1.0 Overview

The U.S. Regional Economic Service of Global Insight develops economic forecasts for nine census divisions, 50 states and the District of Columbia, 319 primary metropolitan statistical areas (PMSAs), and 3,110 counties of the United States. Quarterly-frequency forecasts are produced four times a year for states and 114 major metropolitan areas using behavioral econometric models. Annual-frequency forecasts are prepared twice a year for the 205 smaller metro areas and counties using simulation-rule models. The spring and fall forecasts for the states, all 319 PMSAs and the counties are 25-year forecasts, while the summer and winter forecasts for the states and the 114 largest MSAs are 5-year forecasts.

Global Insight’s state models are dynamic econometric models of competition and growth. Structural details of inter-industry purchasing relationships are integrated into the manufacturing sector of each model. Decisions of businesses to locate or expand in a state are driven by the competitive environment, represented by tax rates, the costs of labor and energy, and climate. Wage rates by industry, components of personal income, housing market activity, population, labor force, and unemployment rates are predicted within the models for each state. This dynamic system captures the interactions between production, employment, incomes, industry costs, population, labor supply, and housing markets.

Global Insight’s state econometric models are linked to our newly revised Quarterly Model of the U.S. Economy, incorporating national demands for goods and services as drivers of economic activity within a state. The influence of the national economy is shaped by state-specific conditions of industry mix; relative cost structures, demographics, and income/expenditure patterns. A state’s evolving competitive strengths and weaknesses determine its success in capturing a share of the national market by industry sector.

2.0 Theoretical Foundation

The Global Insight approach to state and metropolitan area models represents a significant departure from most previous multi-regional modeling and forecasting efforts. Most other regional models are constructed as proportions of the United States. In the Global Insight system, however, each area is modeled individually and then linked into a national system. Thus, our models do not forecast regional growth as simple proportions of U.S. totals, but focus on internal growth dynamics and differential business cycle response. This approach is referred to as "top-down bottom-up." It contrasts sharply with pure share (top-down) models, and models that are not linked to a national macroeconomic model (bottom-up), and contain the best of both approaches.

Our basic objective is to project how state economic activity varies, given an economic environment as laid out by Global Insight’s US Macroeconomic and US Industry forecasts. In order to do this, we must be able to explain the two key phenomena:
• Why states react differently from one another over the business cycle;
• Why states grow or decline relative to each other over the longer run.

Another general characteristic of Global Insight’s state models are that they are policy sensitive. There are a number of reasons for this sensitivity, including the following:

• Each state is modeled individually, with different model structures specified according to the characteristics of the state
• National policy is explicitly captured,
• The comparative advantage of one state over another is explicitly modeled using relative cost variables.

The three major components or blocks of Global Insight’s state econometric models are discussed below; the key income sector is then described, followed by the housing and consumption sectors. Most of the discussion that follows explicitly refers to our State models, but a similar structure also exists in the metropolitan area models.

3.0 The Export Module

The major linkages among the models occur in the economic base or export sectors. These we identify as primarily agriculture, mining, the federal government, and most manufacturing industries. Global Insight’s state modeling approach is an extension of the export base (or economic base) theory, whereby a state’s economic growth is enhanced by the sale of its goods and services to markets outside the region. By exporting, industries generate new jobs and income that, in turn, promotes the expansion of businesses that serve the local market, such as retail trade, utilities, services, and construction. As described in the accelerator-multiplier theory, business investment increases as the capital stock adjusts to changes in product demand. New job opportunities attract an in-migration of population, increasing demand for housing.

The ability of an economy to sustain higher growth is, however, constrained by competitive forces captured in Global Insight’s state economic models. The entry of new workers into the labor force lags behind gains in employment, causing labor markets to tighten and putting upward pressure on wage rates. Higher operating costs for businesses and higher living costs for residents make the region less attractive, dampening economic growth.

This dynamic process represents a departure from the simple export base theory. The multiplier response to an initial stimulus or policy change is not constant, but rises initially with higher consumption and investment and then moderates as resource constraints and cost pressures impede further growth. Moreover, the response to an economic stimulus will vary across industries and states, depending on their technologies, cost structures, and inter-industry purchasing relationships. Part of the income created by export sales will be spent on goods and services outside the state, diminishing the export multiplier. In the development of the state manufacturing employment equations, Global Insight has incorporated a number of innovations to enhance the explanatory richness of the equations.

• The equations capture inter-industry, interregional, and dynamic linkages by integrating input-output, spatial theory, and econometric concepts.
• The employment equations are estimated using quarterly employment data beginning in 1972. These data cover all two-digit manufacturing sectors across all states, and were derived by Global Insight using data from the Bureau of Labor Statistics (ES-202 and
790 survey data), the Bureau of Economic Analysis, and the Census Bureau. With quarterly data, the equations are able to capture the timing and amplitude of turning points in the business cycle. In addition, at the two-digit level, employment data are the most reliable, accurate, and timely measure of state industrial activity.

- Employment levels are estimated using national and state-specific explanatory variables. Through direct linkages to the national economy we ensure consistency with the Global Insight national forecasts, and we capitalize on the depth of the macroeconomic model and its detailed industrial production sector.

The manufacturing employment equation for each two-digit industry in a given state uses the following independent variables: 1) employment by industry, national; 2) industry mix relative to U.S.; 3) relative inter-industry demand; 4) costs of doing business, relative to U.S.; 5) labor productivity; and 6) final demand factor. The first two terms are the key linkages to U.S. economic activity, and may enter the equation in two ways. First, is the case where U.S. employment by two-digit industry is modified by that industry's mix in the state relative to that in the nation. The second can be interpreted as state-weighted industrial production, modified by national productivity trends in each industry.

Industry mix effects are captured in the "weighted industrial production index," or WJIP, a concept common to all previous versions of the DRI-WEFA regional models. The difference in the current version is in the use of the index of separate two-digit industry equations rather than for total manufacturing alone. The WJIP is simply a re-weighting of the U.S. indexes of industrial production at the three-digit level, according to the relative importance of industries within the state's two-digit sectors (using employment as weights in most applications).

Localized demand may also be an important determinant of manufacturing activity. Construction activity, a major source of regional final demand, has already been included in the creation of the intermediate demand variable, but local housing markets are often explicitly included in the equation. The impact of the other final demand categories enters the employment equations through three-digit SIC state employment weighted industrial production indices.

The third term in the manufacturing employment equation is a measure of demand for an industry's products by other industries. An interindustry, interregional demand term is constructed for every two-digit SIC industry in each state. As computed, the importance to each industry of each geographic market varies according to:

- Input-output relationships that quantify demand from 70 key industrial buyers by sector and from selected end-user sectors
- The geographic location of potential markets, measured with employment data
- Transportation costs, measured by distance or known trade patterns between states
- Strength of industrial demand, measured by the expected growth of manufacturing activity by sector in every state.

The third set of independent variables to enter the employment equations is the relative costs of doing business in each state. Any explanation of regional growth must take into account that there are few barriers to the flow of economic activity across borders. States actively and openly compete for new and expanding businesses that determine economic growth. Since most industrial firms charge the same price for their products, regardless of their place of origin, differences in profitability are tied directly to differences in relative costs. The major factors
affecting relative costs are natural resource costs, unit labor costs, unit capital costs, transportation and distribution costs, energy costs (e.g., natural gas and electric power) and unit taxes, all of which are considered in the export block of our state models.

4.0 The Local Module

Most of a state’s economy, in terms of percent shares of employment, income, and value added (e.g., gross state product) is captured in the non-manufacturing sector. The classic examples are construction, wholesale, and retail trade, services, local government, utilities, and the like. These are nearly always support services, providing the necessary infrastructure for the base (export) sectors and the local population. The income generated by the export sectors circulates and multiplies through the local economy and generates the greater part of regional employment. These interactions and simultaneities can only be captured in an independent model. Some non-manufacturing sectors, although usually driven by local requirements, can also serve national markets. The best examples are the insurance industry in Connecticut, the banking interests in New York and Chicago and tourism in Hawaii. These exceptions are export sectors in selected states. Where they are export-oriented, these non-manufacturing sectors are driven by national variables.

4.1 General Structure of Local Module

The Global Insight state econometric models forecast nine categories of locally-oriented non-manufacturing: 1) Construction; 2) Retail Trade; 3) Wholesale Trade; 4) Transportation, Communications and Public Utilities (TCPU); 5) Finance, Insurance and Real Estate (FIRE); 6) Health Services; 7) Business Services; 8) Other Services; and 9) State and Local Government. Each of these sectors contains a diversified group of sub-industries that vary considerably from state to state. All of these require special analysis and monitoring by our regional analysts; just as in manufacturing, an understanding of underlying structure is critical to making reasonable forecasts. Finally, the generalized structure of the non-manufacturing equations contains four key factors: 1) measures of activity; 2) a cost term; 3) national conditions of importance to a particular sector, and 4) a measure of the stage of the business cycle.

4.2 Measuring Local Activity in Non-Manufacturing Sectors

One of the most crucial objectives in developing a model of the localized economy is to find a suitable measure of the activities driving a particular sector. Real personal income is the most frequently used variable, either alone or in combination with others. It is the best measure of aggregate economic activity at the state level, capturing wages, transfer payments, and non-wage income. Population is another key measure of sector activity. In the DRI-WEFA regional models, population and real income often enter in the same equation, measuring different aspects of the need for services or other non-manufacturing sectors. In summary, non-manufacturing employment and income are so closely intertwined that any model, which does not treat them simultaneously, cannot capture the local economy’s short-term behavior. Population is also intertwined with income and employment, but on a longer time scale. The Demographic Forecasting Module will be discussed below.

4.3 Costs

When real wages are high and/or rising rapidly, then the tendency of business, government, and other organizations is to hold employment down as much as possible. The reverse holds true
when real wages are low or falling rapidly. In the manufacturing sector, wage costs were shown to be one of the principle determinants of business location decisions. In the non-manufacturing support sectors, this is reflected in the level rather than the location of employment. Thus, employment is inversely proportional to real wage costs. Real wages enter many of the non-manufacturing employment equations. For forecast purposes, this wage rate is related to the appropriate national variable and the growth rate of the sector itself.

4.4 National Conditions

The national economy is reflected in three areas in the non-manufacturing sectors. First, certain macroeconomic conditions affect local activity significantly, even non-manufacturing. The best example of this is credit availability. Tight credit conditions with high interest rates have an adverse impact on local construction activity, sales of autos, and other durable and the like. The second class of national variables are those that reflect nationwide trends. An example of this is the trend towards an increasingly larger services sector. Capturing this secular trend is sometimes difficult when one uses only local variables in the non-manufacturing equations. The third application of national variables is to the export-oriented non-manufacturing sectors, such as the insurance and banking industries in certain states. In states where tourism is a significant factor in generating services employment, such as Hawaii, more national variables enter the non-manufacturing equations.

4.5 Stage of the Business Cycle

A cyclical variable, which measures the stage of the national business cycle, is usually included with each non-manufacturing sector. The purpose of this variable, which is the employment rate or capacity utilization, is to capture the hiring/firing cycle. As the local economy slides into a recession, employers are reluctant to lay off workers until necessary. It is costly to dismiss and then re-hire employees, and it is usually difficult to tell whether a recession is really coming in the early stages of a downturn. Conversely, as the economy pulls out of a recession, employers are reluctant to hire new employees until the recovery is clearly underway. Thus, there is a clear lag between the behavior of the activity variables, such as income or export sector employment, and the behavior of employment in the non-manufacturing sectors. Many sectors have a cyclical variable in the specification to capture this lagged effect.

The complex structures and feedback loops contained in the state export sectors, local economy sectors, and demographic formulations are designed to meet three key objectives. The first is to capture the complex interactions between the various sectors, allowing the most sophisticated policy analysis possible. The second is to provide consistent forecasts of output and employment by sector, which are key statistics for many business and government applications. The third is to produce accurate forecasts of personal income because of its important to the whole state economy.

5.0 The Demographic Module

5.1 Population

The purpose of the Global Insight state population model is to capture the dynamic relationship between population growth and the economy while capturing demographic factors through “cohort-component” techniques. Population change at the state level is made up of births, death, and net migration. During the 1990s, natural increase accounted for a majority of population
growth nationwide, but in a number of fast-growing states in the South and West, net migration accounted for over half of the gain, making interstate mobility an important determinant of state population growth. Global Insight’s econometric analysis of net migration based upon economic determinants differentiates its forecasts from the Census Bureau’s trended state projections.

The demographic factors in population change are built into the model through the use of “cohort-component” techniques. This method projects a given population by applying age and sex-specific rates of fertility, mortality, and migration. Birth, death, and foreign immigration rates are based upon Census Bureau projections, adjusted for interstate differences. Because considerable age and sex detail is maintained over the projection period, the model reflects the sensitivity of population change to variations in age structure and permits analyses of the relative roles of natural increase and migration. The use of age-specific rates allows the distinction to be made between, for example, population growth due to increased birth or survival rates and that due to a change in the age structure, even though the rates at each age may remain constant.

5.2 Births and Deaths

One of the most significant demographic developments over the past two decades has been the dramatic drop in the national birth rate. Although U.S. fertility patterns have been characterized by long, regular cycles, there are indications that the most recent downturn reflects structural as well as temporal changes that are likely to reduce the amplitude of future cycles. In order to forecast state births, crude birth rates are calculated based upon these detailed fertility rates. The rates are updated periodically as new state fertility information becomes available.

The differences between the states in life expectancy at birth and in the age-sex structure of survival rates are marked enough to advise against the use of a single set of national survival rates as is generally done. The mortality component of the Global Insight state population model takes account of these differences by applying age and sex-specific adjustment factors for each of the states as they relate to the national survival rates projected by the Census Bureau. These adjustment factors were calculated as the ratio of state to national birth rates in 2000 and 2001 as reported by the National Center for Health Statistics (NCHS).

5.3 Net Migration

In our demographic sector, net migration is driven by economic conditions. The principal assumption is that people follow jobs and higher incomes rather than vice-versa. This does not mean that non-pecuniary determinants of migration do not exist. However, these are either fixed (climate and landscape) or vary only slowly (urbanization) or are special in nature (the ability to sell homes and retire to Sunbelt areas). The important thing is to provide the correct direction of causality. Demographic factors are most important on the consumption side of the regional economy. They are a significant factor in housing, retail sales, autos, etc., and the relationships are captured in the models. Population is also an important long-term determinant of the size of such sectors as state and local government.

Interstate migration is related to regional disparities in economic activity so that, for example, states with rapidly growing employment can be expected to attract a new inflow of migrants. To reflect this view of migration, the annual net migration rate for each of the states has been modeled as a function of relative economic performance such as relative employment or unemployment rates, real per capita income, wages rates, housing costs and housing market activity, and lagged population growth. All explanatory variables are lagged to reflect the
decision period for making a move. Relative employment or unemployment rates measure job opportunities, while relative real per capita income measures differences in the standard of living across states. Housing market activity, as measured by starts and sales, is used as a friction term. When houses are difficult to sell, people are less likely to move. Conversely, in a boom period, the ease of selling one’s house encourages a move.

6.0 Income

Personal income is most the frequently updated and the best overall measure of activity within a state, capturing labor income, property income and transfer payments. Good employment forecasts are critical to a good forecast of personal income since wages and other labor income constitute over 70 percent of income. In addition, there are multiple feedbacks between various employment sectors, cost variables, income, and population.

Compared with most factors of production, there is mobility in the labor market. Consequently, we expect the real wage to be similar across the United States, and nominal wages should increase with the local price level. From the demand side, we expect real wages to vary directly with labor productivity and with state manufacturing output relative to the United States. Finally, in the short-term, the unemployment ratio to population will affect the average wage rate. In order to model manufacturing wages, we explicitly account for the industry mix in the state, as well as the differences in wages per employee between industries as experienced by the state. To accomplish this, a variable called “generated wages” was calculated. The generated wage bill used in the manufacturing wage bill relationship is the sum of locally weighted national hourly earnings at the two-digit SIC level. For the non-manufacturing sector, there are stochastic relationships for components of the total wage bill in each state model. The endogenous components of the wage bill are TCPU, Trade, FIRE, Services, Construction and Mining, State and Local Government, and Manufacturing. The Federal Government is exogenous.

7.0 Residential Construction

Housing starts is one of the most complex regional variables to forecast. There are two reasons for this -- a lack of data and the nature of the industry. The data problems are legend and probably familiar to many readers. No state-by-state figures on housing starts are available, but rather only permit data. These permit data usually cover only a portion of each state, i.e., “permit issuing places.” Thus, historical data on housing starts by state must be estimated from limited coverage permit data. This is an inexact process that can only be verified in Census years (1990 and 2000). The second problem is that housing starts are extremely volatile, responding rapidly to interest rates, credit availability, changes in vacancy rates, strikes, usury ceilings, weather, and other factors. Forecasting housing is analogous to forecasting the change in employment rather than the level of employment. Thus, we are forecasting a volatile series for which historical data must be estimated; our approach for dealing with these problems is summarized below.

Housing starts in permit-issuing areas are calculated by applying monthly, Census Bureau conversion rates by region to county permit data. These rates reflect the lag between the issuance of a permit and the actual housing start. Each ratio represents the proportion of permits issued in month t-i that were started in month t, where i ranges from one to 20 months prior to permit issuance. Starts-to-permits ratios for each of the four Census Regions (Northeast, North Central, West, and South) and by housing type (single-family metro, single-family nonmetro, an five or more units) are assigned to counties according to membership in a particular region. A single set of monthly rates representing a U.S. average is applied to buildings with two or four units. The
application of these ratios to permit yields an initial estimate of starts. These estimates are then made consistent with published Census Bureau series on starts in permit areas by Census region.

8.0 Consumption and Finance

Up to this point, we have covered the parts of the model that capture the fundamental elements of the state economy: production, employment, population, and income formation. Consumption and finance do not play a central role in the Global Insight regional model for two reasons:

- Regional economies are open economies. Thus, local production is not driven by local consumption, and local capital formation is not dependent upon local financial markets.
- Regional consumption and financial data are severely limited.

Thus, the consumption and finance sectors are essentially satellite models which are driven by the economic and demographic variables described earlier, but which have few direct feedback links to the core model. A good example is retail sales. Above, we described how employment in wholesale and retail trade was related to disposable income and population, among other factors. A fair question is why retail sales have not been used in place of income as a “demand” variable. The answer is that state-level retail sales data were available for only 19 states, and the collection of this data stopped in 1996. Fortunately, in the case of the wholesale/retail employment sector, disposable personal income and retail sales are closely correlated, and little forecasting accuracy is lost by using income as an explanatory variable. We also make full use of the insights provided by the Global Insight’s Consumer Service at the national level.

9.0 Model Structure and Forecasting Sequence

As described above, the U.S. macroeconomic forecasts and the forecasts of related services such as international, energy, agriculture and the consumer sector serve as the basic drivers for the Regional Core forecast. These forecasts, in turn, provide the foundation for the other regional forecasting services such as Real Estate. Together, the inter-relationships provide a dynamically consistent modeling system that preserves the basic assumptions underlying each forecast. The key linkages within the Regional Core forecasting block can be traced in a straightforward manner. The basic starting point is the Export sector with 23 industries. Local employment is not usually directly affected by the export sector (except in special cases such as agriculture’s effect on wholesale trade in some states), but rather is connected via current and lagged personal income.

After wages are determined for each industry group, the model calculates categories of personal income that depend upon wages or simultaneously upon income. A “residence adjustment” to income is made to account for workers who work in one state but live in another. At this point the federal income tax liabilities are calculated using effective rates of tax that vary from state to state; the rates vary primarily because of differences in per capita income and the progressive nature of the federal tax system. State and local personal taxes and fees are calculated in a similar manner. After-tax or disposable income is the result of the calculation, and is the primary explanatory factor in the non-manufacturing (local) employment equations. This closes the major simultaneous block in the state model.

Also simultaneous with employment determination is the demographic/housing block. Net migration in each state is usually determined by job growth or unemployment rates relative to the nation or to other states. State population growth by age group is then determined by adding net
migration and net births to last period’s population. Household formation, a key determinant of housing demand, is calculated by applying age-specific “headship rates” to population. Single family and multi-family housing starts that are forecast as a function of household formation, the stock of housing units, housing prices, income, credit conditions, and national housing trends, then are important determinants of construction employment.

The number of unemployed relative to working-age population in each state (the unemployment ratio) is explained by local employment and population growth and national unemployment patterns. This unemployment ratio, which is much more stable than published state unemployment rates, is used as an explanatory variable in many of the model’s wage equations.

### 10.0 Conversion from SIC to NAICs

At the time this description was updated in October 2003, Global Insight was in the process of converting all our state and MSA economic models from an SIC basis to a NAICS basis. This process required the re-estimation of equations where personal income and employment variables are either the dependent variables, or are used as independent variables. The employment coverage was expanded to include all the NAICS “super sectors”, and some important sub-sectors such as wholesale and retail trade. The number of sectors for which the wage and salary component of personal income is forecast was similarly expanded. Starting in March 2003 when the BLS 790 employment data was released in NAICS format for the first time, we prepared employment forecasts in both a NAICS and an SIC basis for our Spring and Summer 2003 forecasts. The NAICS personal income data for states that was released in the summer of 2003 contained history back only to 2001q1; in order to create the income time series needed to re-estimate our models, we created a NAICS personal income series back to 1990q1. A number of clients have requested this series since NAICS personal income data back this far is not available from the Bureau of Economic Analysis. The employment and personal income variables in our state and metro models have been forecast on a NAICS basis since the Fall 2003 forecast. The only variable that has not been converted to NAICS is gross state product (GSP); BEA plans to release GSP data in NAICS for the first time in the Fall of 2004.