GSLCOR
Gross investment	**GSLGIR**
Equipment	GSLGIER
Construction	GSLGISR
Interest, dividends, transfer payments, subsidies, and accruals:	
Net interest payments	**INTNETGSL**
Transfers to individuals	**YPTRFGSL**
Medical	YPTRFGSLPAM
Non-medical	YPTRFGSLPAO
Subsidies less current surplus	**SUBLSURPGSL**
Dividends received	**YGSLADIV**

Data source: U.S. Energy Information Administration

Table A6. Components of nominal national income of the National Energy Modeling System (NEMS)

Gross National Product	GNP
Wage and salary disbursements	YPCOMPWSD
Private sector	YPCOMPWSDP
Government	YPCOMPWSDG
Excise tax receipts	TXIM
Federal	TXIMGF
State and local	TXSIGSL
Capital consumption allowances with adjustment	CKF
Private	CKFP
Corporate	CKFCORP
Non-corporate	CKFNCORP
Government	CKFG
Rental income	YPRENTADJ
Proprietors' income	
Nonfarm	YPPROPADJNF
Farm	YPPROPADJF
Corporate Profits	ZB
Business interest payments	INTNETBUS
Other labor income	YPCOMPSUPPAI
Health insurance	YPCOMPSUPPAIHI
Other benefits	YPCOMPSUPPAIO
Employer-paid payroll taxes	TXSIEC
Federal	TXSIECGF
State and local	TXSIECGSL
Subsidies less current surplus	
Federal enterprises	SUBLSURPGF
State and local government enterprises	SUBLSURPGSL
Transfer payments by business	TRFBUS
Adjustment for capital consumption allowance	CKFADJCORP
Corporate inventory valuation adjustment	IVACORP
Statistical discrepancy	STAT

Data source: U.S. Energy Information Administration

Table A7. Components of nominal personal income of the National Energy Modeling System

Personal income	YP
Wage and salary disbursements	YPCOMPWSD
Private sector	YPCOMPWSDP
Government	YPCOMPWSDG
Other labor income	YPCOMPSUPPAI
Health insurance	YPCOMPSUPPAIHI
Other benefits	YPCOMPSUPPAIO
Dividend payments to individuals	YPADIV
Transfer payments to residents	
Federal	YPTRFGF
Social Security	YPTRFGFSISS
Medicare	YPTRFGFSIHI
Other full-employment	YPTRFGFFEO
Remaining cyclical component	YPTRFGFO
State and Local	YPTRFGSL
Medical	YPTRFGSLPAM
All other	YPTRFGSLPAO
Personal interest income	YPAINT
Business transfers to individuals	YPTRFBUS
Rental income	YPRENTADJ
Proprietors' income	
Nonfarm	YPPROPADJNF
Farm	YPPROPADJF
Social insurance tax receipts from individuals	TXSIWC

Data source: U.S. Energy Information Administration

Table A8. Key variables in the tax sector of the National Energy Modeling System (NEMS)

Federal tax receipts	**TXGF**
Personal	TXPGF
Corporate	TXCORPGF
Production and imports	TXIMGF
Value-added tax (VAT)	TXIMGFVAT
Other	TXIMGFOTH
From rest of the world	TXRWGF
State and local tax receipts	**TXGSL**
Personal	TXPGSL
Corporate	TXCORPGSL
Excise	TXIMGSL
Federal average tax rates	
Personal	
Effective	RTXPGF
Marginal	RTXPMARGF
Corporate	
Statutory rate	RTXCGFS
Investment tax credits (marginal rates)	RITC
Payroll	RTXSIGF
State and local average tax rates	
Personal	RTXPGSL
Corporate	RTXCGSL
Payroll	RTXSIGSL

Data source: U.S. Energy Information Administration

Table A9. Key variables in the trade sector of the National Energy Modeling System (NEMS)

Real exports	
Goods	**XGR**
Foods, feeds, and beverages	XGFFBR
Industrial materials and supplies	XGINR
Capital goods except motor vehicles	XGKR
Aircraft	XGKCAEPR
Computer equipment	XGKCPPR
Other capital equipment	XGKOR
Motor vehicles and parts	XGAUTOR
Consumer goods except motor vehicles	XGCR
Miscellaneous goods	XGOR
Services	**XSVTOTR**
Real imports	
Goods	**MGR**
Foods, feeds, and beverages	MGFFBR
Industrial materials and supplies	MGINAPETR
Petroleum and products	MGPETR
Other	MGINR
Capital goods except motor vehicles	MGKR
Aircraft	MGKCAEPR
Computer equipment	MGKCPPR
Other capital equipment	MGKOR
Motor vehicles and parts	MGAUTOR
Consumer goods except motor vehicles	MGCR
Miscellaneous goods	MGOR
Services	**MSVTOTR**
Trade-weighted exchange rates	
With major trading partners	JEXCHMTP
With other important trading partners	JEXCHOITP
Prices	
Industrial countries	WPIWMTP
Developing countries	WPIWOITP
Lever controlling relative price impacts	TRADEPLEV
Lever controlling U.S. price feedthroughs	WPIWLEV
Output	
Real trade-weighted GDP in other industrial countries	JGDPMTPR
Real trade-weighted GDP in developing countries	JGDPOITPR
Long-term government bond yield—major trading partners	RMGBLMTP

Data source: U.S. Energy Information Administration

Table A10. Key variables in the financial sector of the National Energy Modeling System (NEMS)

Interest rates	
Federal funds rate	RMFF
Supply of reserve as instrument	RMFFRES
Reaction function as instrument	RMFFRCT
Treasury yield	
3-month bill rate	RMTB3M
6-month bill rate	RMTB6M
1-year note yield	RMTCM1Y
2-year note yield	RMTCM2Y
5-year note yield	RMTCM5Y
10-year note yield	RMTCM10Y
Long-term bond yield	RMTCM25AY
Other	
Prime rate	RMPRIME
3-month CDs, secondary market	RMCD3SEC
3-month commercial paper	RMCMLP3M
3-month Eurodollar deposits	RMEUROD3M
Rate on commercial bank loans for new light vehicles	RMCBLV
New York Fed discount rate	RMDWPRIME
11th district cost of funds	RMCOF11D
30-year mortgage rate	RMMTG30CON
Yield on Aaa corporate bonds	RMCORPAAA
Yield on Baa corporate bonds	RMCORPBAA
Rate on Aa-rated public utility bonds	RMCORPPUAA
Rate on high grade 20-year municipal bonds	RMMUNIAAA
Municipal bond buyer 20-bond index	RMMUNIBB20
Other financial variables	
Currency and travelers' checks	M1CURATC
Household net worth	HHNETW
Real estate and other nonfinancial assets	HHLB
Financial assets	HHAF
Equities	HHAFEQ
Money	HHAFM
Other	HHAFO
Home mortgages outstanding	MTGHO
Non-mortgage consumer credit	LCNMTGO
Business loans at commercial banks	LCBCAI
S&P 500 stock index	SP500
Wilshire 5000 stock index	WL5000

Data source: U.S. Energy Information Administration

Table A11. Macroeconomic expenditure categories driving the Industrial Output Model of the National Energy Modeling System (NEMS)

Variable	Description
Personal consumption expenditures	
CDRECIPR	Real consumer spending on computers and software
CDFHER	Real consumer spending on furniture and appliances
CDMVR	Real consumer spending on light vehicles
CDMVPAR	Real consumer spending on motor vehicle parts
CDOR	Real consumer spending on other durables plus medical devices
CDRECOR	Real consumer spending on other recreational goods and vehicles
CNCSR	Real consumer spending on clothing and shoes
CNEFAOR	Real consumer spending on fuel oil and coal
CNEGAOR	Real consumer spending on gasoline and motor oil
CNFR	Real consumer spending on off-site food and beverage
CNOPMPR	Real consumer spending on prescription and over-the-counter drugs
CNOTOBR	Real consumer spending on tobacco products
CNOOR	Real consumer spending on other nondurable goods
CSVUR	Real consumer spending on utilities
CSVFAACR	Real consumer spending on food services and accommodations
CSVHR	Real consumer spending on housing
CSVHCR	Real consumer spending on medical services
CSVFINR	Real consumer spending on financial services
CSVRECR	Real consumer spending on recreation services
CSVTSPUBR	Real consumer spending on public transportation
CSVTSMVXLSR	Real consumer spending on other user-operated transportation
CSVTSMVOLSR	Real consumer spending on motor vehicle leases
CSVOOR	Real consumer spending on other services
Investment and inventories	
IFMVNATLR	Real gross investment purchases of light vehicles
IFNREEINDR	Real gross nonresidential investment in industrial equipment
IFNREEIPCCR	Real gross nonresidential investment in computer equipment
IFNREIPSR	Real gross nonresidential investment in software
IFNREEIPCTR	Real gross nonresidential investment in communications equipment
IFNREEIPOR	Real gross nonresidential investment in other information processing equipment
IFNREETACR	Real gross nonresidential investment in aircraft
IFNREETOR	Real gross nonresidential investment in other transportation equipment
IFNREEOR	Real gross nonresidential investment in other transportation equipment
IFSR	Real gross investment in all structures
IIR	Real change in stock of business inventories
Government spending	
GFMLGIR	Real federal defense gross investment
GFMLR	Real federal defense purchases of goods and services
GFOGIR	Real federal non-defense gross investment
GFOR	Real federal non-defense purchases of goods and services
GSLGIR	Real state and local gross investment
GSLR	Real state and local purchases of goods and services
Exports	
XGAUTOR	Real exports of motor vehicles and parts
XGCR	Real exports of non-automotive consumer goods

Variable	Description
XGFFBR	Real exports of foods, feeds, and beverages
XGINR	Real exports of industrial materials and supplies
XGKCAEPR	Real exports of aircraft
XGKCPPR	Real exports of computer equipment
XGKOR	Real exports of other capital equipment
XGOR	Real exports of other goods
XSVTOTR	Real exports of services
Imports	
MGAUTOR	Real imports of motor vehicles and parts
MGCR	Real imports of non-automotive consumer goods
MGFFBR	Real imports of foods, feeds, and beverages
MGINR	Real imports of industrial supplies, excluding petroleum
MGKCAEPR	Real imports of aircraft
MGKCPPR	Real imports of computer equipment
MGKOR	Real imports of other capital equipment
MGPETR	Real imports of petroleum and products
MGOR	Real imports of other goods
MSVTOTR	Real imports of services

Data source: U.S. Energy Information Administration

The following prefixes are used in NEMS:

- The industrial output series has an *rr* prefix (for example, rr111).
- The employment series has *e* as a prefix (for example, enrm111).
- The MAM variable names for output values have an *REV* prefix (for example, REVIND1).
- The MAM variable names for employment have an *EMP* prefix (for example, EMPIND1).

The MAM variables are placed into three NEMS variables: MC_REVIND (output of industrial sectors), MC_REVSER (output of services sectors), and MC_EMPNA (employment).

Table A12. Detailed sector classification for industry and employment models of the National Energy Modeling System (NEMS)

US model code	Description	NAICS (2012) codes	NEMS sector (Emp/IO)
Manufacturing industries			
311	Food products	311	IND1/1
3112	Grain and oilseed milling	3112	IND1/2
3115	Dairy products	3115	IND1/3
3116T7	Animal slaughtering and seafood products	3116-7	IND1/4
311O	Remaining food products codes	3111, 3113-4, 3118-9	IND1/5
312	Beverage and tobacco products	312	IND2/6
313T316	Textile mills and products, apparel, and leather products	313-6	IND3/7
321	Wood products	321	IND4/8
337	Furniture and related products	337	IND5/9
322	Pulp and paper products	322	IND6/10
3221	Pulp, paper, and paperboard mills	3221	IND6/11
32221	Paperboard container manufacturing	32221	IND6/12
322O	Other paper manufacturing	32222-9	IND6/13
323	Printing	323	IND7/14
32512T8	Basic inorganic chemicals	32512-8	IND8/15
32511A9	Basic organic chemicals	32511, 32519	IND8/16
325193	Ethanol	321593	IND8/17
3252	Resins, synthetic rubber, and synthetic fibers	3252	IND8/18
3253	Pesticide, fertilizer, and other agricultural chemicals	3253	IND8/19
3254T9	Other chemical products	3254–3259	IND9/20
3254	Pharmaceuticals and medicines	3254	IND9/21
3255	Paints, coatings, and adhesives	3255	IND9/22
3256	Soaps and cleaning products	3256	IND9/23
325O	Other chemicals	3259	IND9/24
32411	Petroleum refineries	32411	IND10/25
324O	Other petroleum and coal products manufacturing	32412, 32419	IND10/26

US model code	Description	NAICS (2012) codes	NEMS sector (Emp/IO)
326	Plastics and rubber products	326	IND11/27
3272	Glass and glass products	3272	IND12/28
327211	Flat glass manufacturing	327211	IND12/29
32731	Cement	32731	IND12/30
3274	Lime and gypsum	3274	IND12/31
327O	Other non-metallic mineral products	3271, 32732-32739, 3279	IND12/32
3311A2	Iron and steel mills and ferroalloy and steel products	3311-2	IND13/33
3313	Alumina and aluminum products	3313	IND13/34
3314A5	Other primary metals	3314-5	IND13/35
332	Fabricated metal products	332	IND14/36
333	Machinery	333	IND15/37
334	Computer and electronic products	334	IND16/38
336	Transportation equipment	336	IND17/39
335	Electric equipment and appliances	335	IND18/40
339	Miscellaneous durable products	339	IND19/41
Nonmanufacturing industries			
Agriculture, animal, forestry, and other			
111	Crop production	111	IND20/42
112	Animal production	112	IND21/43
113	Forestry and logging	113	IND21/44
11O	Agriculture, other	114-5	IND21/44
Mining			
2121	Coal mining	2121	IND22/45
211A3	Oil and gas extraction and support activities (drilling)	211, 213	IND23/46
2122	Metal ore mining	2122	IND24/47
2123	Nonmetallic mineral mining	2123	IND24/47
Construction			
23	Construction	23	na/48
2361	Construction residential buildings	2361	IND25/na
2362	Construction nonresidential buildings	2362	IND26/na
23O	Construction excluding residential and nonresidential	23O	IND27/na
Services			
Transportation			
48A9	Transportation and warehousing	48, 49	SER6/1
515	Broadcasting (except internet)	515	SER8/2
517	Telecommunications	517	SER9/2
Utilities			

US model code	Description	NAICS (2012) codes	NEMS sector (Emp/IO)
2211	Power generation and supply	2211	SER1/3
2212	Natural gas distribution	2212	SER2/4
2213	Water, sewage, and related systems	2213	SER3/5
Wholesale and retail trade			
42	Wholesale trade	42	SER4/6
44A5	Retail trade	44, 45	SER5/7
Other services			
52	Finance and insurance	52	SER10/8
53	Real estate and rental and leasing	53	SER11/8
511	Newspaper, periodicals, book, and directory publishers	511	SER7/9
SERV	Other private services	5112, 512, 514, 54-81	SER12/9
921	Federal government	921	SER12/10
922A3	State and local government	922, 923	SER12/10

Data source: U.S. Energy Information Administration

Notes: "US model code" is the NAICS code used to identify industries in the IHS Markit US model.
"EMP/IO" stands for employment and industrial output.

Regional Model detail

Table A13. Regional economic variables of the National Energy Modeling System (NEMS)

Variable	Description
CPI	Consumer price index, all urban, 1982−84 = 1.0
YPDR	Real disposable personal income, billions of chained 2012 dollars
YPCOMPWSD	Wage and salary disbursements, billions of nominal dollars
YP	Personal income, billions of nominal dollars
HUSMFG	Shipments of mobile homes, millions of units
HUSPS1	Single-family housing starts, millions of units
HUSPS2A	Multifamily housing starts, millions of units
KHUMFG	Stock of mobile homes, millions of units
KHUPS1	Stock of single-family housing, millions of units
KHUPS2A	Stock of multifamily housing, millions of units
NP	Total population, including armed forces overseas, millions
NP16A	Population aged 16 and over, millions
RWM	Average annual manufacturing wages, thousands of nominal dollars
RWNM	Average annual nonmanufacturing wages, thousands of nominal dollars

Data source: U.S. Energy Information Administration

Table A14. Regional industry output and employment of the National Energy Modeling System (NEMS)

NEMS Sector (Emp/IO)	Description	NAICS (2012) codes
Manufacturing industries:		
IND1	Food products	311
IND1/2	Grain and oilseed milling	3112
IND1/3	Dairy products	3115
IND1/4	Animal slaughter and seafood products	3116–7
IND1/5	Other food products	3111, 3–4, 8–9
IND2/6	Beverage and tobacco products	312
IND3/7	Textile, apparel, and leather	313–316
IND4/8	Wood products	321
IND5/9	Furniture and related products	337
IND6/10	Paper products	322
IND6/11	Pulp and paper mills	3221
IND6/12	Paperboard containers	32221
IND6/13	Other paper products	32222–9
IND7/14	Printing	323
IND8/15	Basic inorganic chemicals	32512–32518
IND8/16	Basic organic chemicals	32511, 32519
IND8/17	Ethanol	325193
IND8/18	Resins and synthetics	3252
IND8/19	Agricultural chemicals	3253
IND9/20	Other chemical products	3254–3259
IND9/21	Pharma products	3254
IND9/22	Paint products	3255
IND9/23	Soaps and cleaning products	3256
IND9/24	Other chemical products	3259
IND10/25	Petroleum refining	32411
IND10/26	Other petroleum and coal products	32412, 32419
IND11/27	Plastics and rubber products	326
IND12/28	Glass and glass products	3272
IND12/29	Flat glass	327211
IND12/30	Cement manufacturing	32731
IND12/31	Lime manufacturing	3274
IND12/32	Other non-metallic mineral products	327 less 3272, 3274, and 32731
IND13/33	Iron and steel products	3311, 3312
IND13/34	Alumina and aluminum products	3313
IND13/35	Other primary metals	3314, 3315
IND14/36	Fabricated metal products	332

NEMS Sector (Emp/IO)	Description	NAICS (2012) codes
IND15/37	Machinery	333
IND16/38	Computers and electronic products	334
IND17/39	Transportation equipment	336
IND18/40	Appliance and electrical equipment	335
IND19/41	Miscellaneous manufacturing	339
Nonmanufacturing industries:		
IND20/42	Crop production	111
IND21/43	Animal production	112
IND21/44	Other agriculture	113–115
IND22/45	Coal mining	2121
IND23/46	Oil and natural gas extraction and support activities	211, 213
IND24/47	Other mining and quarrying	2122, 2123
INDX/48	Construction	23
IND25/X	Construction of buildings	236
IND26/X	Heavy and civil engineering construction	237
IND27/X	Specialty trade contractors	238
Services:		
SER6/1	Transportation and warehousing	48, 49
SERX/2	Broadcasting and telecommunications	515, 517
SER7/X	Publishing Industries except internet	511
SER8/X	Broadcasting except internet	515
SER9/X	Telecommunications	517
SER1/3	Electric power generation and distribution	2211
SER2/4	Natural gas distribution	2212
SER3/5	Water, sewage, and related systems	2213
SER4/6	Wholesale trade	42
SER5/7	Retail trade	44, 45
SERX/8	Finance and insurance, real estate	52, 53
SER12/9	Other services	51, 54–81
SER12/10	Public administration	921, 922, 923
SER10/X	Finance and insurance	52
SER11/X	Real estate and rental/leasing	53

Data source: U.S. Energy Information Administration
Notes: “EMP/IO” stands for employment and industrial output.

Table A15. Commercial floor space types of the National Energy Modeling System (NEMS)

Code	Description
STORES	Stores and restaurants
WARE	Manufacturing and wholesale trade, public and federally owned warehouses
OFFICE	Private, federal, and state and local offices
AUTO	Auto service and parking garages
MFG	Manufacturing
EDUC	Primary, secondary and higher education
HEALTH	Health—hospitals and nursing homes
PUB	Federal and state and local government
REL	Religious
AMUSE	Amusement
MISCNR	Miscellaneous, non-residential—transportation related and all other not elsewhere classified
HOTEL	Hotels and motels
DORM	Dormitories, educational and federally owned (primarily military)

Data source: U.S. Energy Information Administration

Appendix B: MAM Inputs and Outputs

Introduction

Appendix B describes the inputs, parameters, and files required to execute the Direct Link, Industrial Output, Employment, Regional, Commercial Floor Space, and Transportation models of the Macroeconomic Activity Module (MAM). This appendix also presents the primary outputs generated by the MAM for the benefit of NEMS and of the MAM output files. The Direct Link subroutine of MAM uses IHS Markit's model of the U.S. economy. EIA staff and contract support developed the remaining models of the MAM. These include models of industrial output, regional economic activity, industrial output and employment, growth of regional stocks of commercial floor space, and unit sales of light trucks. Unlike the IHS Markit's model of the U.S. economy, the EIA models are not proprietary. Table B1 identifies the files the MAM uses and creates during the execution of the NEMS. The table also indicates whether each file is an input or an output file and describes its contents.

Inputs

Table B2 describes the MAM parameters and controls specified at the start of a NEMS run. They include user-specified modeling switches and array dimensions used in MAM's FORTRAN source code. The user-specified switches enable the modeler to choose among alternative assumptions for the base or alternative case.

Inputs from NEMS

Before the MAM executes IHS Markit's model of the U.S. economy in EViews, 122 energy assumptions are computed using inputs from the NEMS. These energy assumptions are exogenous to the MAM models. Table B3 lists and defines these energy assumptions. For each, the IHS Markit model of the U.S. economy mnemonic is given along with its definition. The final column of Table B3 lists the NEMS variables used to calculate the corresponding IHS Markit variable.

The MAM also calculates gross industrial output growth rates for the energy sectors (petroleum refining, coal mining, oil and natural gas extraction, electric utilities, and natural gas utilities) based on physical activity for the appropriate NEMS supply or conversion modules and then applies them to the historical output series in the Industrial Output Model. Table B4 describes the NEMS variables used to calculate the growth rates for each sector.

Outputs

Table B5 lists the U.S. Macroeconomic Module outputs returned to the MAM from EViews. Annual data beginning in 1990 and estimated through 2050 are recorded in the spreadsheet named MC_NATIONAL.

Table B6 defines industrial gross output variables contained within the Industrial Output Model of the MAM. Projected growth rates of the five energy industry sectors are replaced by the NEMS results. MC_INDUSTRIAL is a spreadsheet that presents the history and projections of industrial output by sector for the nine census divisions and for the United States.

Table B7 defines the employment variables. Historical and estimated values for the detailed industrial sectors and aggregates are shown in the MC_EMPLOYMENT spreadsheet.

Table B8 defines the light-truck variables contained in the TRANC subroutine of the MAM. Annual data beginning in 1990 and estimated through 2050 are recorded in the spreadsheet named MC_VEHICLES.

Regional data and commercial floor space data produced by the Regional Model and the Commercial Floor Space Model of the MAM are presented in the MC_REGIONAL spreadsheet. Table B9 describes the regions and variables contained in that spreadsheet. The same regional projections for economic activity, commercial floor space, employment, and industrial output contained in the MC_REGIONAL spreadsheet are also found in the MC_REGMAC, MC_COMMFLR, MC_REGEMP, and MC_REGIO spreadsheets, respectively. Table B10 describes the regions and variables contained in the output spreadsheet MC_REGMAC for EIA's Regional Economic Activity Model. Table B11 describes the regions and variables contained in the output spreadsheet MC_COMMFLR for EIA's Regional Commercial Floor Space Model. Table B12 describes the regions and variables contained in the output spreadsheet MC_REGEMP for EIA's Regional Employment Model. Table B13 describes the regions and variables contained in the output spreadsheet MC_REGIO for EIA's Regional Industrial Output Model.

Table B14 lists the MACOUT common block variables referenced by other NEMS modules. The final column lists the referencing NEMS modules. A description of the module abbreviations follows Table B14.

Table B1. Macroeconomic Activity Module (MAM) input and output files of the National Energy Modeling System (NEMS)

Filename	Content	Input or output
ALTDATA.CSV	NEMS energy price and quantity data used as MAM drivers	Input
COMFLOOR.XLS	Data for EIA's Regional, Industrial Output, and Employment Models	Input
DRIVERS.PRG	Run-specific EViews program file	Input
DRVDATA.WF1	EViews workfile of annual frequency	Input
EPMAC.CSV	Projection of Macroeconomic, Industrial Output, and Employment Models in levels	Input
EVIEWSDB.EDB	Intermediary database for workfiles of annual and quarterly frequency	Input
MC_COMMFLR.CSV	Regional Commercial Floor Space Model solution	Output
MC_COMMON.CSV	MAM projections written to Global Data Structure	Output
MC_DETAIL.CSV	Detailed U.S. Macroeconomic Model solution	Output
MC_EMPLOYMENT.CSV	U.S. Employment Model solution and base	Output
MC_ENERGY.CSV	NEMS energy variables read from Global Data Structure	Output
MC_INDUSTRIAL.CSV	U.S. Industrial Output Model solution and base	Output
MC_NATIONAL.CSV	U.S. Macroeconomic Model solution, base, and percentage change from base	Output
MC_REGEMP.CSV	Regional Employment Model solution	Output
MC_REGIO.CSV	Regional Industrial Output Model solution	Output
MC_REGIONAL.CSV	Regional Model solution and base	Output
MC_REGMAC.CSV	Regional Economic Model solution and base	Output
MC_VEHICLES.CSV	Light truck Unit Sales Model solution	Output
MCEVCODE.TXT	Generic EViews program file used to create run-specific drivers program file	Input
MCEVRGMD.WF1	Regional Economic Model	Input/Output
MCEVSUBS.PRG	EViews subroutines	Input
MCEVWORK.WF1	U.S. Macroeconomic Model	Input/Output
MCHIGHLO.XLS	High and low economic activity model factors and transportation model size class data	Input
MCPARMS.TXT	Parameters	Input
MCREGIND.WF1	Regional Industrial Output and Employment Models	Output
MC_XTABS.CSV	Detailed projection of U.S. economic activity	Output

Data source: U.S. Energy Information Administration

File extension key

File extension	File type
EDB	EViews database
PRG	EViews program file
TXT	Text file
WF1	EViews workfile
CSV	Comma Separated text file
XLS	Microsoft Excel file

Table B2. Macroeconomic Activity Module (MAM) input controls and parameters of the National Energy Modeling System (NEMS)

Parameter Name	Input Type (filename)	Input Description
CAFÉ	User-defined parameter (SCEDES)	Unit cost of automobiles under new CAFE standards, 0=No change from baseline, 1=factor cost determined by NEMS TRAN results
CONTROLTARGET=1	MAM parameter (MCPARMS)	Commercial floor space add factor switch 1=ON 0=OFF
EVVERS	Run-time option (SCEDES)	Version of EViews used in simulation; 10 = v.10
EXM	Run-time option (SCEDES)	MAM Module Switch, 1 = on, 0 = off
GISWITCH=-1	MAM parameter (MCPARMS)	IHS Markit Scenario Switch: ”1:”FF; ”="_0”; 1=”_pes”; 2=”_opt”; 3="_cyc"
MACFDBK	Run-time option (SCEDES)	Macroeconomic feedback lever, 1 = on, 0 = off
MACTAX	User-defined parameter (SCEDES)	Distribution of energy tax, 0=No distribution, other parameter values defined according to requirements of study
MCNMFLTYPE=9	MAM parameter (MCPARMS)	Number of commercial floor space types, including total
MCNMIND=48	MAM parameter (MCPARMS)	Number of regionalized industry output variables
MCNMMAC=75	MAM parameter (MCPARMS)	Number of non-regionalized macroeconomic variables
MCNMMACREG=73	MAM parameter (MCPARMS)	Number of regionalized macroeconomic variables
MCNMNATREG=14	MAM parameter (MCPARMS)	Number of regionalized macroeconomic variables
MCNMSERV=10	MAM parameter (MCPARMS)	Number of non-regionalized service output variables
MCNUMMNF=41	MAM parameter (MCPARMS)	Number of manufacturing industry variables
MCNUMREGS=11	MAM parameter (MCPARMS)	The nine census divisions, a placeholder for California (currently not in use), and the national total of all census divisions
MMAC	Run-time option (SCEDES)	Macroeconomic growth scenario: 1 = Low, 2 = Reference, 3 = High
NEMSENERGYNUM=362	MAM parameter (MCPARMS)	Number of exogenous variables (aggregates and components) from NEMS
NUMEMPL=39	MAM parameter (MCPARMS)	Number of industrial employment categories
NUMEPMAC=186	MAM parameter (MCPARMS)	Number of solution variables returned to MAM from EViews

Parameter Name	Input Type (filename)	Input Description
NUMGIXTAB=206	MAM parameter (MCPARMS)	Number of variables for extra IHS Markit tables
NUMXTABS=158	MAM parameter (MCPARMS)	Number of solution variables returned to NEMS for extra macro tables
SCENNUM=164	MAM parameter (MCPARMS)	Number of driver variables passed to EViews models from MAM
TTECH	User-defined parameter (SCEDES)	Technology scenario: 1 = Low, 2 = Reference, 3 = High

Data source: U.S. Energy Information Administration

Table B3. NEMS input variables for Macroeconomic Activity Module (MAM) national model of the National Energy Modeling System (NEMS)

MAM variable name	Definition	NEMS variable name and source
CNEFAOR	Consumption of household fuel oil	**QBLK common block** QTPRS-Total petroleum, residential
CNEGAOR	Consumption of consumer gasoline and oil	**QBLK common block** QDSTR-Distillate, transportation QETTR-Ethanol, transportation QMGTR-Motor gasoline, transportation
CSVUER	Consumption of household electricity	**QBLK common block** QELRS-Electricity, residential
CSVUGR	Consumption of household natural gas	**QBLK common block** QNGRS-Natural gas, residential
DALLFUELSBIO	Total demand for biofuels	**CONVFACT common block** CFBIOBUTE–Biobutanol CFBIOD–Biodiesel CFBTLLIQ–Liquids from biomass CFCORN–Corn CFPET–Pure ethanol CFVEGGIE–Biodiesel to vegetable oil **LFMMOUT common block** CORNCD–Corn consumption RFBIOBUTECD–Production of biobutanol **PMMOUT common block** BTLFRAC–Biomass-to-liquids (BTL) liquid component produced CBTLFRAC–Liquids produced from coal/biomass combo plant CFCBTLLIQ–Liquids from coal and biomass QBMRFBTL–Quantity of biomass for BTL UBAVOL–Upgraded bio-oil A7 **PMMRPT common block** BIMQTYCD–Quantity biodiesel produced CLLETHCD–Ethanol produced from cellulose CRNETHCD–Ethanol produced from corn OTHETHCD–Advanced ethanol **QBLK common block**

MAM variable name	Definition	NEMS variable name and source
		QBMAS–Biomass, all sectors QBMRF–Biomass, refinery
DALLFUELSCOAL	Total demand for coal	**CONVFACT common block** CFNGC–Natural gas consumption **NGTDMREP common block** OGSUPGAS–Supplemental natural gas supplies **QBLK common block** QCIIN–Net coal coke imports, industrial QCLAS–Coal, all sectors QMCIN–Metallurgical coal, industrial
DALLFUELSNG	Total demand for natural gas	**CONVFACT common block** CFGTLLIQ–Liquids from gas CFNGN–Natural gas, non-utility consumption **QBLK common block** QGPTR–Natural gas, pipeline QHYTR –Liquid hydrogen, transportation QLPIN–Natural gas, lease and plant fuel QNGAS–Natural gas, all sectors QNGLQ–Natural gas used for liquefaction
DALLFUELSOO	Total demand for other fuels	**QBLK common block** QBMAS–Biomass, all sectors QEIEL–Electricity imports QETTR–Ethanol, transportation QGERS–Geothermal, residential QHOAS–Hydropower, all sectors QHYTR–Liquid hydrogen, transportation QPVCM–Photovoltaic, commercial QPVRS–Photovoltaic, residential QSTCM–Solar thermal, commercial QSTRS–Solar thermal, residential QTRAS–Total renewables, all sectors QUREL–Uranium, electricity **WNCMSEL common block** WNCMSEL–Util municipal solid waste non-bio consumption
DALLFUELSPET	Total demand for petroleum	**QBLK common block** QETTR–Ethanol, transportation QMETR–Methanol, transportation

MAM variable name	Definition	NEMS variable name and source
		QTPAS–Total petroleum, all sectors
DENDUBIO	End-use demand for biofuels	**CONVFACT common block** CFBIOBUTE-Biobutanol CFBIOD–Biodiesel CFCORN-Corn, bushels to British thermal units CFGTLLIQ–Liquids from gas CFNGC–Natural gas consumption CFNGN–Natural gas, non-utility consumption CFPET–Pure ethanol CFVEGGIE-Biodiesel to vegetable oil **LFMMOUT common block** CORNCD-Corn consumption RFBIOBUTECD–Production of biobutanol **NGTDMREP common block** OGSUPGAS–Supplemental natural gas supplies **PMMOUT common block** BTLFRAC–BTL liquid component produced CBTLFRAC–Liquids produced from coal and biomass combo plant CFCBTLLIQ–Liquids from coal and biomass QBMRFBTL–Quantity of biomass for BTL UBAVOL–Upgraded bio-oil A7 **PMMRPT common block** BIMQTYCD-Quantity of biodiesel produced by type CLLETHCD–Ethanol produced from cellulose CRNETHCD–Ethanol produced from corn OTHETHCD–Advanced ethanol **QBLK common block** QBMAS-Biomass, all sectors QBMAS-Biomass, all sectors QBMRF-Biomass, refinery QCIIN–Net coal coke imports, industrial

MAM variable name	Definition	NEMS variable name and source
		QCLAS–Coal, all sectors QETTR–Ethanol, transportation QGERS-Geothermal, residential QGPTR–Natural gas, pipeline QHOAS–Hydropower, all sectors QHYTR –Liquid hydrogen, transportation QLPIN–Natural gas, lease and plant fuel QMCIN–Metallurgical coal, industrial QMETR–Methanol, transportation QNGAS–Natural gas, all sectors QNGLQ–Natural gas used for liquefaction QPVCM-Photovoltaic, commercial QPVRS-Photovoltaic, residential QSTCM-Solar thermal, commercial QSTRS-Solar thermal, residential QTPAS–Total petroleum, all sectors QTRAS-Total renewables, all sectors QUREL-Uranium, electricity **WRENEW common block** WNCMSEL-Util, MSW non-bio consumption
DENDUCOAL	End-use demand for coal	**QBLK common block** QCIIN-Net coal coke imports, industrial QCLAS-Coal, all sectors QCLEL-Coal, electricity generation QMCIN-Metallurgical coal, industrial
DENDUELC	Electricity sales to ultimate consumers	**QBLK common block** QELAS-Purchased electricity, all sectors
DENDUNG	End-use demand for natural gas	**QBLK common block** QGPTR-Natural gas, pipeline, transportation QLPIN-Lease and plant fuel, industrial QNGAS-Natural gas, all sectors QNGEL-Natural gas, electricity
DENDUPET	End-use demand for petroleum	**QBLK common block** QASIN-Asphalt and road oil, industrial QDSAS-Distillate, all sectors QDSEL-Distillate, electricity QJFTR-Jet fuel, transportation QKSAS-Kerosene, all sectors

MAM variable name	Definition	NEMS variable name and source
		QLGAS-Liquefied petroleum gases, all sectors QMGAS-Motor gasoline, all sectors QOTAS-Other petroleum, all sectors QPCIN-Petroleum coke, industrial QPFIN-Petrochemical feedstocks, industrial QRSAS-Residual fuel, all sectors QRSEL-Residual fuel, electricity QSGIN-Still gas, industrial
ENDUSEPCCOAL	Steam coal share in electrical generation	**QBLK common block** QCLE -Coal, electricity generation QEIEL-Net electricity imports QTSEL-Total energy consumption-electric power
ENDUSEPCNG	Natural gas share in electrical generation	**QBLK common block** QEIEL-Net electricity imports QNGEL-Electricity, natural gas QTSEL-Total energy consumption-electric power
ENDUSEPCPET	Distillate and residual fuel oil share in electrical generation	**QBLK common block** QDSEL-Distillate, electricity QEIEL-Net electricity imports QRSEL -Residual fuel, electricity QTSEL-Total energy consumption-electric power
ENGDOMBIO	Domestic production of energy from biomass	**CONVFACT common block** CFCORN-Corn, bushels to British thermal units CFVEGGIE-Biodiesel to vegetable oil **LFMMOUT common block** CORNCD-Corn consumption **PMMFTAB common block** SBO2GDTPD-Soy bean oil to green diesel WGR2GDTPD-White grease to green diesel YGR2GDTPD-Yellow grease to green diesel **PMMOUT common block** QBMRFBTL-Biomass for BTL **PMMRPT common block**

MAM variable name	Definition	NEMS variable name and source
		BIMQTYCD-Quantity of biodiesel produced by type **QBLK common block** QBMAS-Biomass, all sectors QBMRF-Biomass, refinery
ENGDOMCOAL	Domestic production of energy from coal	**COALREP common block** CQSBB-Coal production WC_PROD_BTU-WC distribution including exports
ENGDOMNG	Domestic production of energy from natural gas	**CONVFACT common block** CFNGL-Natural gas liquids (NGL) **PMMOUT common block** RFPQNGL-Price and quantity of NGL
ENGDOMOO	Domestic production of energy from other fuels	**CONVFACT common block** CFCRDDOM-Domestic crude oil production CFMEQT-Methanol CFRSQ-Residual fuel CFVEGGIE-Convert biodiesel output to vegetable oil input **PMMFTAB common block** RFHCXH2IN-Hydrogen from natural gas input to refinery RFMETM85-Production of M85 SBO2GDTPD-Soy bean oil to green diesel WGR2GDTPD-White grease to green diesel YGR2GDTPD-Yellow grease to green diesel **QBLK common block** QBMAS-Biomass, all sectors QETTR-Ethanol, transportation QGERS-Geothermal, residential QHOAS-Hydropower, all sectors QPVCM-Photovoltaic, commercial QPVRS-Photovoltaic, residential QSTCM-Solar thermal, commercial QSTRS-Solar thermal, residential QTRAS-Total renewables, all sectors QUREL-Uranium, electricity **WRENEW common block**

MAM variable name	Definition	NEMS variable name and source
		WNCMSEL-Util, MSW non-bio consumption
ENGDOMPET	Domestic production of energy from petroleum	**CONVFACT common block** CFCRDDOM-Domestic crude production **PMMOUT common block** RFQTDCRD-Production of crude oil
ENGEXPBIO	Exports of biofuels	**CONVFACT common block** CFBIOBUTE–Biobutanol CFBIOD–Biodiesel CFPET–Pure ethanol **LFMMOUT common block** BIOBUTEEXP–Exports of biobutanol **PMMRPT common block** BIODEXP–Biodiesel exports ETHEXP–Ethanol exports
ENGEXPCOAL	Exports of coal	**COALOUT common block** CQDBFB–Imports, exports, and stock changes
ENGEXPNG	Exports of natural gas	**CONVFACT common block** CFNGE–Natural gas exports **NGTDMREP common block** NGEXPVOL–Total export volumes
ENGEXPOO	Exports of other fuels	**COALOUT common block** CQDBFB–Imports, exports, and stock changes **CONVFACT common block** CFBIOBUTE–Biobutanol CFBIOD–Biodiesel CFCRDEXP–Crude oil exports CFEXPRD–Refined petroleum product exports CFNGE–Natural gas exports CFPET–Pure ethanol **LFMMOUT common block** BIOBUTEEXP–Exports of biobutanol NGEXPVOL–Total export volumes **PMMRPT common block** BIODEXP–Biodiesel exports ETHEXP–Ethanol exports RFQEXCRD–Crude oil exported RFQEXPRDT–Crude oil exported

MAM variable name	Definition	NEMS variable name and source
ENGEXPPET	Exports of petroleum	**CONVFACT common block** CFCRDEXP–Crude oil exports CFEXPRD–Refined petroleum product exports **PMMRPT common block** RFQEXCRD–Crude oil exported RFQEXPRDT–Crude oil exported
ENGIMPBIO	Exports of biofuels	**CONVFACT common block** CFBIOBUTE–Biobutanol CFBIOD–Biodiesel CFPET–Pure ethanol **LFMMOUT common block** BIOBUTEIMP–Imports of biobutanol **PMMRPT common block** BIODIMP–Biodiesel imports ETHIMP–Ethanol imports
ENGIMPCOAL	Imports of coal	**COALOUT common block** CQDBFB–Imports, exports, and stock changes
ENGIMPNG	Imports of natural gas	**CONVFACT common blocks** CFNGI–Natural gas imports **NGTDMREP common block** NGIMPVOL–Total import volumes
ENGIMPOO	Imports of other fuels	**QBLK common block** QCIIN–Net coal coke imports, industrial QEIEL–Electricity imports
ENGIMPPET	Imports of petroleum	**CONVFACT common block** CFCBOB –Conventional gasoline before oxygenate blending CFCRDIMP –Crude oil imports CFIMPRD –Petroleum product imports CFIMUO –Unfinished oil imports CFRBOB –Reformulated gasoline before oxygenate blending **LFMMOUT common block** RFIPQCBOB –Imports, CBOB RFIPQRBOB –Imports, RBOB **PMMOUT common block** RFSPRIM –SPR imports **PMMRPT common block**

MAM variable name	Definition	NEMS variable name and source
		RFMTBI –Imported MTBE RFPQIPRDT –Total imported product RFPQUFC –Total imports of unfinished RFQICRD –Imported total crude
ENGRESIDUAL	Inventory change and statistical discrepancy for all fuels	**COALOUT common block** CQDBFB–Imports, exports and stock changes **COALREP common block** CQSBB-Coal production WC_PROD_BTU-WC distribution including exports **CONVFACT common block** CFBIOBUTE–Biobutanol CFBIOD–Biodiesel CFBTLLIQ–Liquids from biomass CFCBOB –Conventional gasoline before oxygenate blending CFCORN-Corn, bushels to British thermal units CFCRDDOM-Domestic crude production CFCRDEXP–Crude oil exports CFCRDIMP –Crude oil imports CFEXPRD–Refined petroleum product exports CFGTLLIQ–Liquids from gas CFIMPRD –Petroleum product imports CFIMUO –Unfinished oil imports CFMEQT-Methanol CFNGC–Natural gas consumption CFNGE–Natural gas exports CFNGI–Natural gas imports CFNGN–Natural gas, non-utility consumption CFPET–Pure ethanol CFRBOB –Reformulated gasoline before oxygenate blending CFRSQ-Residual fuel CFVEGGIE-Convert biodiesel output to vegetable oil input **LFMMOUT common block** BIOBUTEEXP–Exports of biobutanol

MAM variable name	Definition	NEMS variable name and source
		BIOBUTEIMP–Imports of biobutanol
		CORNCD-Corn consumption
		NGEXPVOL–Total export volumes
		RFBIOBUTECD–Production of biobutanol
		RFIPQCBOB –Imports, CBOB
		RFIPQRBOB –Imports, RBOB
		NGTDMREP common block
		OGSUPGAS–Supplemental natural gas supplies
		NGEXPVOL–Total export volumes
		NGIMPVOL–Total import volumes
		PMMFTAB common block
		RFHCXH2IN-Hydrogen from natural gas input to refinery
		RFMETM85-Production of M85
		SBO2GDTPD-Soy bean oil to green diesel
		SBO2GDTPD-Soy bean oil to green diesel
		WGR2GDTPD-White grease to green diesel
		WGR2GDTPD-White grease to green diesel
		YGR2GDTPD-Yellow grease to green diesel
		YGR2GDTPD-Yellow grease to green diesel
		PMMOUT common block
		BTLFRAC–BTL liquid component produced
		CBTLFRAC–Liquids produced from coal and biomass combo plant
		CFCBTLLIQ–Liquids from coal and biomass
		QBMRFBTL-Biomass for BTL
		RFPQNGL-Price and quantity of NGL
		RFQTDCRD-Production of crude oil
		RFSPRIM –SPR imports
		UBAVOL–Upgraded bio-oil A7
		PMMRPT common block

MAM variable name	Definition	NEMS variable name and source
		BIMQTYCD-Quantity of biodiesel produced by type
		BIODEXP–Biodiesel exports
		BIODIMP–Biodiesel imports
		CLLETHCD–Ethanol produced from cellulose
		CRNETHCD–Ethanol produced from corn
		ETHEXP–Ethanol exports
		ETHIMP–Ethanol imports
		OTHETHCD–Advanced ethanol
		RFMTBI –Imported MTBE
		RFPQIPRDT –Total imported product
		RFPQUFC –Total imports of unfinished
		RFQEXCRD–Crude oil exported
		RFQEXPRDT–Crude oil exported
		RFQICRD –Imported total crude
		QBLK common block
		QBMAS-Biomass, all sectors
		QBMRF-Biomass, refinery
		QCIIN–Net coal coke imports, industrial
		QCLAS–Coal, all sectors
		QEIEL–Electricity imports
		QETTR-Ethanol, transportation
		QGERS-Geothermal, residential
		QGPTR–Natural gas, pipeline
		QHOAS-Hydropower, all sectors
		QHYTR –Liquid hydrogen, transportation
		QLPIN–Natural gas, lease and plant fuel
		QMCIN–Metallurgical coal, industrial
		QMETR–Methanol, transportation
		QNGAS–Natural gas, all sectors
		QNGLQ–Natural gas used for liquefaction
		QPVCM-Photovoltaic, commercial
		QPVRS-Photovoltaic, residential
		QSTCM-Solar thermal, commercial
		QSTRS-Solar thermal, residential
		QTPAS–Total petroleum, all sectors
		QUREL-Uranium, electricity
		WRENEW common block

MAM variable name	Definition	NEMS variable name and source
		WNCMSEL-Util, MSW non-bio consumption
IPSG211A3	Industrial production index, oil and natural gas extraction	**CONVFACT common block** CFNGC-Natural gas consumption and production **NGTDMREP common block** OGPRDNG-Production of dry natural gas **PMMOUT common block** RFPQNGL-Production of natural gas liquids RFQTDCRD-Production of crude oil
IPSN2121	Industrial production index, coal mining	**COALOUT common block** CQSBB-Coal production (East, West Miss)
JPCNEFAO	Personal consumption deflator, household fuel oil	**MPBLK common block** PTPRS-Residential total petroleum price
JPCNEGAO	Personal consumption deflator, consumer gasoline and oil	**AMPBLK common block** PDSTR-Transportation distillate price PETTR-Transportation, ethanol price PMGTR-Transportation motor gasoline price **QBLK common block** QDSTR-Distillate, transportation QETTR-Ethanol, transportation QMGTR-Motor gasoline, transportation
JPCSVUE	Personal consumption deflator, household electricity	**AMPBLK common block** PELRS-Residential purchased electricity price
JPCSVUG	Personal consumption deflator, household natural gas	**AMPBLK common block** PNGRS-Residential natural gas price
PNGHH	Henry Hub cash market price of natural gas	**NGTDMREP common block** OGHHPRNG-Price of natural gas at Henry Hub
POILIMP	Weighted average price of imported crude oil	**INTOUT common block** IT_WOP-World oil price
POILWTI	Price of West Texas Intermediate crude oil	**PMMRPT common block** RFTPQCLL-Price of West Texas Intermediate crude oil
QGASASF	Highway consumption of gasoline and special fuels	**QBLK common block** QDSTR-Distillate, transportation

MAM variable name	Definition	NEMS variable name and source
		QETTR-Ethanol, transportation QMGTR-Motor gasoline, transportation
WPI051	Producer price index -coal	**AMPBLK common block** PCLIN-Industrial purchased coal price
WPI053	Producer price index-gas fuels	**NGTDMREP common block** OGWPRNG –Natural gas wellhead price
WPI054	Producer price index -electric power	**AMPBLK common block** PELCM-Commercial purchased electricity price PELIN-Industrial purchased electricity price PELRS-Residential purchased electricity price PELTR-Transportation purchased electricity price **QBLK common block** QELCM-Commercial purchased electricity QELIN-Industrial purchased electricity QELRS-Residential purchased electricity QELTR-Transportation purchased electricity
WPI055	Producer price index-utility natural gas	**AMPBLK common block** PNGCM-Commercial natural gas price PNGEL-Natural gas price to electric generators PNGIN-Industrial natural gas price PNGRS-Residential natural gas price PNGTR-Transportation natural gas price **QBLK common block** QNGCM-Commercial purchased natural gas QNGEL-Electricity, natural gas QNGIN -Industrial purchased natural gas QNGRS-Residential purchased natural gas QNGTR-Transportation purchased natural gas
WPI0561	Producer price index -crude petroleum	**INTOUT common block** IT_WOP-World oil price

MAM variable name	Definition	NEMS variable name and source
WPI057	Producer price index -refined petroleum product	**AMPBLK common block** PDSCM-Commercial distillate price PDSIN-Industrial distillate price PDSTR-Transportation distillate price PJFTR-Transportation jet fuel price PMGTR-Transportation motor gasoline price PRSCM-Commercial residual fuel price PRSIN-Industrial residual fuel price PRSTR-Transportation residual fuel price PTPRS-Residential total petroleum price **QBLK common block** QDSCM-Commercial distillate QDSIN-Industrial distillate QDSTR-Transportation distillate QJFTR-Transportation jet fuel QMGTR-Transportation motor gasoline QRSCM-Commercial residual fuel QRSIN-Industrial residual fuel QRSTR-Transportation residual fuel QTPRS-Residential total petroleum
WPI0574	Producer price index-residual petroleum fuels	**AMPBLK common block** PRSIN –Residual fuel, industrial **MPBLK common block** PRSCM –Residual fuel, commercial PRSTR –Residual fuel, transportation **QBLK common block** QRSCM –Residual fuel, commercial QRSIN –Residual fuel, industrial QRSTR –Residual fuel, transportation

Data source: U.S. Energy Information Administration

Table B4. Energy industry growth determined by the National Energy Modeling System (NEMS) projections

MACOUT common block name	Industry sector definition	NEMS variable name and source
MC_REVIND(25)	Production, petroleum refining	**PMMOUT common block** RFQPRDT – Total petroleum product supplied **PMMRPT common block** RFPQIPRDT – Total imported petroleum products
MC_REVIND(45)	Production, coal mining	**COALOUT common block** CQSBB – Total coal production
MC_REVIND(46)	Production, oil and natural gas extraction and support activities	**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
MC_REVSER(3)	Production, electric power generation and distribution	**UEFDOUT common block** UGNTLNR – Total electricity generation
MC_REVSER(4)	Production, natural gas distribution	**PMMOUT common block** OGPRDNG – Total dry natural gas production

Data source: U.S. Energy Information Administration

Table B5. MC_NATIONAL output variables of the National Energy Modeling System (NEMS)

MACOUT common block name	Description
MC_GDPR	Gross domestic product, billions of chained 2012 dollars
MC_GDPFER	Gross domestic product at full employment, billions of chained 2012 dollars
MC_CONSR	Consumer spending on all goods and services, billions of chained 2012 dollars
MC_IRC	Gross private domestic investment, billions of chained 2012 dollars
MC_XR	Exports of goods and services, billions of chained 2012 dollars
MC_MR	Imports of goods and services, billions of chained 2012 dollars
MC_GR	Government purchases of goods and services, billions of chained 2012 dollars
MC_CDR	Consumer spending on durable goods, billions of chained 2012 dollars
MC_CNR	Consumer spending on nondurable goods, billions of chained 2012 dollars
MC_CSVR	Consumer spending on services, billions of chained 2012 dollars
MC_IFNRESR	Gross nonresidential investment in structures, billions of chained 2012 dollars
MC_IFRESR	Gross residential investment, billions of chained 2012 dollars
MC_IFNREER	Gross nonresidential investment in equipment, billions of chained 2012 dollars
MC_IFREER	Gross residential investment in equipment, billions of chained 2012 dollars
MC_IFXR	Gross private fixed investment, billions of chained 2012 dollars
MC_IFNRER	Gross private fixed nonresidential investment, billions of chained 2012 dollars
MC_IFRER	Gross private fixed residential investment, billions of chained 2012 dollars
MC_XGFFBR	Exports, foods, feeds, and beverages, billions of chained 2012 dollars
MC_XGINR	Exports, industrial supplies and materials, billions of chained 2012 dollars
MC_XGKR	Exports, capital goods excluding autos, billions of chained 2012 dollars
MC_XGAUTOR	Exports, automotive vehicles, engines and parts, billions of chained 2012 dollars
MC_XGCR	Exports, consumer goods except automotive, billions of chained 2012 dollars
MC_XGR	Exports, goods, billions of chained 2012 dollars
MC_XSVTOTR	Exports, services, billions of chained 2012 dollars
MC_MGFFBR	Imports, foods, feeds, and beverages, billions of chained 2012 dollars
MC_MGINAPETR	Imports, industrial supplies and materials, billions of chained 2012 dollars
MC_MGKR	Imports, capital goods excluding motor vehicles, billions of chained 2012 dollars
MC_MGAUTOR	Imports, motor vehicles and parts, billions of chained 2012 dollars
MC_MGCR	Imports, non-automotive consumer goods, billions of chained 2012 dollars
MC_MSVTOTR	Imports, services, billions of chained 2012 dollars
MC_IIR	Change in real stock of business inventories, billions of chained 2012 dollars
MC_GFMLR	Federal defense purchases of goods and services, billions of chained 2012 dollars
MC_GDP	Gross domestic product, billions of nominal dollars
MC_CONS	Consumer spending on all goods and services, billions of nominal dollars
MC_I	Gross private domestic investment, billions of nominal dollars
MC_GNPR	Gross national product, billions of chained 2012 dollars
MC_JPGDP	Chain-type price index, GDP, 2012 = 1.0 (1987 = 1.0 in MC_COMMON)
MC_RMTB3M	Discount rate on 3-month U.S. Treasury Bills
MC_RMMTG30CON	Conventional 30-year mortgage commitment rate

MACOUT common block name	Description
MC_RMCORPPUAA	Yield on AA utility bonds
MC_RMGBLUSREAL	Real average yield on U.S. Treasury long-term bonds
MC_JECIWSP	Employment cost index, wages and salaries, Private Sector, June 1989 = 1.0
MC_SUVA	Unit sales of automobiles, total, millions of units
MC_SUVLV	Unit sales of light duty vehicles, domestic, millions of units
MC_SUVTL	Unit sales of new light trucks, millions of units
MC_SUVTHAM	Unit sales of heavy and medium trucks, millions of units
MC_RUC	Unemployment rate, all civilian workers
MC_WPI	Producer price index, all commodities, 1982 = 1.0
MC_WPI11	Producer price index, machinery and equipment, 1982 = 1.0
MC_WPI14	Producer price index, transportation equipment, 1982 = 1.0
MC_NLFC	Civilian labor force as measured by the household survey, millions of people
MC_RMFF	Effective rate on federal funds
MC_WPI05	Producer price index, fuels, related products and power, 1982 = 1.0
MC_RMTCM10Y	Yield on 10-year Treasury Notes
MC_RMCORPBAA	Yield on Baa-Rated Corporate Bonds
MC_CPIE	Consumer price index for energy
MC_NP65A	Population aged 65 and over
MC_JQPCMHNF	Index of output per hour in nonfarm business
MC_WPISOP3200	Producer price index–finished producer goods
MC_WPI10	Producer price index–metals and metal products
MC_GSLGISNHWYR	State and local government real gross investment in highways and streets, billions of chained 2012 dollars
MC_RLRMCORPPUAA	Real yield on Baa-Rated Corporate Bonds

Data source: U.S. Energy Information Administration

Table B6. MC_INDUSTRIAL output variables (variables by region) for the National Energy Modeling System (NEMS)

Regions

Census division	Description
NENG	New England
MATL	Middle Atlantic
ENC	East North Central
WNC	West North Central
SATL	South Atlantic
ESC	East South Central
WSC	West South Central
MTN	Mountain
PAC	Pacific
US	United States

Variables

MACOUT common block name	Description
MC_REVIND(1)	Production, food products (billions of fixed 2012 dollars)
MC_REVIND(2)	Production, grain and oilseed milling (billions of fixed 2012 dollars)
MC_REVIND(3)	Production, dairy products (billions of fixed 2012 dollars)
MC_REVIND(4)	Production, animal slaughter and seafood products (billions of fixed 2012 dollars)
MC_REVIND(5)	Production, other food products (billions of fixed 2012 dollars)
MC_REVIND(6)	Production, beverage and tobacco products (billions of fixed 2012 dollars)
MC_REVIND(7)	Production, textile, apparel, and leather (billions of fixed 2012 dollars)
MC_REVIND(8)	Production, wood products (billions of fixed 2012 dollars)
MC_REVIND(9)	Production, furniture and related products (billions of fixed 2012 dollars)
MC_REVIND(10)	Production, paper products (billions of fixed 2012 dollars)
MC_REVIND(11)	Production, pulp and paper mills (billions of fixed 2012 dollars)
MC_REVIND(12)	Production, paperboard containers (billions of fixed 2012 dollars)
MC_REVIND(13)	Production, other paper products (billions of fixed 2012 dollars)
MC_REVIND(14)	Production, printing (billions of fixed 2012 dollars)
MC_REVIND(15)	Production, basic inorganic chemicals (billions of fixed 2012 dollars)
MC_REVIND(16)	Production, basic organic chemicals (billions of fixed 2012 dollars)
MC_REVIND(17)	Production, ethanol (billions of fixed 2012 dollars)
MC_REVIND(18)	Production, resins and synthetics (billions of fixed 2012 dollars)
MC_REVIND(19)	Production, agricultural chemicals (billions of fixed 2012 dollars)
MC_REVIND(20)	Production, other chemical products (billions of fixed 2012 dollars)
MC_REVIND(21)	Production, pharma products (billions of fixed 2012 dollars)
MC_REVIND(22)	Production, paint products (billions of fixed 2012 dollars)
MC_REVIND(23)	Production, soaps and cleaning products (billions of fixed 2012 dollars)
MC_REVIND(24)	Production, other chemical products (billions of fixed 2012 dollars)

MACOUT common block name	Description
MC_REVIND(25)	Production, petroleum refining (billions of fixed 2012 dollars)
MC_REVIND(26)	Production, other petroleum and coal products (billions of fixed 2012 dollars)
MC_REVIND(27)	Production, plastics and rubber products (billions of fixed 2012 dollars)
MC_REVIND(28)	Production, glass and glass products (billions of fixed 2012 dollars)
MC_REVIND(29)	Production, flat glass (billions of fixed 2012 dollars)
MC_REVIND(30)	Production, cement manufacturing (billions of fixed 2012 dollars)
MC_REVIND(31)	Production, lime manufacturing (billions of fixed 2012 dollars)
MC_REVIND(32)	Production, other non-metallic mineral products (billions of fixed 2012 dollars)
MC_REVIND(33)	Production, iron and steel products (billions of fixed 2012 dollars)
MC_REVIND(34)	Production, alumina and aluminum products (billions of fixed 2012 dollars)
MC_REVIND(35)	Production, other primary metals (billions of fixed 2012 dollars)
MC_REVIND(36)	Production, fabricated metal products (billions of fixed 2012 dollars)
MC_REVIND(37)	Production, machinery (billions of fixed 2012 dollars)
MC_REVIND(38)	Production, computers and electronic products (billions of fixed 2012 dollars)
MC_REVIND(39)	Production, transportation equipment (billions of fixed 2012 dollars)
MC_REVIND(40)	Production, appliance and electrical equipment (billions of fixed 2012 dollars)
MC_REVIND(41)	Production, miscellaneous manufacturing (billions of fixed 2012 dollars)
MC_REVIND(42)	Production, crop production (billions of fixed 2012 dollars)
MC_REVIND(43)	Production, animal production (billions of fixed 2012 dollars)
MC_REVIND(44)	Production, other agriculture (billions of fixed 2012 dollars)
MC_REVIND(45)	Production, coal mining (billions of fixed 2012 dollars)
MC_REVIND(46)	Production, oil and natural gas extraction and support activities (billions of fixed 2012 dollars)
MC_REVIND(47)	Production, other mining and quarrying (billions of fixed 2012 dollars)
MC_REVIND(48)	Production, construction (billions of fixed 2012 dollars)
MC_REVIND(49)	Production, sum of all chemicals (billions of fixed 2012 dollars)
MC_REVIND(50)	Production, sum of all petroleum (billions of fixed 2012 dollars)
MC_REVIND(51)	Production, sum of all stone, clay, glass, and cement (billions of fixed 2012 dollars)
MC_REVIND(52)	Production, sum of all primary metals (billions of fixed 2012 dollars)
MC_REVSER(1)	Service, transportation and warehousing (billions of fixed 2012 dollars)
MC_REVSER(2)	Service, broadcasting and telecommunications (billions of fixed 2012 dollars)
MC_REVSER(3)	Service, electric power generation and distribution (billions of fixed 2012 dollars)
MC_REVSER(4)	Service, natural gas distribution (billions of fixed 2012 dollars)
MC_REVSER(5)	Service, water, sewage, and related system (billions of fixed 2012 dollars)
MC_REVSER(6)	Service, wholesale trade (billions of fixed 2012 dollars)
MC_REVSER(7)	Service, retail trade (billions of fixed 2012 dollars)
MC_REVSER(8)	Service, finance, insurance, and real estate (billions of fixed 2012 dollars)
MC_REVSER(9)	Service, other services (billions of fixed 2012 dollars)
MC_REVSER(10)	Service, public administration (billions of fixed 2012 dollars)
MC_REVSER(11)	Service, total non-industrial/service gross output (billions of fixed 2012 dollars)

Data source: U.S. Energy Information Administration

Table B7. MC_EMPLOYMENT output variables of the National Energy Modeling System (NEMS)

Employment variable name	Description
EMPIND1	Food products (millions of employees)
EMPIND2	Beverage and tobacco products (millions of employees)
EMPIND3	Textile, apparel, and leather (millions of employees)
EMPIND4	Wood products (millions of employees)
EMPIND5	Furniture and related products (millions of employees)
EMPIND6	Paper products (millions of employees)
EMPIND7	Printing (millions of employees)
EMPIND8	Bulk chemicals (millions of employees)
EMPIND9	Other chemical products (millions of employees)
EMPIND10	Petroleum and coal products (millions of employees)
EMPIND11	Plastics and rubber products (millions of employees)
EMPIND12	Non-metallic mineral (millions of employees)
EMPIND13	Primary metals (millions of employees)
EMPIND14	Fabricated metal products (millions of employees)
EMPIND15	Machinery (millions of employees)
EMPIND16	Computers and electronic products (millions of employees)
EMPIND17	Transportation equipment (millions of employees)
EMPIND18	Appliance and electrical equipment (millions of employees)
EMPIND19	Miscellaneous manufacturing (millions of employees)
EMPIND20	Crop production (millions of employees)
EMPIND21	Other agriculture (millions of employees)
EMPIND22	Coal mining (millions of employees)
EMPIND23	Oil and natural gas extraction and support activities (millions of employees)
EMPIND24	Other mining and quarrying (millions of employees)
EMPIND25	Construction of buildings (millions of employees)
EMPIND26	Heavy and civil engineering construction (millions of employees)
EMPIND27	Specialty trade contractors (millions of employees)
EMPSER1	Electric power generation and distribution (millions of employees)
EMPSER2	Natural gas distribution (millions of employees)
EMPSER3	Water, sewage, and related systems (millions of employees)
EMPSER4	Wholesale trade (millions of employees)
EMPSER5	Retail trade (millions of employees)
EMPSER6	Transportation and warehousing (millions of employees)
EMPSER7	Publishing industries except internet (millions of employees)
EMPSER8	Broadcasting except internet (millions of employees)
EMPSER9	Telecommunications (millions of employees)
EMPSER10	Finance and insurance (millions of employees)
EMPSER11	Real estate and rental/leasing(millions of employees)
EMPSER12	Other services (millions of employees)

Employment variable name	Description
(Aggregate)	Total manufacturing (millions of employees)
(Aggregate)	Total nonmanufacturing (millions of employees)
(Aggregate)	Total services (millions of employees)
(Aggregate)	Total nonfarm (millions of employees)

Data source: U.S. Energy Information Administration

Table B8. MC_VEHICLES output variables of the National Energy Modeling System (NEMS)

MACOUT common block name	Description
MC_VEHICLES(1)	Unit sales of Class 1 Light Trucks, 0 to 6,000 lbs., Wards Communication, thousands of vehicles
MC_VEHICLES(2)	Unit sales of Class 2 Light Trucks, 6,001 to 10,000 lbs., Wards Communication, thousands of vehicles
MC_VEHICLES(3)	Unit sales of Class 3 Light Trucks, 10,000 to 14,000 lbs., Wards Communication, thousands of vehicles

Data source: U.S. Energy Information Administration

Table B9. MC_REGIONAL output variables of the National Energy Modeling System (NEMS)

Regions

Census division	Description
NENG	New England
MATL	Middle Atlantic
ENC	East North Central
WNC	West North Central
SATL	South Atlantic
ESC	East South Central
WSC	West South Central
MTN	Mountain
PAC	Pacific
US	United States

Variables

MACOUT common block name	Description
MC_CPI	Consumer price index (all urban)—all items (1982–84 = 1.0)
MC_YPDR	Disposable personal income (billions of chained 2012 dollars)
MC_YPCOMPWSD	Wage and salary disbursements (billions of nominal dollars)
MC_YP	Personal income (billions of nominal dollars)
MC_HUSMFG	Mobile homes shipments (millions of units)
MC_HUSPS1	Single-family housing starts, private including farm (millions of units)
MC_HUSPS2A	Multifamily housing starts, private including farm (millions of units)
MC_KHUMFG	Stock of mobile homes (millions of units)
MC_KHUPS1	Stock of single-family housing (millions of units)
MC_KHUPS2A	Stock of multifamily housing (millions of units)
MC_NP	Population including armed forces overseas (millions of persons)
MC_NP16A	Population aged 16 and over (millions of persons)
MC_RWM	Average annual manufacturing wages (thousands of nominal dollars)
MC_RWNM	Average annual nonmanufacturing wages (thousands of nominal dollars)
MC_COMMFLSP(1)	Commercial floor space, amusement and religious (rate of growth)
MC_COMMFLSP(2)	Commercial floor space, education (rate of growth)
MC_COMMFLSP(3)	Commercial floor space, health (rate of growth)
MC_COMMFLSP(4)	Commercial floor space, hotel and dorms (rate of growth)
MC_COMMFLSP(5)	Commercial floor space, office (rate of growth)
MC_COMMFLSP(6)	Commercial floor space, auto (rate of growth)
MC_COMMFLSP(7)	Commercial floor space, stores (rate of growth)
MC_COMMFLSP(8)	Commercial floor space, warehouse (rate of growth)
MC_COMMFLSP(9)	Commercial floor space, miscellaneous (rate of growth)

MACOUT common block name	Description
MC_EMPNA(1)	Employment, total nonfarm (millions of persons)
MC_EMPNA(2)	Employment, beverage and tobacco products (millions of persons)
MC_EMPNA(3)	Employment, textile, apparel, and leather (millions of persons)
MC_EMPNA(4)	Employment, wood products (millions of persons)
MC_EMPNA(5)	Employment, furniture and related products (millions of persons)
MC_EMPNA(6)	Employment, paper products (millions of persons)
MC_EMPNA(7)	Employment, printing (millions of persons)
MC_EMPNA(8)	Employment, bulk chemicals (millions of persons)
MC_EMPNA(9)	Employment, other chemical products (millions of persons)
MC_EMPNA(10)	Employment, petroleum and coal products (millions of persons)
MC_EMPNA(11)	Employment, plastics and rubber products (millions of persons)
MC_EMPNA(12)	Employment, non-metallic minerals (millions of persons)
MC_EMPNA(13)	Employment, primary metals (millions of persons)
MC_EMPNA(14)	Employment, fabricated metal products (millions of persons)
MC_EMPNA(15)	Employment, machinery (millions of persons)
MC_EMPNA(16)	Employment, computers and electronic products (millions of persons)
MC_EMPNA(17)	Employment, transportation equipment (millions of persons)
MC_EMPNA(18)	Employment, appliance and electrical equipment (millions of persons)
MC_EMPNA(19)	Employment, miscellaneous manufacturing (millions of persons)
MC_EMPNA(20)	Employment, crop production (millions of persons)
MC_EMPNA(21)	Employment, other agriculture (millions of persons)
MC_EMPNA(22)	Employment, coal mining (millions of persons)
MC_EMPNA(23)	Employment, oil and natural gas extraction and support activities (millions of persons)
MC_EMPNA(24)	Employment, other mining and quarrying (millions of persons)
MC_EMPNA(25)	Employment, construction of buildings (millions of persons)
MC_EMPNA(26)	Employment, heavy and civil engineering construction (millions of persons)
MC_EMPNA(27)	Employment, specialty trade contractors (millions of persons)
MC_EMPSER(1)	Employment, electric power generation and distribution (millions of persons)
MC_EMPSER(2)	Employment, natural gas distribution (millions of persons)
MC_EMPSER(3)	Employment, water, sewage, and related systems (millions of persons)
MC_EMPSER(4)	Employment, wholesale trade (millions of persons)
MC_EMPSER(5)	Employment, retail trade (millions of persons)
MC_EMPSER(6)	Employment, transportation and warehousing (millions of persons)
MC_EMPSER(7)	Employment, publishing industries except internet (millions of persons)
MC_EMPSER(8)	Employment, broadcasting except internet (millions of persons)
MC_EMPSER(9)	Employment, telecommunications (millions of persons)
MC_EMPSER(10)	Employment, finance and insurance (millions of persons)
MC_EMPSER(11)	Employment, real estate and rental/leasing (millions of persons)
MC_EMPSER(12)	Employment, other services (millions of persons)

MACOUT common block name	Description
MC_REVIND(1)	Production, food products (billions of fixed 2012 dollars)
MC_REVIND(2)	Production, grain and oilseed milling (billions of fixed 2012 dollars)
MC_REVIND(3)	Production, dairy products (billions of fixed 2012 dollars)
MC_REVIND(4)	Production, animal slaughter and seafood products (billions of fixed 2012 dollars)
MC_REVIND(5)	Production, other food products (billions of fixed 2012 dollars)
MC_REVIND(6)	Production, beverage and tobacco products (billions of fixed 2012 dollars)
MC_REVIND(7)	Production, textile mills and products, apparel, and leather (billions of fixed 2012 dollars)
MC_REVIND(8)	Production, wood products (billions of fixed 2012 dollars)
MC_REVIND(9)	Production, furniture and related products (billions of fixed 2012 dollars)
MC_REVIND(10)	Production, paper products (billions of fixed 2012 dollars)
MC_REVIND(11)	Production, pulp and paper mills (billions of fixed 2012 dollars)
MC_REVIND(12)	Production, paperboard containers (billions of fixed 2012 dollars)
MC_REVIND(13)	Production, other paper products (billions of fixed 2012 dollars)
MC_REVIND(14)	Production, printing (billions of fixed 2012 dollars)
MC_REVIND(15)	Production, basic inorganic chemicals (billions of fixed 2012 dollars)
MC_REVIND(16)	Production, basic organic chemicals (billions of fixed 2012 dollars)
MC_REVIND(17)	Production, ethanol (billions of fixed 2012 dollars)
MC_REVIND(18)	Production, resins and synthetics (billions of fixed 2012 dollars)
MC_REVIND(19)	Production, agricultural chemicals (billions of fixed 2012 dollars)
MC_REVIND(20)	Production, other chemical products (billions of fixed 2012 dollars)
MC_REVIND(21)	Production, pharma products (billions of fixed 2012 dollars)
MC_REVIND(22)	Production, paint products (billions of fixed 2012 dollars)
MC_REVIND(23)	Production, soaps and cleaning products (billions of fixed 2012 dollars)
MC_REVIND(24)	Production, other chemical products (billions of fixed 2012 dollars)
MC_REVIND(25)	Production, petroleum refineries (billions of fixed 2012 dollars)
MC_REVIND(26)	Production, other petroleum and coal products (billions of fixed 2012 dollars)
MC_REVIND(27)	Production, plastics and rubber products (billions of fixed 2012 dollars)
MC_REVIND(28)	Production, glass and glass products (billions of fixed 2012 dollars)
MC_REVIND(29)	Production, flat glass (billions of fixed 2012 dollars)
MC_REVIND(30)	Production, cement manufacturing (billions of fixed 2012 dollars)
MC_REVIND(31)	Production, lime manufacturing (billions of fixed 2012 dollars)
MC_REVIND(32)	Production, other non-metallic mineral products (billions of fixed 2012 dollars)
MC_REVIND(33)	Production, iron and steel products (billions of fixed 2012 dollars)
MC_REVIND(34)	Production, alumina and aluminum products (billions of fixed 2012 dollars)
MC_REVIND(35)	Production, other primary metals (billions of fixed 2012 dollars)
MC_REVIND(36)	Production, fabricated metal products (billions of fixed 2012 dollars)
MC_REVIND(37)	Production, machinery (billions of fixed 2012 dollars)
MC_REVIND(38)	Production, computers and electronic products (billions of fixed 2012 dollars)

MACOUT common block name	Description
MC_REVIND(39)	Production, transportation equipment (billions of fixed 2012 dollars)
MC_REVIND(40)	Production, appliance and electrical equipment (billions of fixed 2012 dollars)
MC_REVIND(41)	Production, miscellaneous manufacturing (billions of fixed 2012 dollars)
MC_REVIND(42)	Production, crop production (billions of fixed 2012 dollars)
MC_REVIND(43)	Production, animal production (billions of fixed 2012 dollars)
MC_REVIND(44)	Production, other agriculture (billions of fixed 2012 dollars)
MC_REVIND(45)	Production, coal mining (billions of fixed 2012 dollars)
MC_REVIND(46)	Production, oil and natural gas extraction and support activities (billions of fixed 2012 dollars)
MC_REVIND(47)	Production, other mining and quarrying (billions of fixed 2012 dollars)
MC_REVIND(48)	Production, construction (billions of fixed 2012 dollars)
MC_REVIND(49)	Production, sum of all chemicals (billions of fixed 2012 dollars)
MC_REVIND(50)	Production, sum of all petroleum (billions of fixed 2012 dollars)
MC_REVIND(51)	Production, sum of all stone, clay, glass, and cement (billions of fixed 2012 dollars)
MC_REVIND(52)	Production, sum of all primary metals (billions of fixed 2012 dollars)
MC_REVSER(1)	Service, transportation and warehousing (billions of fixed 2012 dollars)
MC_REVSER(2)	Service, broadcasting and telecommunications (billions of fixed 2012 dollars)
MC_REVSER(3)	Service, electric power generation and distribution (billions of fixed 2012 dollars)
MC_REVSER(4)	Service, natural gas distribution (billions of fixed 2012 dollars)
MC_REVSER(5)	Service, water, sewage, and related system (billions of fixed 2012 dollars)
MC_REVSER(6)	Service, wholesale trade (billions of fixed 2012 dollars)
MC_REVSER(7)	Service, retail trade (billions of fixed 2012 dollars)
MC_REVSER(8)	Service, finance, insurance, and real estate (billions of fixed 2012 dollars)
MC_REVSER(9)	Service, other services (billions of fixed 2012 dollars)
MC_REVSER(10)	Service, public administration (billions of fixed 2012 dollars)
MC_REVSER(11)	Service, total non-industrial/service gross output (billions of fixed 2012 dollars)

Data source: U.S. Energy Information Administration

Table B10. MC_REGMAC output variables (variables by region) of the National Energy Modeling System (NEMS)

Regions

Census division	Description
NENG	New England
MATL	Middle Atlantic
ENC	East North Central
WNC	West North Central
SATL	South Atlantic
ESC	East South Central
WSC	West South Central
MTN	Mountain
PAC	Pacific
US	United States

Variables

Economic activity variable name	Description
CPI	Consumer price index (all urban)—all items (1982–84 = 1.0)
YPDR	Disposable personal income (billions of chained 2012 dollars)
YPCOMPWSD	Wage and salary disbursements (billions of nominal dollars)
YP	Personal income (billions of nominal dollars)
HUSMFG	Mobile homes shipments (millions of units)
HUSPS1	Single-family housing starts, private including farm (millions of units)
HUSPS2A	Multifamily housing starts, private including farm (millions of units)
KHUMFG	Stock of mobile homes (millions of units)
KHUPS1	Stock of single-family housing (millions of units)
KHUPS2A	Stock of multifamily housing (millions of units)
NP	Population including armed forces overseas (millions of persons)
NP16A	Population aged 16 and over (millions of persons)
RWM	Average annual manufacturing wages (thousands of nominal dollars)
RWNM	Average annual nonmanufacturing wages (thousands of nominal dollars)

Data source: U.S. Energy Information Administration

Table B11. MC_COMMFLR output variables (variables by region) of the National Energy Modeling System (NEMS)

Regions

Census division	Description
ENC	East North Central
ESC	East South Central
MATL	Middle Atlantic
MTN	Mountain
NENG	New England
PAC	Pacific
SATL	South Atlantic
WNC	West North Central
WSC	West South Central
SUM	United States

Variables

Commercial floor space variable name	Description
AMUSE	Commercial floor space, amusement (rate of growth)
AUTO	Commercial floor space, auto service and parking garages (rate of growth)
DORM	Commercial floor space, educational and federally owned (primarily military) (rate of growth)
EDUC	Commercial floor space, primary/secondary and higher education (rate of growth)
HEALTH	Commercial floor space, hospitals and nursing homes (rate of growth)
HOTEL	Commercial floor space, hotels and motels (rate of growth)
MFG	Commercial floor space, manufacturing (rate of growth)
MISCNR	Commercial floor space, miscellaneous, non-residential--transportation-related and all other not elsewhere classified (rate of growth)
OFFICE	Commercial floor space, private, federal, and state and local offices (rate of growth)
PUB	Commercial floor space, federal and state and local (rate of growth)
REL	Commercial floor space, religious (rate of growth)
STORES	Commercial floor space, stores and restaurants (rate of growth)
WARE	Commercial floor space, manufacturing and wholesale trade, public and federally owned warehouses (rate of growth)

Data source: U.S. Energy Information Administration

Table B12. MC_REGEMP output variables (variables by region) of the National Energy Modeling System (NEMS)

Regions

Census division	Description
NENG	New England
MATL	Middle Atlantic
ENC	East North Central
WNC	West North Central
SATL	South Atlantic
ESC	East South Central
WSC	West South Central
MTN	Mountain
PAC	Pacific
US	United States

Variables

Employment variable name	Description
EMPIND1	Employment, food products (millions of persons)
EMPIND2	Employment, beverage and tobacco products (millions of persons)
EMPIND3	Employment, textile, apparel, and leather (millions of persons)
EMPIND4	Employment, wood products (millions of persons)
EMPIND5	Employment, furniture and related products (millions of persons)
EMPIND6	Employment, paper products (millions of persons)
EMPIND7	Employment, printing (millions of persons)
EMPIND8	Employment, bulk chemicals (millions of persons)
EMPIND9	Employment, other chemical products (millions of persons)
EMPIND10	Employment, petroleum and coal products (millions of persons)
EMPIND11	Employment, plastics and rubber products (millions of persons)
EMPIND12	Employment, non-metallic mineral products (millions of persons)
EMPIND13	Employment, primary metals (millions of persons)
EMPIND14	Employment, fabricated metal products (millions of persons)
EMPIND15	Employment, machinery (millions of persons)
EMPIND16	Employment, computers and electronic products (millions of persons)
EMPIND17	Employment, transportation equipment (millions of persons)
EMPIND18	Employment, appliance and electrical equipment (millions of persons)
EMPIND19	Employment, miscellaneous manufacturing (millions of persons)

Employment variable name	Description
EMPIND20	Employment, crop production (millions of persons)
EMPIND21	Employment, other agriculture (millions of persons)
EMPIND22	Employment, coal mining (millions of persons)
EMPIND23	Employment, oil and natural gas extraction and support activities (millions of persons)
EMPIND24	Employment, other mining and quarrying (millions of persons)
EMPIND25	Employment, construction of buildings (millions of persons)
EMPIND26	Employment, heavy and civil engineering construction (millions of persons)
EMPIND27	Employment, specialty trade contractors (millions of persons)
EMPSER1	Employment, electric power generation and distribution (millions of persons)
EMPSER2	Employment, natural gas distribution (millions of persons)
EMPSER3	Employment, water, sewage, and related system (millions of persons)
EMPSER4	Employment, wholesale trade (millions of persons)
EMPSER5	Employment, retail trade (millions of persons)
EMPSER6	Employment, transportation and warehousing (millions of persons)
EMPSER7	Employment, publishing industries except internet (millions of persons)
EMPSER8	Employment, broadcasting except internet (millions of persons)
EMPSER9	Employment, telecommunications (millions of persons)
EMPSER10	Employment, finance and insurance (millions of persons)
EMPSER11	Employment, real estate and rental/leasing (millions of persons)
EMPSER12	Employment, other services (millions of persons)

Data source: U.S. Energy Information Administration

Table B13. MC_REGIO output variables (variables by region) of the National Energy Modeling System (NEMS)

Regions

Census division	Description
NENG	New England
MATL	Middle Atlantic
ENC	East North Central
WNC	West North Central
SATL	South Atlantic
ESC	East South Central
WSC	West South Central
MTN	Mountain
PAC	Pacific
US	United States

Variables

Industrial output variable name	Description
REVIND1	Production, food products (billions of fixed 2012 dollars)
REVIND2	Production, grain and oilseed milling (billions of fixed 2012 dollars)
REVIND3	Production, dairy products (billions of fixed 2012 dollars)
REVIND4	Production, animal slaughter and seafood products (billions of fixed 2012 dollars)
REVIND5	Production, other food products (billions of fixed 2012 dollars)
REVIND6	Production, beverage and tobacco products (billions of fixed 2012 dollars)
REVIND7	Production, textile, apparel, and leather (billions of fixed 2012 dollars)
REVIND8	Production, wood products (billions of fixed 2012 dollars)
REVIND9	Production, furniture and related products (billions of fixed 2012 dollars)
REVIND10	Production, paper products (billions of fixed 2012 dollars)
REVIND11	Production, pulp and paper mills (billions of fixed 2012 dollars)
REVIND12	Production, paperboard container (billions of fixed 2012 dollars)
REVIND13	Production, other paper products (billions of fixed 2012 dollars)
REVIND14	Production, printing (billions of fixed 2012 dollars)
REVIND15	Production, basic inorganic chemicals (billions of fixed 2012 dollars)
REVIND16	Production, basic organic chemicals (billions of fixed 2012 dollars)
REVIND17	Production, ethanol (billions of fixed 2012 dollars)
REVIND18	Production, resins and synthetics (billions of fixed 2012 dollars)
REVIND19	Production, agricultural chemicals (billions of fixed 2012 dollars)
REVIND20	Production, other chemical products (billions of fixed 2012 dollars)
REVIND21	Production, pharma products (billions of fixed 2012 dollars)

Industrial output variable name	Description
REVIND22	Production, paint products (billions of fixed 2012 dollars)
REVIND23	Production, soaps and cleaning products (billions of fixed 2012 dollars)
REVIND24	Production, other chemical products (billions of fixed 2012 dollars)
REVIND25	Production, petroleum refineries (billions of fixed 2012 dollars)
REVIND26	Production, other petroleum and coal products (billions of fixed 2012 dollars)
REVIND27	Production, plastics and rubber products (billions of fixed 2012 dollars)
REVIND28	Production, glass and glass products (billions of fixed 2012 dollars)
REVIND29	Production, flat glass (billions of fixed 2012 dollars)
REVIND30	Production, cement manufacturing (billions of fixed 2012 dollars)
REVIND31	Production, lime manufacturing (billions of fixed 2012 dollars)
REVIND32	Production, other non-metallic mineral products (billions of fixed 2012 dollars)
REVIND33	Production, iron and steel products (billions of fixed 2012 dollars)
REVIND34	Production, alumina and aluminum products (billions of fixed 2012 dollars)
REVIND35	Production, other primary metals (billions of fixed 2012 dollars)
REVIND36	Production, fabricated metal products (billions of fixed 2012 dollars)
REVIND37	Production, machinery (billions of fixed 2012 dollars)
REVIND38	Production, computers and electronic products (billions of fixed 2012 dollars)
REVIND39	Production, transportation equipment (billions of fixed 2012 dollars)
REVIND40	Production, appliance and electrical equipment (billions of fixed 2012 dollars)
REVIND41	Production, miscellaneous manufacturing (billions of fixed 2012 dollars)
REVIND42	Production, crop production (billions of fixed 2012 dollars)
REVIND43	Production, animal production (billions of fixed 2012 dollars)
REVIND44	Production, other agriculture (billions of fixed 2012 dollars)
REVIND45	Production, coal mining (billions of fixed 2012 dollars)
REVIND46	Production, oil and natural gas extraction and support activities (billions of fixed 2012 dollars)
REVIND47	Production, other mining and quarrying (billions of fixed 2012 dollars)
REVIND48	Production, construction (billions of fixed 2012 dollars)

Data source: U.S. Energy Information Administration

Table B14. Macroeconomic Activity Module (MAM) variables used by other National Energy Modeling System (NEMS) modules

MACOUT common block name	Macroeconomic variable description	Referencing NEMS module
MC_COMMFLSP	Commercial floor space by type of building (rate of growth)	COMM
MC_CPI	Consumer price index (all urban)—all items (1982–84 = 1.0)	IND
		TRAN
MC_EEA	Employment--total nonfarm payrolls (millions)	TRAN
MC_EMPNA	Employment by industrial sector (millions)	IND
		TRAN
MC_GDPR	Gross domestic product (billions of chained 2012 dollars)	IND
		RENEW
		TRAN
		TRANAIR
MC_GFMLR	Federal defense purchases of goods and services (billions of chained 2012 dollars)	TRAN
MC_HUSMFG	Mobile homes shipments (millions of units)	RESD
MC_HUSPS1	Single-family housing starts (millions of units)	RESD
MC_HUSPS2A	Multifamily housing starts (millions of units)	RESD
MC_JPGDP	Chained price index, GDP (2012 = 100.0, 1987 = 1.0 in MACOUT)	COMM
		EPM
		HMM
		IND
		REFINE
		RENEW
		RESD
		TRAN
		TRANAIR
		TRANFRT
		UAIMMS
		UAIMMS_READAIM
		UDAT
		UECP
		UEFD
		UEFP
		ULDSM
		UNUGS
		UTIL
		WELLCOST
		WELLDCF
		WELLIMP
		WELLOFF

MACOUT common block name	Macroeconomic variable description	Referencing NEMS module
		WELLOGS
		WELLON
		WELLREP
		WORLD
MC_KHUPS1	Stock of single-family housing units (millions of units)	RESD
MC_KHUPS2a	Stock of multifamily housing units (millions of units)	RESD
MC_MGAUTOR	Real imports of motor vehicles and parts (billions of chained 2012 dollars)	TRANFRT
MC_MGCR	Real imports of non-automotive consumer goods (billions of chained 2012 dollars)	TRANFRT
MC_MGKR	Real imports of capital equipment (billions of chained 2012 dollars)	TRANFRT
MC_MR	Imports of goods and services (billions of chained 2012 dollars)	TRAN
MC_NP	Population including armed forces overseas (millions)	COMM
		RENEW
		RESD
		TRAN
		TRANAIR
MC_NP16A	Population aged 16 and over (millions)	RESD
		TRAN
MC_NP65A	Population aged 65 and over (millions)	RESD
MC_REVIND	Real revenues by industrial sector (billions of 2012 dollars)	IND
		TRAN
		TRANFRT
MC_REVSER	Real revenues by service sector (billions of 2012 dollars)	COMM
		TRAN
		TRANFRT
MC_RMCORPBAA	Yield on Baa-rated corporate bonds (percent per annum)	UEFP
		WELLOGS
MC_RMCORPPUAA	Rate on Aa-rated public utility bonds (percent per annum)	UEFP
MC_RMGBLUSREAL	Real yield on U.S. Treasury long-term bonds (percent per annum)	COMM
MC_RMMTG30CON	Commitment rate on conventional 30-year mortgage--all lenders (percent per annum)	RESD
MC_RMTCM10Y	Yield on 10-year Treasury notes (percent per annum)	HMM
		IND
		UEFP
		WELLOGS
MC_SUVA	Unit sales of automobiles, total (millions of units)	TRAN
MC_SUVTHAM	Unit sales of new heavy and medium trucks (millions of units)	TRANFRT
MC_VEHICLES	Unit sales of light trucks by size class (millions of units)	TRAN

MACOUT common block name	Macroeconomic variable description	Referencing NEMS module
		TRANFRT
MC_WPI10	Producer price index – metals and metal products (index 1982 = 1.0)	UDAT
MC_XGFFBR	Real exports of foods, feeds, and beverages (billions of 2012 dollars)	TRANFRT
MC_XGINR	Real exports of industrial materials and supplies (billions of 2012 dollars)	TRANFRT
MC_XGR	Real exports of goods (billions of 2012 dollars)	TRANAIR
MC_XR	Real exports of goods and services (billions of 2012 dollars)	TRAN
MC_YPDR	Real disposable income (billions of 2012 dollars)	COMM RESD TRAN TRANAIR

NEMS module descriptions

Name	Description
COMM	Commercial Demand Module
EPM	Future Emission Policy Module
HMM	Hydrogen Market Module
IND	Industrial Demand Module
REFINE	Petroleum Market Module, Refinery Processes
RENEW	Renewable Fuels Module
RESD	Residential Demand Module
TRAN	Transportation Demand Module
TRANAIR	Transportation Demand Module, Air Freight
TRANFRT	Transportation Demand Module, Freight Transport
UAIMMS	Electricity Market Module, AIMMS Interface Routines
UAIMMS_READAIM	Electricity Market Module, AIMMS Interface Routines for EFD and ECP LPs
UDAT	Electricity Market Module, Electricity Data Processing
UECP	Electricity Market Module, Electricity Capacity Planning
UEFD	Electricity Market Module, Electricity Fuel Dispatch
UEFP	Electricity Market Module, Finance and Pricing
ULDSM	Electricity Market Module, Load and Demand-Side Management
UNUGS	Electricity Market Module, Non-Traditional Utility (End use) Generation
UTIL	Electricity Market Module, Main Driver
WELLCOST	Oil and Gas Supply Module, Cost
WELLDCF	Oil and Gas Supply Module, System Routines
WELLIMP	Oil and Gas Supply Module, Foreign Supply

Name	Description
WELLOFF	Oil and Gas Supply Module, Offshore Supply
WELLOGS	Oil and Gas Supply Module, Main Module
WELLON	Oil and Gas Supply Module, Supporting Routines
WELLREP	Oil and Gas Supply Module, Report Routines
WORLD	International Energy Module, Main Routine

Data source: U.S. Energy Information Administration

Appendix C: Equations in Regional Model

Appendix C1: Regional Macroeconomic Model

Endogenous variables:

CPI_{R}	Consumer price index, all urban, 1982−84=1.0, regional
GSPR_{R}	Real gross state product, billions of 2012 dollars, regional
GSPRZNP_{R}	Real per capita gross state product, billions of 2012 dollars per person, regional
RWM_{R}	Average annual manufacturing wages, thousands of dollars, regional
RWNM_{R}	Average annual nonmanufacturing wages, thousands of dollars, regional
YP_{R}	Personal income, billions of dollars, regional
YPCOMPWSD_{R}	Wage and salary disbursements, billions of dollars, regional
YPCOMPWSDG_{R}	Wage and salary disbursements by government, billions of dollars, regional
YPCOMPWSDP_{R}	Wage and salary disbursements by private sector, billions of dollars, regional
YPD_{R}	Personal disposable income, billions of dollars, regional
YPDR_{R}	Real personal disposable income, billions of 2012 dollars, regional
YPDRZNP_{R}	Real per capita personal disposable income, billions of 2012 dollars, regional
YPOTH_{R}	Other personal income, billions of dollars, regional

Model description is in Chapter 4. Codes and descriptions of the regions are in Table B9.

Exogenous variables:

CPI	Consumer price index, all urban, 1982−84=1.0, national
CPIZ_{R}	Regional consumer price index relative share to national, regional
GDPR	Real gross domestic product, billions of 2012 dollars, national
JECIWSP	Employment cost index, private-sector wages and salaries, Dec. 2005 = 1.0, national

Exogenous variables (cont.):

NP	Population, millions, national
NP_{R}	Population, millions, regional
YP	Personal income, billions of dollars, national
YPCOMPWSD	Wage and salary disbursements, billions of dollars, national
YPCOMPWSDG	Wage and salary disbursements by government, billions of dollars, national
YPD	Personal disposable income, billions of dollars, national
YPDR	Real personal disposable income, billions of 2012 dollars, national

Equations:

CPI – Consumer price index

Eqn 1: CPI_{R} = (CPI_{R} / CPI_{R}_AVE) * CPI

GSPR – Real gross state product

Eqn 2: GSPR_{R} = (GSPR_{R} /GSPR_{R}_SUM) * GDPR

GSPRZNP – Real per capita gross state product

Eqn 3: LOG(GSPRZNP_ENC/GDPRZN) = 1.0052571064*LOG(GSPRZNP_ENC(-1)/GDPRZN(-1))

Eqn 4: LOG(GSPRZNP_ESC/GDPRZN) = 1.52764027005*LOG(GSPRZNP_ESC(-1)/GDPRZN(-1)) - 0.527988488415*@MOVAV(LOG(GSPRZNP_ESC(-1)/GDPRZN(-1)),3)

Eqn 5: LOG(GSPRZNP_MATL/GDPRZN) = 1.00151550108*LOG(GSPRZNP_MATL(-1)/GDPRZN(-1))

Eqn 6: LOG(GSPRZNP_MTN/GDPRZN) = 0.988401613154*LOG(GSPRZNP_MTN(-1)/GDPRZN(-1))

Eqn 7: LOG(GSPRZNP_NENG/GDPRZN) = 1.00466139868*LOG(GSPRZNP_NENG(-1)/GDPRZN(-1))

Eqn 8: LOG(GSPRZNP_PAC/GDPRZN) = 1.56853212181*LOG(GSPRZNP_PAC(-1)/GDPRZN(-1)) - 0.569412166976*@MOVAV(LOG(GSPRZNP_PAC(-1)/GDPRZN(-1)),3)

Eqn 9: LOG(GSPRZNP_SATL/GDPRZN) = 1.00824323784*LOG(GSPRZNP_SATL(-1)/GDPRZN(-1))

Eqn 10 LOG(GSPRZNP_WNC/GDPRZN) = 0.97375055948*LOG(GSPRZNP_WNC(-1)/GDPRZN(-1))

Eqn 11: LOG(GSPRZNP_WSC/GDPRZN) = 0.971762462463*LOG(GSPRZNP_WSC(-1)/GDPRZN(-1))

RWM—Average annual manufacturing wages

Eqn 12: DLOG(RWM_ENC) = 1.01869328702*DLOG(JECIWSP)

Eqn 13: DLOG(RWM_ESC) = 1.22880757647*DLOG(JECIWSP)

Eqn 14: DLOG(RWM_MATL) = 1.10548610918*DLOG(JECIWSP)

Eqn 15: DLOG(RWM_MTN) = 1.31783386031*DLOG(JECIWSP)

Eqn 16: DLOG(RWM_NENG) = 1.26005568167*DLOG(JECIWSP)

Eqn 17: DLOG(RWM_PAC) = 1.24283633836*DLOG(JECIWSP)

Eqn 18: DLOG(RWM_SATL) = 1.2974640807*DLOG(JECIWSP)

Eqn 19: DLOG(RWM_WNC) = 1.07970967608*DLOG(JECIWSP)

Eqn 20: DLOG(RWM_WSC) = 1.23818579934*DLOG(JECIWSP)

RWNM—Average annual nonmanufacturing wages

Eqn 21: DLOG(RWNM_ENC) = 1.15089697853*DLOG(JECIWSP)

Eqn 22: DLOG(RWNM_ESC) = 1.15731093606*DLOG(JECIWSP)

Eqn 23: DLOG(RWNM_MATL) = 1.25045110248*DLOG(JECIWSP)

Eqn 24: DLOG(RWNM_MTN) = 1.23471573654*DLOG(JECIWSP)

Eqn 25: DLOG(RWNM_NENG) = 1.3239634903*DLOG(JECIWSP)

Eqn 26: DLOG(RWNM_PAC) = 1.19362030775*DLOG(JECIWSP)

Eqn 27: DLOG(RWNM_SATL) = 1.19460013116*DLOG(JECIWSP)

Eqn 28: DLOG(RWNM_WNC) = 1.22186061807*DLOG(JECIWSP)

Eqn 29: DLOG(RWNM_WSC) = 1.24941541178*DLOG(JECIWSP)

YP—Personal income

Eqn 30: YP_{R} = YP * (YP_{R} / YP_{R}_SUM)

YPCOMPWSD—Wage and salary disbursements

Eqn 31: YPCOMPWSD_{R} = YPCOMPWSD * (YPCOMPWSD_{R} / YPCOMPWSD_{R}_SUM)

YPCOMPWSDG—Wage and salary disbursements by government

Eqn 32: YPCOMPWSDG_{R} = YPCOMPWSDG * (YPCOMPWSDG_{R} / YPCOMPWSDG_{R}_SUM)

YPCOMPWSDP—Wage and salary disbursements by private sector

Eqn 33: YPCOMPWSDP_{R} = YPCOMPWSDP * (YPCOMPWSDP_{R} / YPCOMPWSDP_{R}_SUM)

YPD—Personal disposable income

Eqn 34: YPD_{R} = YPD * (YPD_{R} / YPD_{R}_SUM)

YPDR—Real personal disposable income

Eqn 35: YPDR_{R} = YPDR * (YPDR_{R} / YPDR_{R}_SUM)

YPDRZNP—Real per capita personal disposable income

Eqn 36: YPDRZNP_{R} = YPDR_{R} / NP_{R}

YPOTH—Other personal income

Eqn 37: YPOTH_{R} = YP_{R} - YPCOMPWSD_{R}

Appendix C2: Regional Commercial Floor Space Model

Endogenous variables:

$Comflr_{ij}$ Commercial floor space j, rate of growth, census division i

The 13 commercial floor space types, j, 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 nine census divisions, i, are:

1. New England
2. Middle Atlantic
3. South Atlantic
4. East North Central
5. East South Central
6. West North Central
7. West South Central
8. Mountain
9. Pacific

Model description is in Chapter 4.

Exogenous variables:

$COMFLRSTK_i(t)$ stock of commercial floor space type i for quarter *t*; in thousands of square feet, national

$COMFLRSTKTREND_i(t)$ long-term trend of stock of commercial floor space type i for quarter *t*; in thousands of square feet, national

$CONSR(t)$ real consumer spending on all goods and services for quarter *t*, in billions of chained 2012 dollars, national

$GDPR(t)$ real gross domestic product for quarter *t*, in billions of chained 2012 dollars, national

$IFNRER(t)$ private fixed nonresidential investment for quarter *t*, in billions of dollars, national

$JQPCMHFE(t)$ full-employment productivity in nonfarm business for quarter *t*, index - 2012 = 100, national

$NP16A(t)$ population aged 16 and over for quarter *t*, millions of persons, national

$RMCORPAAA(t)$ yield on Aaa-rated corporate bonds for quarter t; in percent per annum, national

$YPDR(t)$ disposable income for quarter t, in billions of chained 2012 dollars, national

Equations:

AMUSE **Amusement**

Eqn 1: D(ENC_AMUSE_DLBSD) = -0.000832072762079 - 0.0720745117198*D(ENC_AMUSE_DLBSD(-1)) + 0.0387720579392*DLOG(GDPR/NP16A) + 0.123709747517*(DLOG(ENC_AMUSE_FTREND(-1))-ENC_AMUSE_DLBSD(-1))

Eqn 2: D(ESC_AMUSE_DLBSD) = -0.00373081894175 - 0.335401842634*D(ESC_AMUSE_DLBSD(-1)) + 0.196077546232*DLOG(JQPCMHFE) - 0.00215116224691*DLOG(RLRMCORPAAA) + 0.239116058712*(DLOG(ESC_AMUSE_FTREND(-1))-ESC_AMUSE_DLBSD(-1))

Eqn 3: D(MA_AMUSE_DLBSD) = -0.000407103391862 - 0.453802866795*D(MA_AMUSE_DLBSD(-1)) + 0.0170573314379*DLOG(CONSR/NP16A) + 0.31894314048*(DLOG(MA_AMUSE_FTREND(-1))-MA_AMUSE_DLBSD(-1))

Eqn 4: D(MTN_AMUSE_DLBSD) = -0.00102948763286 - 0.461561895286*D(MTN_AMUSE_DLBSD(-1)) - 0.0270661122754*DLOG(NP16A) + 0.0777665300309*(DLOG(MTN_AMUSE_FTREND(-1))-MTN_AMUSE_DLBSD(-1))

Eqn 5: D(NENG_AMUSE_DLBSD) = -0.000439795525973 - 0.103738750214*D(NENG_AMUSE_DLBSD(-1)) + 0.0111085314729*DLOG(GDPR/NP16A) + 0.249976767744*(DLOG(NENG_AMUSE_FTREND(-1))-NENG_AMUSE_DLBSD(-1))

Eqn 6: D(PAC_AMUSE_DLBSD) = -0.000659284929041 - 0.165972843453*D(PAC_AMUSE_DLBSD(-1)) + 0.0181819094362*DLOG(GDPR/NP16A) + 0.249167884848*(DLOG(PAC_AMUSE_FTREND(-1))-PAC_AMUSE_DLBSD(-1))

Eqn 7: D(SATL_AMUSE_DLBSD) = -0.000600986186757 + 0.0789994738504*D(SATL_AMUSE_DLBSD(-1)) + 0.00413598294789*DLOG(IFNRER/NP16A) + 0.130913154656*(DLOG(SATL_AMUSE_FTREND(-1))-SATL_AMUSE_DLBSD(-1))

Eqn 8: D(WNC_AMUSE_DLBSD) = -0.000418727578021 - 0.457243752305*D(WNC_AMUSE_DLBSD(-1)) + 0.00106921945163*DLOG(IFNRER/NP16A) + 0.203881689504*(DLOG(WNC_AMUSE_FTREND(-1))-WNC_AMUSE_DLBSD(-1))

Eqn 9: D(WSC_AMUSE_DLBSD) = -0.000969474178273 - 0.339772488402*D(WSC_AMUSE_DLBSD(-1)) + 0.0247112564141*DLOG(GDPR/NP16A) + 0.151944370279*(DLOG(WSC_AMUSE_FTREND(-1))-WSC_AMUSE_DLBSD(-1))

Eqn 10: TOTAL_AMUSE_DLBSD = 0.175014381 * ENC_AMUSE_DLBSD + 0.063751448 * ESC_AMUSE_DLBSD + 0.141906182 * MA_AMUSE_DLBSD + 0.061541654 * MTN_AMUSE_DLBSD + 0.050935824 * NENG_AMUSE_DLBSD + 0.138725549 * PAC_AMUSE_DLBSD + 0.178501786 * SATL_AMUSE_DLBSD + 0.076720845 * WNC_AMUSE_DLBSD + 0.112902331 * WSC_AMUSE_DLBSD

AMUSE_REL Amusement and religious

Eqn 11: ENC_AMUSE_REL_DLBSD = 0.441821 * ENC_AMUSE_DLBSD + 0.558179 * ENC_REL_DLBSD

Eqn 12: ESC_AMUSE_REL_DLBSD = 0.416758 * ESC_AMUSE_DLBSD + 0.583242 * ESC_REL_DLBSD

Eqn 13: MA_AMUSE_REL_DLBSD = 0.432946 * MA_AMUSE_DLBSD + 0.567054 * MA_REL_DLBSD

Eqn 14: MTN_AMUSE_REL_DLBSD = 0.485667 * MTN_AMUSE_DLBSD + 0.514333 * MTN_REL_DLBSD

Eqn 15: NENG_AMUSE_REL_DLBSD = 0.425248 * NENG_AMUSE_DLBSD + 0.574752 * NENG_REL_DLBSD

Eqn 16: PAC_AMUSE_REL_DLBSD = 0.545379 * PAC_AMUSE_DLBSD + 0.454621 * PAC_REL_DLBSD

Eqn 17: SATL_AMUSE_REL_DLBSD = 0.477301 * SATL_AMUSE_DLBSD + 0.522699 * SATL_REL_DLBSD

Eqn 18: WNC_AMUSE_REL_DLBSD = 0.418214 * WNC_AMUSE_DLBSD + 0.581786 * WNC_REL_DLBSD

Eqn 19: WSC_AMUSE_REL_DLBSD = 0.428857 * WSC_AMUSE_DLBSD + 0.571143 * WSC_REL_DLBSD

Eqn 20: TOTAL_AMUSE_REL_DLBSD = 0.174753352 * ENC_AMUSE_REL_DLBSD + 0.071649653 * ESC_AMUSE_REL_DLBSD + 0.130168272 * MA_AMUSE_REL_DLBSD + 0.064923786 * MTN_AMUSE_REL_DLBSD + 0.048771059 * NENG_AMUSE_REL_DLBSD + 0.116627761 * PAC_AMUSE_REL_DLBSD + 0.185364574 * SATL_AMUSE_REL_DLBSD + 0.08150079 * WNC_AMUSE_REL_DLBSD + 0.126240736 * WSC_AMUSE_REL_DLBSD

AUTO Automotive; auto service and parking garages

Eqn 21: D(ENC_AUTO_DLBSD) = -0.000698320914555 - 0.374414175583*D(ENC_AUTO_DLBSD(-1)) + 0.0319383662535*DLOG(GDPR/NP16A) + 0.157685868071*(DLOG(ENC_AUTO_FTREND(-1))-ENC_AUTO_DLBSD(-1))

Eqn 22: D(ESC_AUTO_DLBSD) = -0.00022970456735 - 0.463373708792*D(ESC_AUTO_DLBSD(-1)) + 0.0160571406109*DLOG(IFNRER/NP16A) + 0.11846994155*(DLOG(ESC_AUTO_FTREND(-1))-ESC_AUTO_DLBSD(-1))

Eqn 23: D(MA_AUTO_DLBSD) = -0.000113846304232 - 0.113325347023*D(MA_AUTO_DLBSD(-1)) + 0.0142624158465*DLOG(GDPR/NP16A) + 0.179638968358*(DLOG(MA_AUTO_FTREND(-1))-MA_AUTO_DLBSD(-1))

Eqn 24: D(MTN_AUTO_DLBSD) = -0.00110722935793 - 0.304747448767*D(MTN_AUTO_DLBSD(-1)) + 0.0727848103751*DLOG(GDPR/NP16A) + 0.0502079272969*(DLOG(MTN_AUTO_FTREND(-1))-MTN_AUTO_DLBSD(-1))

Eqn 25: D(NENG_AUTO_DLBSD) = -0.00147252453357 - 0.434501155681*D(NENG_AUTO_DLBSD(-1)) + 0.091031116583*DLOG(GDPR/NP16A) + 0.151761789883*(DLOG(NENG_AUTO_FTREND(-1))-NENG_AUTO_DLBSD(-1))

Eqn 26: D(PAC_AUTO_DLBSD) = -0.00108663879968 + 0.0688030098099*D(PAC_AUTO_DLBSD(-1)) + 0.0448925979779*DLOG(GDPR/NP16A) + 0.0701644274347*(DLOG(PAC_AUTO_FTREND(-1))-PAC_AUTO_DLBSD(-1))

Eqn 27: D(SATL_AUTO_DLBSD) = -0.00230849453045 + 0.0286760424046*D(SATL_AUTO_DLBSD(-1)) + 0.150207389855*DLOG(GDPR/NP16A) + 0.0400779035565*(DLOG(SATL_AUTO_FTREND(-1))-SATL_AUTO_DLBSD(-1))

Eqn 28: D(WNC_AUTO_DLBSD) = -0.000288537915879 - 0.255844155194*D(WNC_AUTO_DLBSD(-1)) + 0.0177332859535*DLOG(GDPR/NP16A) + 0.137366512501*(DLOG(WNC_AUTO_FTREND(-1))-WNC_AUTO_DLBSD(-1))

Eqn 29: D(WSC_AUTO_DLBSD) = -0.00105219311707 - 0.0144702257427*D(WSC_AUTO_DLBSD(-1)) + 0.0499751320672*DLOG(CONSR/NP16A) + 0.144777124583*(DLOG(WSC_AUTO_FTREND(-1))-WSC_AUTO_DLBSD(-1))

Eqn 30: TOTAL_AUTO_DLBSD = 0.165014789 * ENC_AUTO_DLBSD + 0.055705552 * ESC_AUTO_DLBSD + 0.117778519 * MA_AUTO_DLBSD + 0.064440837 * MTN_AUTO_DLBSD + 0.053263054 * NENG_AUTO_DLBSD + 0.162838531 * PAC_AUTO_DLBSD + 0.188263062 * SATL_AUTO_DLBSD + 0.077287587 * WNC_AUTO_DLBSD + 0.11540807 * WSC_AUTO_DLBSD

DORM Dormitories; educational and federally owned (primarily military)

Eqn 31: D(ENC_DORM_DLBSD) = -0.000292728153498 - 0.275938017905*D(ENC_DORM_DLBSD(-1)) + 0.0362791354246*DLOG(GDPR/NP16A) + 0.0578273626442*(DLOG(ENC_DORM_FTREND(-1))-ENC_DORM_DLBSD(-1))

Eqn 32: D(ESC_DORM_DLBSD) = 7.99456168547e-05 - 0.103684576537*D(ESC_DORM_DLBSD(-1)) + 0.0120637101023*DLOG(GDPR/NP16A) + 0.219492265906*(DLOG(ESC_DORM_FTREND(-1))-ESC_DORM_DLBSD(-1))

Eqn 33: D(MA_DORM_DLBSD) = -0.000992916021542 - 0.370645109695*D(MA_DORM_DLBSD(-1)) + 0.0380549755945*DLOG(GDPR/NP16A) + 0.109670373509*(DLOG(MA_DORM_FTREND(-1))-MA_DORM_DLBSD(-1))

Eqn 34: D(MTN_DORM_DLBSD) = -0.000421958315899 - 0.422975687985*D(MTN_DORM_DLBSD(-1)) + 0.0224891639683*DLOG(YPDR/NP16A) + 0.301143116034*(DLOG(MTN_DORM_FTREND(-1))-MTN_DORM_DLBSD(-1))

Eqn 35: D(NENG_DORM_DLBSD) = -0.000418458394142 - 0.154081330667*D(NENG_DORM_DLBSD(-1)) + 0.00309472652408*DLOG(GDPR/NP16A) + 0.231106333618*(DLOG(NENG_DORM_FTREND(-1))-NENG_DORM_DLBSD(-1))

Eqn 36: D(PAC_DORM_DLBSD) = -0.0011832043442 - 0.180492422719*D(PAC_DORM_DLBSD(-1)) + 0.110036928562*DLOG(JQPCMHFE) - 0.00462373061046*DLOG(RLRMCORPAAA) + 0.0940563870735*(DLOG(PAC_DORM_FTREND(-1))-PAC_DORM_DLBSD(-1))

Eqn 37: D(SATL_DORM_DLBSD) = -0.000281949599764 - 0.155350061628*D(SATL_DORM_DLBSD(-1)) + 0.0267092450083*DLOG(GDPR/NP16A) + 0.113395130477*(DLOG(SATL_DORM_FTREND(-1))-SATL_DORM_DLBSD(-1))

Eqn 38: D(WNC_DORM_DLBSD) = -0.000448286326143 - 0.302672585009*D(WNC_DORM_DLBSD(-1)) + 0.0646786279621*DLOG(GDPR/NP16A) + 0.122998902284*(DLOG(WNC_DORM_FTREND(-1))-WNC_DORM_DLBSD(-1))

Eqn 39: D(WSC_DORM_DLBSD) = -0.00193917656251 - 0.533613521511*D(WSC_DORM_DLBSD(-1)) + 0.137776108107*DLOG(JQPCMHFE) - 8.39934202014e-05*DLOG(RLRMCORPAAA) + 0.0706630812566*(DLOG(WSC_DORM_FTREND(-1))-WSC_DORM_DLBSD(-1))

Eqn 40: TOTAL_DORM_DLBSD = 0.115461093 * ENC_DORM_DLBSD + 0.07786562 * ESC_DORM_DLBSD + 0.106164435 * MA_DORM_DLBSD + 0.0737696 * MTN_DORM_DLBSD + 0.057914076 * NENG_DORM_DLBSD + 0.174389063 * PAC_DORM_DLBSD + 0.20975663 * SATL_DORM_DLBSD + 0.06994049 * WNC_DORM_DLBSD + 0.114738993 * WSC_DORM_DLBSD

EDUC Education; primary/secondary and higher education

Eqn 41: D(ENC_EDUC_DLBSD) = -0.000558594601758 + 0.0710396091079*D(ENC_EDUC_DLBSD(-1)) + 0.00410089884199*DLOG(GDPR/NP16A) + 0.0929084163531*(DLOG(ENC_EDUC_FTREND(-1))-ENC_EDUC_DLBSD(-1))

Eqn 42: D(ESC_EDUC_DLBSD) = -0.000754900742091 + 0.0970685451146*D(ESC_EDUC_DLBSD(-1)) + 0.0171612978949*DLOG(GDPR/NP16A) + 0.126801057333*(DLOG(ESC_EDUC_FTREND(-1))-ESC_EDUC_DLBSD(-1))

Eqn 43: D(MA_EDUC_DLBSD) = -0.000337942779065 + 0.255389545402*D(MA_EDUC_DLBSD(-1)) + 0.00334876632934*DLOG(YPDR/NP16A) + 0.144054674232*(DLOG(MA_EDUC_FTREND(-1))-MA_EDUC_DLBSD(-1))

Eqn 44: D(MTN_EDUC_DLBSD) = -0.00119580858239 - 0.10103665862*D(MTN_EDUC_DLBSD(-1)) + 0.0243361847149*DLOG(CONSR/NP16A) + 0.146781026842*(DLOG(MTN_EDUC_FTREND(-1))-MTN_EDUC_DLBSD(-1))

Eqn 45: D(NENG_EDUC_DLBSD) = -0.00103725659202 + 0.209024369154*D(NENG_EDUC_DLBSD(-1)) + 0.0346133107283*DLOG(GDPR/NP16A) + 0.16783949575*(DLOG(NENG_EDUC_FTREND(-1))-NENG_EDUC_DLBSD(-1))

Eqn 46: D(PAC_EDUC_DLBSD) = -0.00102928788872 - 0.0148601606982*D(PAC_EDUC_DLBSD(-1)) + 0.0516099693653*DLOG(GDPR/NP16A) + 0.125890514881*(DLOG(PAC_EDUC_FTREND(-1))-PAC_EDUC_DLBSD(-1))

Eqn 47: D(SATL_EDUC_DLBSD) = -0.00398728660448 - 0.0181574030851*D(SATL_EDUC_DLBSD(-1)) + 0.211617259173*DLOG(JQPCMHFE) - 0.004504375038*DLOG(RLRMCORPAAA) + 0.0960453038904*(DLOG(SATL_EDUC_FTREND(-1))-SATL_EDUC_DLBSD(-1))

Eqn 48: D(WNC_EDUC_DLBSD) = -0.000871913406763 - 0.125738523085*D(WNC_EDUC_DLBSD(-1)) + 0.0311961521531*DLOG(GDPR/NP16A) + 0.0657743120893*(DLOG(WNC_EDUC_FTREND(-1))-WNC_EDUC_DLBSD(-1))

Eqn 49: D(WSC_EDUC_DLBSD) = -0.000320176005805 + 0.00209705688424*D(WSC_EDUC_DLBSD(-1)) + 0.0144603726048*DLOG(GDPR/NP16A) + 0.0409332059821*(DLOG(WSC_EDUC_FTREND(-1))-WSC_EDUC_DLBSD(-1))

Eqn 50: TOTAL_EDUC_DLBSD = 0.174086374 * ENC_EDUC_DLBSD + 0.063034543 * ESC_EDUC_DLBSD + 0.150215507 * MA_EDUC_DLBSD + 0.06158221 * MTN_EDUC_DLBSD + 0.059590026 * NENG_EDUC_DLBSD + 0.126166958 * PAC_EDUC_DLBSD + 0.175296984 * SATL_EDUC_DLBSD + 0.074693572 * WNC_EDUC_DLBSD + 0.115333826 * WSC_EDUC_DLBSD

HEALTH Health; hospitals and nursing homes

Eqn 51: D(ENC_HEALTH_DLBSD) = -0.00163138555574 - 0.0750460795316*D(ENC_HEALTH_DLBSD(-1)) + 0.0649441486851*DLOG(GDPR/NP16A) + 0.150021021342*(DLOG(ENC_HEALTH_FTREND(-1))-ENC_HEALTH_DLBSD(-1))

Eqn 52: D(ESC_HEALTH_DLBSD) = -0.00157632834414 - 0.156655033622*D(ESC_HEALTH_DLBSD(-1)) + 0.0209906180303*DLOG(GDPR/NP16A) + 0.490037862535*(DLOG(ESC_HEALTH_FTREND(-1))-ESC_HEALTH_DLBSD(-1))

Eqn 53: D(MA_HEALTH_DLBSD) = -0.0013771989046 + 0.232300119039*D(MA_HEALTH_DLBSD(-1)) + 0.0781074937729*DLOG(GDPR/NP16A) + 0.313664646447*(DLOG(MA_HEALTH_FTREND(-1))-MA_HEALTH_DLBSD(-1))

Eqn 54: D(MTN_HEALTH_DLBSD) = -0.00182491328659 - 0.361819977701*D(MTN_HEALTH_DLBSD(-1)) + 0.0680175895917*DLOG(GDPR/NP16A) + 0.0285730449717*(DLOG(MTN_HEALTH_FTREND(-1))-MTN_HEALTH_DLBSD(-1))

Eqn 55: D(NENG_HEALTH_DLBSD) = -0.00139084621644 - 0.0847666009765*D(NENG_HEALTH_DLBSD(-1)) + 0.0066821981229*DLOG(GDPR/NP16A) + 0.721884451386*(DLOG(NENG_HEALTH_FTREND(-1))-NENG_HEALTH_DLBSD(-1))

Eqn 56: D(PAC_HEALTH_DLBSD) = -0.000961255664591 + 0.00515194415965*D(PAC_HEALTH_DLBSD(-1)) - 0.000976478986494*DLOG(IFNRER/NP16A) + 0.196816642353*(DLOG(PAC_HEALTH_FTREND(-1))-PAC_HEALTH_DLBSD(-1))

Eqn 57: D(SATL_HEALTH_DLBSD) = -0.00190425260659 + 0.0837854048057*D(SATL_HEALTH_DLBSD(-1)) + 0.0668024287851*DLOG(GDPR/NP16A) + 0.183853921581*(DLOG(SATL_HEALTH_FTREND(-1))-SATL_HEALTH_DLBSD(-1))

Eqn 58: D(WNC_HEALTH_DLBSD) = -0.000860938400014 - 0.19637502629*D(WNC_HEALTH_DLBSD(-1)) + 0.0221057118259*DLOG(GDPR/NP16A) + 0.265971185114*(DLOG(WNC_HEALTH_FTREND(-1))-WNC_HEALTH_DLBSD(-1))

Eqn 59: D(WSC_HEALTH_DLBSD) = -0.000804358776461 - 0.163246639743*D(WSC_HEALTH_DLBSD(-1)) + 0.00132498282258*DLOG(GDPR/NP16A) + 0.214120556607*(DLOG(WSC_HEALTH_FTREND(-1))-WSC_HEALTH_DLBSD(-1))

Eqn 60: TOTAL_HEALTH_DLBSD = 0.178028051 * ENC_HEALTH_DLBSD + 0.068358138 * ESC_HEALTH_DLBSD + 0.155416667 * MA_HEALTH_DLBSD + 0.048975149 * MTN_HEALTH_DLBSD +

0.05557712 * NENG_HEALTH_DLBSD + 0.118768226 * PAC_HEALTH_DLBSD + 0.176866835 * SATL_HEALTH_DLBSD + 0.086777387 * WNC_HEALTH_DLBSD + 0.111232426 * WSC_HEALTH_DLBSD

HOTEL Hotel; hotels and motels

Eqn 61: D(ENC_HOTEL_DLBSD) = -0.00390010031505 + 0.308969769427*D(ENC_HOTEL_DLBSD(-1)) + 0.240518249511*DLOG(GDPR/NP16A) + 0.430505428022*(DLOG(ENC_HOTEL_FTREND(-1))-ENC_HOTEL_DLBSD(-1))

Eqn 62: D(ESC_HOTEL_DLBSD) = -0.00584233911777 + 0.557665903721*D(ESC_HOTEL_DLBSD(-1)) + 0.245968190117*DLOG(GDPR/NP16A) + 0.583355039424*(DLOG(ESC_HOTEL_FTREND(-1))-ESC_HOTEL_DLBSD(-1))

Eqn 63: D(MA_HOTEL_DLBSD) = -0.000487113850181 + 0.0227542167443*D(MA_HOTEL_DLBSD(-1)) + 0.0428376306832*DLOG(GDPR/NP16A) + 0.384402879933*(DLOG(MA_HOTEL_FTREND(-1))-MA_HOTEL_DLBSD(-1))

Eqn 64: D(MTN_HOTEL_DLBSD) = -0.0138513001156 + 0.0644170965426*D(MTN_HOTEL_DLBSD(-1)) + 0.692593071865*DLOG(JQPCMHFE) - 0.00561768605936*DLOG(RLRMCORPAAA) + 0.804910984361*(DLOG(MTN_HOTEL_FTREND(-1))-MTN_HOTEL_DLBSD(-1))

Eqn 65: D(NENG_HOTEL_DLBSD) = -0.00372279220856 - 0.0698339628439*D(NENG_HOTEL_DLBSD(-1)) + 0.183530591689*DLOG(GDPR/NP16A) + 0.281323005398*(DLOG(NENG_HOTEL_FTREND(-1))-NENG_HOTEL_DLBSD(-1))

Eqn 66: D(PAC_HOTEL_DLBSD) = -0.00323885952561 - 0.0260348838575*D(PAC_HOTEL_DLBSD(-1)) + 0.0772551690523*DLOG(GDPR/NP16A) + 0.310051121876*(DLOG(PAC_HOTEL_FTREND(-1))-PAC_HOTEL_DLBSD(-1))

Eqn 67: D(SATL_HOTEL_DLBSD) = -0.0057829881281 + 0.589387935599*D(SATL_HOTEL_DLBSD(-1)) + 0.298830066867*DLOG(GDPR/NP16A) + 0.414626477111*(DLOG(SATL_HOTEL_FTREND(-1))-SATL_HOTEL_DLBSD(-1))

Eqn 68: D(WNC_HOTEL_DLBSD) = -0.00114736493743 + 0.00734398252579*D(WNC_HOTEL_DLBSD(-1)) + 0.0112742952825*DLOG(IFNRER/NP16A) + 0.668494206423*(DLOG(WNC_HOTEL_FTREND(-1))-WNC_HOTEL_DLBSD(-1))

Eqn 69: D(WSC_HOTEL_DLBSD) = -0.00261299275374 + 0.275326708188*D(WSC_HOTEL_DLBSD(-1)) + 0.0443283967817*DLOG(IFNRER/NP16A) + 0.266310206901*(DLOG(WSC_HOTEL_FTREND(-1))-WSC_HOTEL_DLBSD(-1))

Eqn 70: TOTAL_HOTEL_DLBSD = 0.120081877 * ENC_HOTEL_DLBSD + 0.053191674 * ESC_HOTEL_DLBSD + 0.110171724 * MA_HOTEL_DLBSD + 0.115250261 * MTN_HOTEL_DLBSD + 0.045175766 * NENG_HOTEL_DLBSD + 0.159318344 * PAC_HOTEL_DLBSD + 0.227140741 * SATL_HOTEL_DLBSD + 0.065568116 * WNC_HOTEL_DLBSD + 0.104101497 * WSC_HOTEL_DLBSD

HOTEL_DORM **Hotel and dormitories; Hotels and motels and educational and federally owned dormitories (primarily military)**

Eqn 71: ENC_HOTEL_DORM_DLBSD = 0.634201 * ENC_HOTEL_DLBSD + 0.365799 * ENC_DORM_DLBSD

Eqn 72: ESC_HOTEL_DORM_DLBSD = 0.529713 * ESC_HOTEL_DLBSD + 0.470287 * ESC_DORM_DLBSD

Eqn 73: MA_HOTEL_DORM_DLBSD = 0.646117 * MA_HOTEL_DLBSD + 0.353883 * MA_DORM_DLBSD

Eqn 74: MTN_HOTEL_DORM_DLBSD = 0.704116 * MTN_HOTEL_DLBSD + 0.295884 * MTN_DORM_DLBSD

Eqn 75: NENG_HOTEL_DORM_DLBSD = 0.574928 * NENG_HOTEL_DLBSD + 0.425072 * NENG_DORM_DLBSD

Eqn 76: PAC_HOTEL_DORM_DLBSD = 0.601099 * PAC_HOTEL_DLBSD + 0.398901 * PAC_DORM_DLBSD

Eqn 77: SATL_HOTEL_DORM_DLBSD = 0.637119 * SATL_HOTEL_DLBSD + 0.362881 * SATL_DORM_DLBSD

Eqn 78: WNC_HOTEL_DORM_DLBSD = 0.614984 * WNC_HOTEL_DLBSD + 0.385016 * WNC_DORM_DLBSD

Eqn 79: WSC_HOTEL_DORM_DLBSD = 0.593967 * WSC_HOTEL_DLBSD + 0.406033 * WSC_DORM_DLBSD

Eqn 80: TOTAL_HOTEL_DORM_DLBSD = 0.115629647 * ENC_HOTEL_DORM_DLBSD + 0.062403481 * ESC_HOTEL_DORM_DLBSD + 0.104072045 * MA_HOTEL_DORM_DLBSD + 0.108167117 * MTN_HOTEL_DORM_DLBSD + 0.047379489 * NENG_HOTEL_DORM_DLBSD + 0.156446106 * PAC_HOTEL_DORM_DLBSD + 0.228566007 * SATL_HOTEL_DORM_DLBSD + 0.063965981 * WNC_HOTEL_DORM_DLBSD + 0.113370068 * WSC_HOTEL_DORM_DLBSD

MFG **Manufacturing**

Eqn 81: D(ENC_MFG_DLBSD) = -0.000333905007165 + 0.163633899132*D(ENC_MFG_DLBSD(-1)) + 0.0166440882339*DLOG(GDPR/NP16A) + 0.308045689557*(DLOG(ENC_MFG_FTREND(-1))-ENC_MFG_DLBSD(-1))

Eqn 82: D(ESC_MFG_DLBSD) = -0.000129226665978 + 0.291373490412*D(ESC_MFG_DLBSD(-1)) + 0.00430334370186*DLOG(IFNRER/NP16A) + 0.572257153043*(DLOG(ESC_MFG_FTREND(-1))-ESC_MFG_DLBSD(-1))

Eqn 83: D(MA_MFG_DLBSD) = -0.00110476562161 - 0.00875641251539*D(MA_MFG_DLBSD(-1)) + 0.0766879841306*DLOG(NP16A) + 0.483525306038*(DLOG(MA_MFG_FTREND(-1))-MA_MFG_DLBSD(-1))

Eqn 84: D(MTN_MFG_DLBSD) = -0.000531767217707 - 0.00827810977787*D(MTN_MFG_DLBSD(-1)) + 0.010113339807*DLOG(IFNRER/NP16A) + 0.38319855609*(DLOG(MTN_MFG_FTREND(-1))-MTN_MFG_DLBSD(-1))

Eqn 85: D(NENG_MFG_DLBSD) = -0.000316932699958 - 0.33347564153*D(NENG_MFG_DLBSD(-1)) + 0.0072992366873*DLOG(IFNRER/NP16A) + 0.160851726405*(DLOG(NENG_MFG_FTREND(-1))-NENG_MFG_DLBSD(-1))

Eqn 86: D(PAC_MFG_DLBSD) = -0.000618436500209 + 0.12721790266*D(PAC_MFG_DLBSD(-1)) + 0.016289224671*DLOG(IFNRER/NP16A) + 0.119054024724*(DLOG(PAC_MFG_FTREND(-1))-PAC_MFG_DLBSD(-1))

Eqn 87: D(SATL_MFG_DLBSD) = -0.000392806701518 - 0.0329671520865*D(SATL_MFG_DLBSD(-1)) + 0.00681243974875*DLOG(IFNRER/NP16A) + 0.251008973262*(DLOG(SATL_MFG_FTREND(-1))-SATL_MFG_DLBSD(-1))

Eqn 88: D(WNC_MFG_DLBSD) = -0.00758123613289 + 0.277572255489*D(WNC_MFG_DLBSD(-1)) + 0.634422572755*DLOG(NP16A) + 0.690074623934*(DLOG(WNC_MFG_FTREND(-1))-WNC_MFG_DLBSD(-1))

Eqn 89: D(WSC_MFG_DLBSD) = -0.00684853126593 + 0.0327641633334*D(WSC_MFG_DLBSD(-1)) + 0.575534881784*DLOG(NP16A) + 0.480127403063*(DLOG(WSC_MFG_FTREND(-1))-WSC_MFG_DLBSD(-1))

Eqn 90: TOTAL_MFG_DLBSD = 0.247585636 * ENC_MFG_DLBSD + 0.07463863 * ESC_MFG_DLBSD + 0.155291314 * MA_MFG_DLBSD + 0.032496146 * MTN_MFG_DLBSD + 0.062536882 * NENG_MFG_DLBSD + 0.12067783 * PAC_MFG_DLBSD + 0.15447908 * SATL_MFG_DLBSD + 0.072405514 * WNC_MFG_DLBSD + 0.079888968 * WSC_MFG_DLBSD

MISCNR **Miscellaneous, non-residential transportation related and all other not elsewhere classified**

Eqn 91: D(ENC_MISCNR_DLBSD) = -0.00379344820353 - 0.0736723305717*D(ENC_MISCNR_DLBSD(-1)) + 0.0312785986514*DLOG(IFNRER/NP16A) + 0.278069308713*(DLOG(ENC_MISCNR_FTREND(-1))-ENC_MISCNR_DLBSD(-1))

Eqn 92: D(ESC_MISCNR_DLBSD) = -0.00488402387977 - 0.408919951653*D(ESC_MISCNR_DLBSD(-1)) + 0.0419046557703*DLOG(YPDR/NP16A) + 0.406272841895*(DLOG(ESC_MISCNR_FTREND(-1))-ESC_MISCNR_DLBSD(-1))

Eqn 93: D(MA_MISCNR_DLBSD) = -0.00398616081756 - 0.284304150651*D(MA_MISCNR_DLBSD(-1)) + 0.0550734390288*DLOG(CONSR/NP16A) + 0.606858730251*(DLOG(MA_MISCNR_FTREND(-1))-MA_MISCNR_DLBSD(-1))

Eqn 94: D(MTN_MISCNR_DLBSD) = -0.0405102506818 - 0.101572002526*D(MTN_MISCNR_DLBSD(-1)) + 3.47159152284*DLOG(NP16A) + 0.903694349967*(DLOG(MTN_MISCNR_FTREND(-1))-MTN_MISCNR_DLBSD(-1))

Eqn 95: D(NENG_MISCNR_DLBSD) = -0.00445021440183 - 0.43410423953*D(NENG_MISCNR_DLBSD(-1)) + 0.0389638480488*DLOG(YPDR/NP16A) + 0.620468684893*(DLOG(NENG_MISCNR_FTREND(-1))-NENG_MISCNR_DLBSD(-1))

Eqn 96: D(PAC_MISCNR_DLBSD) = -0.0298981082947 - 0.0316274323225*D(PAC_MISCNR_DLBSD(-1)) + 2.53143755986*DLOG(NP16A) + 0.460857095335*(DLOG(PAC_MISCNR_FTREND(-1))-PAC_MISCNR_DLBSD(-1))

Eqn 97: D(SATL_MISCNR_DLBSD) = -0.00469127745954 - 0.197902810379*D(SATL_MISCNR_DLBSD(-1)) + 0.103317535187*DLOG(JQPCMHFE) - 0.0120251664319*DLOG(RLRMCORPAAA) + 0.502765948213*(DLOG(SATL_MISCNR_FTREND(-1))-SATL_MISCNR_DLBSD(-1))

Eqn 98: D(WNC_MISCNR_DLBSD) = -0.00411999921005 - 0.221954474975*D(WNC_MISCNR_DLBSD(-1)) + 0.134581724789*DLOG(GDPR/NP16A) + 0.511139959796*(DLOG(WNC_MISCNR_FTREND(-1))-WNC_MISCNR_DLBSD(-1))

Eqn 99: D(WSC_MISCNR_DLBSD) = -0.0162463414029 - 0.37592021928*D(WSC_MISCNR_DLBSD(-1)) + 1.19041849843*DLOG(NP16A) + 0.58570130876*(DLOG(WSC_MISCNR_FTREND(-1))-WSC_MISCNR_DLBSD(-1))

Eqn 100: TOTAL_MISCNR_DLBSD = 0.163712298 * ENC_MISCNR_DLBSD + 0.054450626 * ESC_MISCNR_DLBSD + 0.110677479 * MA_MISCNR_DLBSD + 0.078805829 * MTN_MISCNR_DLBSD + 0.03496633 * NENG_MISCNR_DLBSD + 0.184376493 * PAC_MISCNR_DLBSD + 0.195534448 * SATL_MISCNR_DLBSD + 0.068779612 * WNC_MISCNR_DLBSD + 0.108696885 * WSC_MISCNR_DLBSD

OFFICE Office; private, federal, and state and local offices

Eqn 101: D(ENC_OFFICE_DLBSD) = -0.000951913191188 + 0.197249740653*D(ENC_OFFICE_DLBSD(-1)) + 0.0486560827483*DLOG(GDPR/NP16A) + 0.207106428571*(DLOG(ENC_OFFICE_FTREND(-1))-ENC_OFFICE_DLBSD(-1))

Eqn 102: D(ESC_OFFICE_DLBSD) = -0.000763558714832 + 0.0340286011465*D(ESC_OFFICE_DLBSD(-1)) + 0.0250398373684*DLOG(CONSR/NP16A) + 0.364337534711*(DLOG(ESC_OFFICE_FTREND(-1))-ESC_OFFICE_DLBSD(-1))

Eqn 103: D(MA_OFFICE_DLBSD) = -0.000955520250851 + 0.00327893227615*D(MA_OFFICE_DLBSD(-1)) + 0.0264966379646*DLOG(CONSR/NP16A) + 0.31621162572*(DLOG(MA_OFFICE_FTREND(-1))-MA_OFFICE_DLBSD(-1))

Eqn 104: D(MTN_OFFICE_DLBSD) = -0.000877903426897 + 0.265361108478*D(MTN_OFFICE_DLBSD(-1)) + 0.00901734785601*DLOG(IFNRER/NP16A) + 0.212714365331*(DLOG(MTN_OFFICE_FTREND(-1))-MTN_OFFICE_DLBSD(-1))

Eqn 105: D(NENG_OFFICE_DLBSD) = -0.000635465117865 + 0.153508954416*D(NENG_OFFICE_DLBSD(-1)) + 0.0322143949688*DLOG(GDPR/NP16A) + 0.216689649165*(DLOG(NENG_OFFICE_FTREND(-1))-NENG_OFFICE_DLBSD(-1))

Eqn 106: D(PAC_OFFICE_DLBSD) = -0.00291649396779 + 0.168666051048*D(PAC_OFFICE_DLBSD(-1)) + 0.137738458298*DLOG(JQPCMHFE) + 0.160331239312*(DLOG(PAC_OFFICE_FTREND(-1))-PAC_OFFICE_DLBSD(-1))

Eqn 107: D(SATL_OFFICE_DLBSD) = -0.000974701075741 + 0.556779578211*D(SATL_OFFICE_DLBSD(-1)) + 0.0287109655647*DLOG(GDPR/NP16A) + 0.183465017209*(DLOG(SATL_OFFICE_FTREND(-1))-SATL_OFFICE_DLBSD(-1))

Eqn 108: D(WNC_OFFICE_DLBSD) = -0.0048886570866 - 0.0083621030688*D(WNC_OFFICE_DLBSD(-1)) + 0.250266981835*DLOG(JQPCMHFE) + 0.434695877208*(DLOG(WNC_OFFICE_FTREND(-1))-WNC_OFFICE_DLBSD(-1))

Eqn 109: D(WSC_OFFICE_DLBSD) = -0.000161171156568 + 0.324192280354*D(WSC_OFFICE_DLBSD(-1)) + 0.0129128355666*DLOG(CONSR/NP16A) + 0.212745378149*(DLOG(WSC_OFFICE_FTREND(-1))-WSC_OFFICE_DLBSD(-1))

Eqn 110: TOTAL_OFFICE_DLBSD = 0.172554356 * ENC_OFFICE_DLBSD + 0.049705679 * ESC_OFFICE_DLBSD + 0.154375382 * MA_OFFICE_DLBSD + 0.054450379 * MTN_OFFICE_DLBSD + 0.060490839 * NENG_OFFICE_DLBSD + 0.15329798 * PAC_OFFICE_DLBSD + 0.175771552 * SATL_OFFICE_DLBSD + 0.070659464 * WNC_OFFICE_DLBSD + 0.108694369 * WSC_OFFICE_DLBSD

PUB Public; federal and state and local

Eqn 111: D(ENC_PUB_DLBSD) = -0.00202872038268 - 0.157413467288*D(ENC_PUB_DLBSD(-1)) + 0.0352666359765*DLOG(GDPR/NP16A) + 0.381161504289*(DLOG(ENC_PUB_FTREND(-1))-ENC_PUB_DLBSD(-1))

Eqn 112: D(ESC_PUB_DLBSD) = -0.0033565273559 - 0.195113186186*D(ESC_PUB_DLBSD(-1)) + 0.0531995927421*DLOG(GDPR/NP16A) + 0.314481857858*(DLOG(ESC_PUB_FTREND(-1))-ESC_PUB_DLBSD(-1))

Eqn 113: D(MA_PUB_DLBSD) = -0.00274605372893 - 0.277698959466*D(MA_PUB_DLBSD(-1)) + 0.0262474589365*DLOG(CONSR/NP16A) + 0.394345887389*(DLOG(MA_PUB_FTREND(-1))-MA_PUB_DLBSD(-1))

Eqn 114: D(MTN_PUB_DLBSD) = -0.00873453687294 - 0.207446726948*D(MTN_PUB_DLBSD(-1)) + 0.361133987789*DLOG(JQPCMHFE) - 0.00111571095577*DLOG(RLRMCORPAAA) + 0.215207598445*(DLOG(MTN_PUB_FTREND(-1))-MTN_PUB_DLBSD(-1))

Eqn 115: D(NENG_PUB_DLBSD) = -0.00530403265311 + 0.100849752098*D(NENG_PUB_DLBSD(-1)) + 0.230067459693*DLOG(JQPCMHFE) - 0.01205052641*DLOG(RLRMCORPAAA) + 0.5449744491*(DLOG(NENG_PUB_FTREND(-1))-NENG_PUB_DLBSD(-1))

Eqn 116: D(PAC_PUB_DLBSD) = -0.00518819375585 - 0.254841027218*D(PAC_PUB_DLBSD(-1)) + 0.178873906427*DLOG(JQPCMHFE) - 0.0104758905606*DLOG(RLRMCORPAAA) + 0.350879476885*(DLOG(PAC_PUB_FTREND(-1))-PAC_PUB_DLBSD(-1))

Eqn 117: D(SATL_PUB_DLBSD) = -0.0043630923957 + 0.0121116671341*D(SATL_PUB_DLBSD(-1)) + 0.143608936388*DLOG(JQPCMHFE) - 0.0127204658624*DLOG(RLRMCORPAAA) + 0.180479833659*(DLOG(SATL_PUB_FTREND(-1))-SATL_PUB_DLBSD(-1))

Eqn 118: D(WNC_PUB_DLBSD) = -0.00632715822636 - 0.145410885128*D(WNC_PUB_DLBSD(-1)) + 0.285597886817*DLOG(JQPCMHFE) - 0.0138975180198*DLOG(RLRMCORPAAA) + 0.282417579949*(DLOG(WNC_PUB_FTREND(-1))-WNC_PUB_DLBSD(-1))

Eqn 119: D(WSC_PUB_DLBSD) = -0.00584640695777 - 0.192497347638*D(WSC_PUB_DLBSD(-1)) + 0.213135128409*DLOG(JQPCMHFE) - 0.0202924418056*DLOG(RLRMCORPAAA) + 0.431142764144*(DLOG(WSC_PUB_FTREND(-1))-WSC_PUB_DLBSD(-1))

Eqn 120: TOTAL_PUB_DLBSD = 0.143986648 * ENC_PUB_DLBSD + 0.061913934 * ESC_PUB_DLBSD + 0.130546352 * MA_PUB_DLBSD + 0.073783279 * MTN_PUB_DLBSD + 0.052851353 * NENG_PUB_DLBSD + 0.145722989 * PAC_PUB_DLBSD + 0.206988869 * SATL_PUB_DLBSD + 0.074175339 * WNC_PUB_DLBSD + 0.110031238 * WSC_PUB_DLBSD

PUB_MISCNR **Public and miscellaneous; Federal, state and local, and non-residential transportation related and all other nec**

Eqn 121: ENC_PUB_MISCNR_DLBSD = 0.634201 * ENC_PUB_DLBSD + 0.365799 * ENC_MISCNR_DLBSD

Eqn 122: ESC_PUB_MISCNR_DLBSD = 0.529713 * ESC_PUB_DLBSD + 0.470287 * ESC_MISCNR_DLBSD

Eqn 123: MA_PUB_MISCNR_DLBSD = 0.646117 * MA_PUB_DLBSD + 0.353883 * MA_MISCNR_DLBSD

Eqn 124: MTN_PUB_MISCNR_DLBSD = 0.704116 * MTN_PUB_DLBSD + 0.295884 * MTN_MISCNR_DLBSD

Eqn 125: NENG_PUB_MISCNR_DLBSD = 0.574928 * NENG_PUB_DLBSD + 0.425072 * NENG_MISCNR_DLBSD

Eqn 126: PAC_PUB_MISCNR_DLBSD = 0.601099 * PAC_PUB_DLBSD + 0.398901 * PAC_MISCNR_DLBSD

Eqn 127: SATL_PUB_MISCNR_DLBSD = 0.637119 * SATL_PUB_DLBSD + 0.362881 * SATL_MISCNR_DLBSD

Eqn 128: WNC_PUB_MISCNR_DLBSD = 0.614984 * WNC_PUB_DLBSD + 0.385016 * WNC_MISCNR_DLBSD

Eqn 129: WSC_PUB_MISCNR_DLBSD = 0.593967 * WSC_PUB_DLBSD + 0.406033 * WSC_MISCNR_DLBSD

Eqn 130: TOTAL_PUB_MISCNR_DLBSD = 0.150531276 * ENC_PUB_MISCNR_DLBSD + 0.060838068 * ESC_PUB_MISCNR_DLBSD + 0.112763418 * MA_PUB_MISCNR_DLBSD + 0.081208022 * MTN_PUB_MISCNR_DLBSD + 0.041693895 * NENG_PUB_MISCNR_DLBSD + 0.157117576 * PAC_PUB_MISCNR_DLBSD + 0.210853121 * SATL_PUB_MISCNR_DLBSD + 0.07031529 * WNC_PUB_MISCNR_DLBSD + 0.114679507 * WSC_PUB_MISCNR_DLBSD

REL Religious

Eqn 131: D(ENC_REL_DLBSD) = -0.000302105364115 + 0.139807158092*D(ENC_REL_DLBSD(-1)) + 0.0161676084845*DLOG(GDPR/NP16A) + 0.0563104479612*(DLOG(ENC_REL_FTREND(-1))-ENC_REL_DLBSD(-1))

Eqn 132: D(ESC_REL_DLBSD) = -0.000849892057999 - 0.106302991414*D(ESC_REL_DLBSD(-1)) + 0.0489400747061*DLOG(GDPR/NP16A) + 0.0647503848461*(DLOG(ESC_REL_FTREND(-1))-ESC_REL_DLBSD(-1))

Eqn 133: D(MA_REL_DLBSD) = -0.000171615531488 - 0.0178871793575*D(MA_REL_DLBSD(-1)) + 0.0109566710121*DLOG(GDPR/NP16A) + 0.0764561157549*(DLOG(MA_REL_FTREND(-1))-MA_REL_DLBSD(-1))

Eqn 134: D(MTN_REL_DLBSD) = -0.00049814270666 + 0.265807340294*D(MTN_REL_DLBSD(-1)) + 0.0186149772397*DLOG(GDPR/NP16A) + 0.228767202742*(DLOG(MTN_REL_FTREND(-1))-MTN_REL_DLBSD(-1))

Eqn 135: D(NENG_REL_DLBSD) = -0.000223363647947 - 0.292736202475*D(NENG_REL_DLBSD(-1)) + 0.0143305174562*DLOG(GDPR/NP16A) + 0.056958479794*(DLOG(NENG_REL_FTREND(-1))-NENG_REL_DLBSD(-1))

Eqn 136: D(PAC_REL_DLBSD) = -0.000299037727945 - 0.250896544896*D(PAC_REL_DLBSD(-1)) + 0.0097669960443*DLOG(GDPR/NP16A) + 0.100491036024*(DLOG(PAC_REL_FTREND(-1))-PAC_REL_DLBSD(-1))

Eqn 137: D(SATL_REL_DLBSD) = -0.000680980312971 + 0.156093423373*D(SATL_REL_DLBSD(-1)) + 0.0355990627798*DLOG(GDPR/NP16A) + 0.0591302872047*(DLOG(SATL_REL_FTREND(-1))-SATL_REL_DLBSD(-1))

Eqn 138: D(WNC_REL_DLBSD) = -0.000343836727568 - 0.3477460253*D(WNC_REL_DLBSD(-1)) + 0.0201261119133*DLOG(GDPR/NP16A) + 0.0871099986751*(DLOG(WNC_REL_FTREND(-1))-WNC_REL_DLBSD(-1))

Eqn 139: D(WSC_REL_DLBSD) = -0.00048782095432 + 0.0681392117221*D(WSC_REL_DLBSD(-1)) + 0.0287712401265*DLOG(GDPR/NP16A) + 0.106996512372*(DLOG(WSC_REL_FTREND(-1))-WSC_REL_DLBSD(-1))

Eqn 140: TOTAL_REL_DLBSD = 0.185862529 * ENC_REL_DLBSD + 0.074847563 * ESC_REL_DLBSD + 0.158734808 * MA_REL_DLBSD + 0.051589853 * MTN_REL_DLBSD + 0.058582307 * NENG_REL_DLBSD + 0.096202919 * EQN 141: PAC_REL_DLBSD + 0.161128962 * SATL_REL_DLBSD + 0.089198557 * WNC_REL_DLBSD + 0.123852501 * WSC_REL_DLBSD

STORES Stores; stores and restaurants

Eqn 141: D(ENC_STORES_DLBSD) = -0.00134902047812 + 0.535250222424*D(ENC_STORES_DLBSD(-1)) + 0.0795330948346*DLOG(GDPR/NP16A) + 0.117907009756*(DLOG(ENC_STORES_FTREND(-1))-ENC_STORES_DLBSD(-1))

Eqn 142: D(ESC_STORES_DLBSD) = -0.00155894456379 + 0.062141474489*D(ESC_STORES_DLBSD(-1)) + 0.0555656768924*DLOG(GDPR/NP16A) + 0.212563687886*(DLOG(ESC_STORES_FTREND(-1))-ESC_STORES_DLBSD(-1))

Eqn 143: D(MA_STORES_DLBSD) = -0.000503668172487 + 0.161089085467*D(MA_STORES_DLBSD(-1)) + 0.0178241277196*DLOG(GDPR/NP16A) + 0.17921237557*(DLOG(MA_STORES_FTREND(-1))-MA_STORES_DLBSD(-1))

Eqn 144: D(MTN_STORES_DLBSD) = -0.00191598085574 + 0.341885753865*D(MTN_STORES_DLBSD(-1)) + 0.0713342456853*DLOG(GDPR/NP16A) + 0.169326896651*(DLOG(MTN_STORES_FTREND(-1))-MTN_STORES_DLBSD(-1))

Eqn 145: D(NENG_STORES_DLBSD) = -0.000825860594111 + 0.0952437092274*D(NENG_STORES_DLBSD(-1)) + 0.0315739573324*DLOG(GDPR/NP16A) + 0.21683673051*(DLOG(NENG_STORES_FTREND(-1))-NENG_STORES_DLBSD(-1))

Eqn 146: D(PAC_STORES_DLBSD) = -0.000943362492963 + 0.395184021158*D(PAC_STORES_DLBSD(-1)) + 0.0339758841911*DLOG(GDPR/NP16A) + 0.228515525034*(DLOG(PAC_STORES_FTREND(-1))-PAC_STORES_DLBSD(-1))

Eqn 147: D(SATL_STORES_DLBSD) = -0.00257433445172 + 0.267701364441*D(SATL_STORES_DLBSD(-1)) + 0.120813655532*DLOG(GDPR/NP16A) + 0.137170239662*(DLOG(SATL_STORES_FTREND(-1))-SATL_STORES_DLBSD(-1))

Eqn 148: D(WNC_STORES_DLBSD) = -0.000948231239961 + 0.0171400471862*D(WNC_STORES_DLBSD(-1)) + 0.0548503559342*DLOG(GDPR/NP16A) + 0.162003373023*(DLOG(WNC_STORES_FTREND(-1))-WNC_STORES_DLBSD(-1))

Eqn 149: D(WSC_STORES_DLBSD) = -0.00187108875875 + 0.474214224476*D(WSC_STORES_DLBSD(-1)) + 0.0966613552765*DLOG(GDPR/NP16A) + 0.380572504971*(DLOG(WSC_STORES_FTREND(-1))-WSC_STORES_DLBSD(-1))

Eqn 150: TOTAL_STORES_DLBSD = 0.192076478 * ENC_STORES_DLBSD + 0.058434199 * ESC_STORES_DLBSD + 0.127053217 * MA_STORES_DLBSD + 0.063659912 * MTN_STORES_DLBSD +

0.049933047 * NENG_STORES_DLBSD + 0.143656911 * PAC_STORES_DLBSD + 0.178647927 * SATL_STORES_DLBSD + 0.075184192 * WNC_STORES_DLBSD + 0.111354116 * WSC_STORES_DLBSD

WARE **Warehouse; manufacturing and wholesale trade, public and federally owned warehouses**

Eqn 151: D(ENC_WARE_DLBSD) = -0.000735497305982 + 0.487162345652*D(ENC_WARE_DLBSD(-1)) + 0.0241993159975*DLOG(IFNRER/NP16A) + 0.359671965825*(DLOG(ENC_WARE_FTREND(-1))-ENC_WARE_DLBSD(-1))

Eqn 152: D(ESC_WARE_DLBSD) = -0.00149883372756 + 0.374415450362*D(ESC_WARE_DLBSD(-1)) + 0.0528038052214*DLOG(GDPR/NP16A) + 0.321366268892*(DLOG(ESC_WARE_FTREND(-1))-ESC_WARE_DLBSD(-1))

Eqn 153: D(MA_WARE_DLBSD) = -4.52105880672e-05 + 0.234789455812*D(MA_WARE_DLBSD(-1)) - 0.0108447517006*DLOG(NP16A) + 0.421524185536*(DLOG(MA_WARE_FTREND(-1))-MA_WARE_DLBSD(-1))

Eqn 154: D(MTN_WARE_DLBSD) = -0.00631009312419 + 0.0717410778331*D(MTN_WARE_DLBSD(-1)) + 0.284940869895*DLOG(JQPCMHFE) + 0.27080418353*(DLOG(MTN_WARE_FTREND(-1))-MTN_WARE_DLBSD(-1))

Eqn 155: D(NENG_WARE_DLBSD) = -0.00140552495376 + 0.215126096779*D(NENG_WARE_DLBSD(-1)) + 0.083870269185*DLOG(GDPR/NP16A) + 0.399885422487*(DLOG(NENG_WARE_FTREND(-1))-NENG_WARE_DLBSD(-1))

Eqn 156: D(PAC_WARE_DLBSD) = -0.000861766748144 + 0.466799200652*D(PAC_WARE_DLBSD(-1)) + 0.00219395160839*DLOG(IFNRER/NP16A) + 0.310831300645*(DLOG(PAC_WARE_FTREND(-1))-PAC_WARE_DLBSD(-1))

Eqn 157: D(SATL_WARE_DLBSD) = -0.00142356466277 + 0.465690458518*D(SATL_WARE_DLBSD(-1)) + 0.00611253042312*DLOG(IFNRER/NP16A) + 0.499132746502*(DLOG(SATL_WARE_FTREND(-1))-SATL_WARE_DLBSD(-1))

Eqn 158: D(WNC_WARE_DLBSD) = -0.00521975359574 + 0.138803050681*D(WNC_WARE_DLBSD(-1)) + 0.416431273128*DLOG(NP16A) + 0.445752834344*(DLOG(WNC_WARE_FTREND(-1))-WNC_WARE_DLBSD(-1))

Eqn 159: D(WSC_WARE_DLBSD) = -0.00022371311624 + 0.400913851463*D(WSC_WARE_DLBSD(-1)) + 0.0127799728308*DLOG(IFNRER/NP16A) + 0.282518280442*(DLOG(WSC_WARE_FTREND(-1))-WSC_WARE_DLBSD(-1))

Eqn 160: TOTAL_WARE_DLBSD = 0.17950886 * ENC_WARE_DLBSD + 0.06263526 * ESC_WARE_DLBSD + 0.119819702 * MA_WARE_DLBSD + 0.059237673 * MTN_WARE_DLBSD + 0.035214647 * NENG_WARE_DLBSD + 0.16874443 * PAC_WARE_DLBSD + 0.177854488 * SATL_WARE_DLBSD + 0.077634802 * WNC_WARE_DLBSD + 0.119350138 * WSC_WARE_DLBSD

Census division totals

Eqn 161: ENC_TOTAL_DLBSD = 0.036844405 * ENC_AMUSE_DLBSD + 0.050853197 * ENC_AUTO_DLBSD + 0.009408377 * ENC_DORM_DLBSD + 0.103175527 * ENC_EDUC_DLBSD + 0.042632644 * ENC_HEALTH_DLBSD + 0.017717483 * ENC_HOTEL_DLBSD + 0.233521442 * ENC_MFG_DLBSD + 0.013294102 * ENC_MISCNR_DLBSD + 0.15063035 * ENC_OFFICE_DLBSD + 0.013121729 * ENC_PUB_DLBSD + 0.045953184 * ENC_REL_DLBSD + 0.167767869 * ENC_STORES_DLBSD + 0.11507969 * ENC_WARE_DLBSD

Eqn 162: ESC_TOTAL_DLBSD = 0.040417518 * ESC_AMUSE_DLBSD + 0.051698228 * ESC_AUTO_DLBSD + 0.019107618 * ESC_DORM_DLBSD + 0.112505124 * ESC_EDUC_DLBSD + 0.049297607 * ESC_HEALTH_DLBSD + 0.023634695 * ESC_HOTEL_DLBSD + 0.212005319 * ESC_MFG_DLBSD + 0.013315649 * ESC_MISCNR_DLBSD + 0.130669536 * ESC_OFFICE_DLBSD + 0.016991786 * ESC_PUB_DLBSD + 0.055729252 * ESC_REL_DLBSD + 0.153703403 * ESC_STORES_DLBSD + 0.120924265 * ESC_WARE_DLBSD

Eqn 163: MA_TOTAL_DLBSD = 0.040020788 * MA_AMUSE_DLBSD + 0.048623699 * MA_AUTO_DLBSD + 0.011588963 * MA_DORM_DLBSD + 0.11926505 * MA_EDUC_DLBSD + 0.049858354 * MA_HEALTH_DLBSD + 0.021776156 * MA_HOTEL_DLBSD + 0.19621626 * MA_MFG_DLBSD + 0.012039916 * MA_MISCNR_DLBSD + 0.180530719 * MA_OFFICE_DLBSD + 0.015937497 * MA_PUB_DLBSD + 0.052575384 * MA_REL_DLBSD + 0.148664332 * MA_STORES_DLBSD + 0.102902883 * MA_WARE_DLBSD

Eqn 164: MTN_TOTAL_DLBSD = 0.042943366 * MTN_AMUSE_DLBSD + 0.065824214 * MTN_AUTO_DLBSD + 0.019924415 * MTN_DORM_DLBSD + 0.120975187 * MTN_EDUC_DLBSD + 0.038873954 * MTN_HEALTH_DLBSD + 0.056363195 * MTN_HOTEL_DLBSD + 0.101592652 * MTN_MFG_DLBSD + 0.021211195 * MTN_MISCNR_DLBSD + 0.157549338 * MTN_OFFICE_DLBSD + 0.022287221 * MTN_PUB_DLBSD + 0.042278267 * MTN_REL_DLBSD + 0.184301875 * MTN_STORES_DLBSD + 0.125875122 * MTN_WARE_DLBSD

Eqn 165: NENG_TOTAL_DLBSD = 0.037328078 * NENG_AMUSE_DLBSD + 0.057139436 * NENG_AUTO_DLBSD + 0.016427733 * NENG_DORM_DLBSD + 0.122941916 * NENG_EDUC_DLBSD + 0.046330219 * NENG_HEALTH_DLBSD + 0.023203023 * NENG_HOTEL_DLBSD + 0.205329823 * NENG_MFG_DLBSD + 0.009884216 * NENG_MISCNR_DLBSD + 0.183819107 * NENG_OFFICE_DLBSD + 0.016766386 * NENG_PUB_DLBSD + 0.050420219 * NENG_REL_DLBSD + 0.151822858 * NENG_STORES_DLBSD + 0.078586984 * NENG_WARE_DLBSD

Eqn 166: PAC_TOTAL_DLBSD = 0.038750802 * PAC_AMUSE_DLBSD + 0.066585399 * PAC_AUTO_DLBSD + 0.01885492 * PAC_DORM_DLBSD + 0.099216517 * PAC_EDUC_DLBSD + 0.037738144 * PAC_HEALTH_DLBSD + 0.031190101 * PAC_HOTEL_DLBSD + 0.151027225 * PAC_MFG_DLBSD + 0.019865965 * PAC_MISCNR_DLBSD + 0.177561752 * PAC_OFFICE_DLBSD + 0.017620708 * PAC_PUB_DLBSD + 0.031560106 * PAC_REL_DLBSD + 0.166489772 * PAC_STORES_DLBSD + 0.143538589 * PAC_WARE_DLBSD

Eqn 167: SATL_TOTAL_DLBSD = 0.040138222 * SATL_AMUSE_DLBSD + 0.061969539 * SATL_AUTO_DLBSD + 0.018256288 * SATL_DORM_DLBSD + 0.110969624 * SATL_EDUC_DLBSD + 0.04523952 * SATL_HEALTH_DLBSD + 0.035796236 * SATL_HOTEL_DLBSD + 0.155628361 * SATL_MFG_DLBSD + 0.016959722 * SATL_MISCNR_DLBSD + 0.163890167 * SATL_OFFICE_DLBSD + 0.020148077 * SATL_PUB_DLBSD + 0.042551525 * SATL_REL_DLBSD + 0.166667276 * SATL_STORES_DLBSD + 0.121785442 * SATL_WARE_DLBSD

Eqn 168: WNC_TOTAL_DLBSD = 0.04035799 * WNC_AMUSE_DLBSD + 0.059514595 * WNC_AUTO_DLBSD + 0.014240526 * WNC_DORM_DLBSD + 0.110614864 * WNC_EDUC_DLBSD + 0.051925268 * WNC_HEALTH_DLBSD + 0.024173282 * WNC_HOTEL_DLBSD + 0.170644109 * WNC_MFG_DLBSD + 0.013955833 * WNC_MISCNR_DLBSD + 0.154125762 * WNC_OFFICE_DLBSD + 0.016890665 * WNC_PUB_DLBSD + 0.055106133 * WNC_REL_DLBSD + 0.164089005 * WNC_STORES_DLBSD + 0.124361968 * WNC_WARE_DLBSD

Eqn 169: WSC_TOTAL_DLBSD = 0.041515462 * WSC_AMUSE_DLBSD + 0.062121329 * WSC_AUTO_DLBSD + 0.01633049 * WSC_DORM_DLBSD + 0.119392701 * WSC_EDUC_DLBSD + 0.04652586 * WSC_HEALTH_DLBSD + 0.026828149 * WSC_HOTEL_DLBSD + 0.131612547 * WSC_MFG_DLBSD + 0.015417145 * WSC_MISCNR_DLBSD + 0.165730625 * WSC_OFFICE_DLBSD + 0.01751435 * WSC_PUB_DLBSD + 0.053485703 * WSC_REL_DLBSD + 0.169883048 * WSC_STORES_DLBSD + 0.133642591 * WSC_WARE_DLBSD

Eqn 170: TOTAL_TOTAL_DLBSD = 0.187613478 * ENC_TOTAL_DLBSD + 0.062299169 * ESC_TOTAL_DLBSD + 0.140048197 * MA_TOTAL_DLBSD + 0.056602409 * MTN_TOTAL_DLBSD + 0.053895133 * NENG_TOTAL_DLBSD + 0.141396156 * PAC_TOTAL_DLBSD + 0.175649242 * SATL_TOTAL_DLBSD + 0.075083705 * WNC_TOTAL_DLBSD + 0.107412511 * WSC_TOTAL_DLBSD

Appendix C3: Regional Industrial Output and Employment Models

Regional Industrial Output Model

Endogenous variables:

REV{I}_{R} Output in billions of real 2012 dollars for sector I, region R (e.g. REVIND1_ENC)

Codes and descriptions of the sectors are presented in Table A14. Codes and descriptions of the regions are in Table B6.

Exogenous variables:

{R}_{I}_outsh Share of sector I in region R

Equations:

REV{I}_{R} = REV{I}_national * {R}_{I}_outsh

where

REV{I}_{R} = output for sector I, region R;

REV{I}_national = output for sector I (national); and

{R}_{I}_outsh = share of sector I in region R.

Regional Employment Model

Endogenous variables:

EMP{I}_{R} Employment in millions for sector I, region R (e.g. EMPIND1_ENC)

Codes and descriptions of the sectors are presented in Table A14. Codes and descriptions of the regions are in Table B6.

Exogenous variables:

{R}_{I}_empsh Share of sector I in region R

Equations:

EMP{I}_{R} = EMP{I}_national*{R}_{I}_empsh

where

EMP{I}_{R} = employment for sector I, region R;

EMP{I}_national = employment for sector I (national); and

{R}_{I}_empsh = share of sector I in region R.