

U.S. State Model



Moody's Economy.com U.S. State Economic Model System



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The Moody's Economy.com U.S. State Economic Model System

Steven G. Cochrane

The Moody's Economy.com economic and demographic projections for U.S. states are produced each month with a quarterly frequency large-scale simultaneous econometric model system. This article describes the design of the state model system.

The motivation for building the model system is to provide a state-of-the-art system of simultaneous econometric state models that have enhanced simulation properties and are more compatible in design with the Moody's Economy.com U.S. macroeconomic model. The model system also is designed to allow for web-based client access.

The model system is designed with the following parameters in mind: 1) the models are easy to use; 2) the models are intuitive with real world logic; 3) equation specifications are bottom-up as much as possible; 4) the models produce stable quarterly-frequency forecasts over a 30-year time span; 5) aggregate model behavior tracks the U.S. macroeconomic model; 6) the models incorporate policy levers and are useful for policy analysis and simulation; 7) the models integrate with the existing Moody's Economy.com regional forecast system and detailed databases; and 8) the state models are compatible with the Moody's Economy.com web-based forecasting system. The system requirement of stability through 150 forecast periods was of paramount importance and had an overriding influence on model design and equation estimation.

The state model system is designed to reflect each state's comparative economic advantage, to fully model the unique economic structure of each state, and to account for the effects of macroeconomic assumptions on the individual state

economies. Comparative advantages are estimated through relative business costs and demographic characteristics. State industrial structure is captured through detailed specifications of output and employment by industry. Macro assumptions drive the state models through links to U.S. forecasts of factors such as interest rates, energy prices and global trade.

As with the previous system of state models in use prior to July 2006, there is no mechanism to force state level totals to equal U.S. totals. Constraining the sum-of-states to equal the U.S. total would add a layer of complexity to the forecast process that could potentially produce counterintuitive results. Further, the sum of state totals for most historical economic data series do not add up to national estimates, which are often gathered from different samples or using different methods. Sum of state totals for top line forecast variables, however, are routinely checked during the monthly forecasting process so that differences with the U.S. remain within historical ranges.

Model structure. The new state model system is fundamentally an output-based industry model that is simultaneously interactive with a demographic model. Simultaneity in the models is controlled by the Gauss-Seidel algorithm, which iterates toward a stable solution as determined by pre-selected convergence criteria. In practice the system is very stable—requiring a minimal number of iterations at standard convergence criteria.

In the solution process, output influences employment, employment influences migration, migration influences population, population creates demand

for output, and so on (see Chart 1). Key factors that determine relative state performance within this construct are industrial mix, labor costs, energy costs, tax rates, net migration and other demographic factors.

The major benefit of the output-based structure of the model is that it allows for the inclusion of cost-of-doing business variables and productivity variables as key determinants of output and employment.

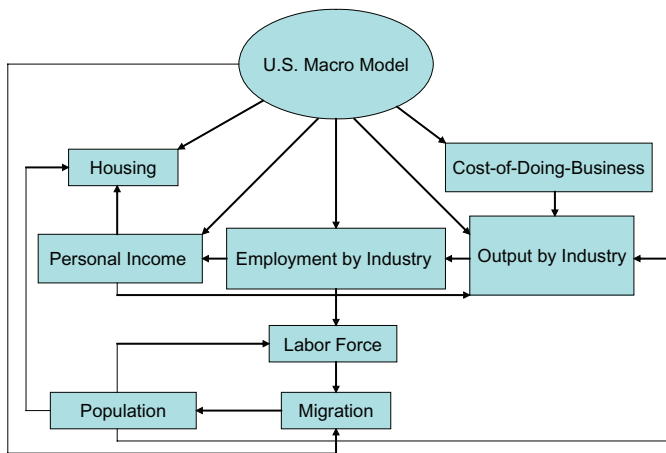
The ability to model the location of industrial output and its subsequent impact on establishment employment is a key feature of this system. It enhances the quality of state output forecasts and makes for a very flexible platform for policy analysis.

Output. The increasingly globalized framework of industrial production makes the locational analysis of production decisions of paramount importance. Capturing the dynamic of industrial location decisions is therefore vital in shaping a long-term regional forecast.

NAICS-based gross state product data from the Bureau of Economic Analysis are used to model industrial output by industry. This approach gains from recent improvements by the BEA in the timeliness of GSP data releases.

In the model system GSP is linked to U.S. GDP through econometric equations that contain a cost-of-doing business (CDB) component. The forecasted CDB component is equivalent to the estimated historical cost-of-doing business structure, which combines a state's labor costs, energy costs, and tax rates, all relative to the U.S. As relative business costs increase in a state, the state's share of industrial output will decrease as businesses seek their lowest cost location.

Chart 1: Flow Chart for State Models, Main Links



Service industry output tends to be driven more by local demand conditions than by national demand and relative business costs. Local demand proxy variables for service industry output include population and personal income.

In forecasting output by industry instead of aggregate output, more forecast control is given to analysts. This also provides more forecast control over the state level detailed databases that allocate gross product down to the four-digit NAICS level of detail.

Labor. Once output is determined, employment by industry is then derived as a function of state level output by industry and U.S. level productivity by industry. This configuration allows for the analysis and manipulation of industry-specific productivity in constructing state forecast scenarios. Employment data by industry are based on data from the BLS's Current Employment Survey and Quarterly Census of Employment and Wages.

During months when employment data are available for the second month of the first forecast quarter, employment series for the first forecast quarter are lined up to the second month of the quarter's employment level. It is assumed that the data for the second month of the quarter are a good estimate of that quarter's average employment level. Forecasters have the ability to make an addfactor adjustment to industry employment if they believe that the second month of the quarter estimate is out of character.

A state's labor force is a function of working age population and the lagged employment-to-population ratio. The

net migration (see Chart 2). Historical total population data are based on Census midyear estimates where the midyear estimates are assigned to the second quarter of the year and then the remaining quarters are interpolated.

Birth rates and death rates are also calculated by state but these variables do not often provide much variability to the population forecast as they typically range only within a narrow band. Birth rate historical data come from the Census Bureau and are forecasted as a function of the U.S. birth rate from the U.S. macroeconomic forecast. State death rate data originate from The Centers for Disease Control and Prevention and are similarly forecasted as a function of the U.S. death rate from the U.S. macro model.

Once aggregate population is established, then population cohorts are determined using cohort shares calculated from state level Census Bureau projections. Typically, the Census Bureau projects population for about 25 years, thus ending prior to the end of our long-term forecasts. Cohort shares are extended through the end of our forecast period at their last Census value. Also, an assumption regarding the distribution of net migration

unemployment rate is a function of the labor force, total employment, and lagged unemployment.

Demographics.

Population growth is a key factor in a state's economic comparative advantage. State population is modeled on an aggregate basis where the key forecast variable is

across age cohorts is made by the Census Bureau in their projections and so that assumption is imbedded in the state population cohort forecasts.

Population flows in response to job availability, retirement, and immigration law are modeled through the net migration equations. Net migration is linked to state job creation and the movement of state unemployment relative to the U.S. rate. As the ratio of state unemployment to national unemployment increases, out-migration to other states will increase.

Net-migration data can be difficult to work with because they are the sum of two time series that can behave independently, namely in-migration and out-migration. Fortunately, the IRS tracks in-migration and out-migration by state and this provides the basis for modeling the two components of net-migration separately. IRS migration ratios were applied to Census net-migration data to estimate in-migration and out-migration series that sum to the historical Census data. These estimated data are the basis for calculating econometric equations for in-migration and for out-migration.

Migration data are also available separated by its domestic and international components. Each state has a forecast equation for net international migration that is based on its historical share of U.S. international migration.

Aggregate households are first forecasted as a function of state population and the U.S. population-to-households ratio, and then the aggregate is shared out into age cohorts. Since the sum of the Census household cohorts

Chart 2: State Models, Demographic Links

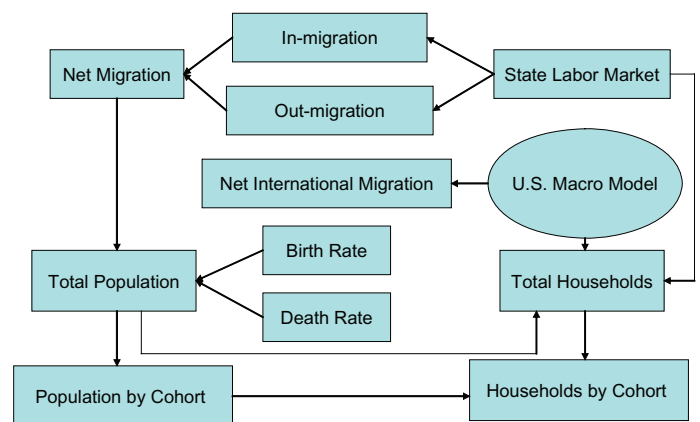


Table 1: Moody's Economy State Model Variable Categories

1. Demographics

- Components of Change
 - a. Migration
 - b. Births/Deaths
- Population (incl. age cohort breakdowns)
- Households (incl. age cohort breakdowns)

2. Labor Markets; Gross Product

- Moody's Economy.com Cost of Doing Business Index
- Gross State Product by BLS Supersector
- Industry Employment by BLS Supersector
- Labor Force

3. Income

- Personal Income by component
- Household Income
- Average Earnings/Effective Wage Rate

4. Credit Quality/Banking

- Consumer Credit
- ABA/MBA delinquency rates
- Bankruptcy Filings (Personal & Corporate)
- Bank Deposits

5. Real Estate

- Residential Permits (Nonres. available for CA only)
- Housing Starts
- Housing Completions
- Existing Home Sales
- Mortgage Originations
- Home Prices (NAR & OFHEO)
- Mobile Home Sales
- Rental Vacancy Rate
- Moody's Economy.com Housing Affordability Index

6. Consumer

- Retail Sales
- Vehicle Registrations

The state model system projects two separate measures of house price—the median sales price of single-family homes and the repeat-purchase house price index from OFHEO. The house-price forecasts are driven over the long term by demographic, income, and labor market factors. Proxies for these factors include relative growth of the working age population, disposable personal income, and the unemployment rate. In the near term, house prices are determined by a more complex set of supply and demand factors, which are thoroughly described in *Is the Price Right?* (see *Regional Financial Review*, March 2006, pp. 11-25).

Credit quality. Finally, income and employment trends drive forecasts for several measures of credit quality that are publicly available at the state level. These include personal bankruptcy filings, the dollar volume of consumer credit as estimated by the Federal Reserve, consumer credit delinquency rates from the American Bankers Association and mortgage delinquency rates from the Mortgage Bankers Association. A complete list of all forecast variables is in Table 1.

Equation estimation. Stochastic equations were estimated in EViews using the ordinary least squares technique. Most equations were estimated as panel regressions, where within-state time series data are combined with observations grouped by region. Cross section effects were fixed. Most panel groups were formed with 50 states plus the District of Columbia. Occasionally panels were grouped by Census Region or Division. In panel regressions elasticities on explanatory variables will be constant across states, enhancing the consistency of individual state performance. Variations in state performance will come from the differing mix of industries by state, from differing exogenous assumptions by state, and from differing trends in historical data.

Forecast stability. The state models are used to provide 30-year forecasts of economic and demographic variables that are updated every month. While underlying economic conditions sometimes do change on a monthly basis, state forecasts should not change in a capricious manner. The forecast line-up procedures ensure stability from forecast to forecast. The first step in the monthly forecast cycle is to

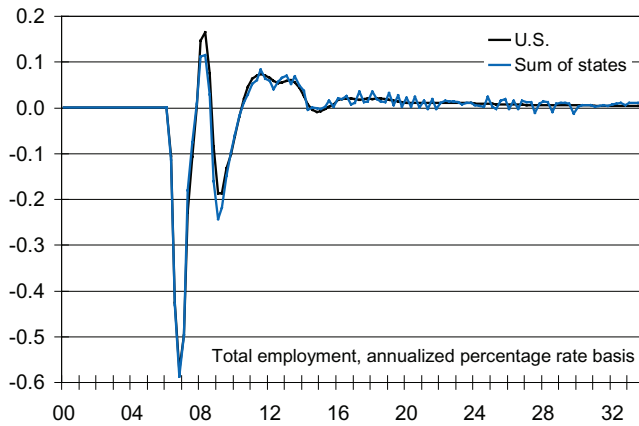
does not total to the currently used household construct, the difference between the sum of the age cohorts and total households is shared back into the cohorts so that households will sum from the bottom up.

Income. The Bureau of Economic Analysis provides quarterly estimates of state personal income by several income categories. Personal income is the link between state employment and demand for consumer goods and services. Wage and salary income makes up the majority of personal income and is directly related to employment levels. In the state models system, wage and salary income is the product of total employment and the

effective wage rate. The historical effective wage rate is calculated as the total wage bill divided by total employment; it is forecast as a function of U.S. average hourly earnings, and state and U.S. productivity. The non-wage components of income are generally functions of their equivalent U.S. concept and state wages and salaries.

Housing. Moody's Economy.com estimates single and multifamily housing permits and starts by state. In the state models, housing permits are driven by labor market conditions and structural demand. Housing starts are a lagged function of permits. Total housing starts feed back into construction output and so are directly linked to construction employment.

Chart 3: Scenario Analysis of State and U.S. Models
Cyclical scenario growth rate minus baseline growth rate



update state level historical data. All forecast series are then lined to the new historical data, keeping the previous month's forecast levels or growth rates as appropriate. New exogenous forecast series from the U.S. model are then brought into the state model and the system is solved simultaneously with no variables excluded. At this point, analysts review the forecast and may make small addfactor corrections. The models are solved again and analysts review the forecast a second time.

Changes to the monthly forecast will come from one or more of three sources. First, new or revised historical data can shift series in the near term. Second, changes to the U.S. forecast on a month-to-month basis will show up in the state forecast. Third, analysts may make changes to the state forecast

based on exogenous information regarding near-term economic trends. An important aspect of model performance for the state modeling system is its response to alternative scenarios generated by the Moody's Economy.com U.S. macroeconomic model. A well-behaved response to alternative macro model scenarios is essential for providing forecast risk analysis. It also ensures users that the regional impacts of their macroeconomic scenarios are meaningful.

Chart 3 shows the response of the state modeling system to a cyclical U.S. forecast generated by the Moody's Economy.com U.S. macroeconomic model. The chart shows the difference in total employment growth rates between the baseline scenario and a cyclical scenario for the U.S. macro model and the sum-of-state outputs for the state models.

The change in the state models tracks the change in the U.S. model

Extensive diagnostics are used in the forecast process to ensure that forecasts are stable from month to month and are consistent with states of similar location or economic structure.

Model performance. An

very closely through the scenario when there is a rapid divergence away from the baseline total employment growth rate in the first quarter of 2006. The peaks in divergence for both model systems occur at the same periods and are very close in magnitude. The growth rate difference for the U.S. model converges back to a small and stable delta value after about 40 forecast periods. The state models track this convergence.

Scenario analysis. The Moody's Economy.com state models are designed to provide a useful and flexible platform for state-level scenario analysis. The models can be used to determine aggregate economic impacts of events such as plant openings and closings, changes in state business costs, changes to immigration law, disasters, and so forth. Also, the forecast series from state level scenarios can be used as exogenous inputs to the 379 U.S. metropolitan area models.

Web-based access. Like the U.S. macroeconomic model, the system of state econometric models can be accessed through the Moody's Economy.com web-based interface. The interface allows users to design macroeconomic scenarios with the U.S. model and then use the output of their U.S. scenarios as exogenous inputs for state-level scenarios with the state models. The web-based system of state models has exactly the same forecasting and simulation properties as the models used to generate the monthly economic and demographic forecasts.

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