

*PROJECT TEMPLATE ON ARIMA MODELING OF PERSONAL INCOME.*

The Excel spread-sheet on personal income shows per-capita income by state over the past century. Each state time series – by itself – is probably a random walk, with a drift of inflation plus a productivity increase.

You might begin a student project by analyzing one state index. Nominal personal income is not stationary. You may take logarithms and first differences to see if the resulting time series can be modeled by an ARIMA process.

Inflation distorts the time series. Converting the nominal dollars to real dollars should leave a time series of productivity growth. Taking logarithms and first differences is now more likely to produce a stationary series.

Personal income, GDP, and unemployment are related. You can form a structural model and fit an ARIMA process to the residuals. You may have to search for GDP and other macroeconomic indices that extend back as far as the personal income index.

The macroeconomics on-line course has extensive analysis of personal income by

- State within the United States.
- Territory or region within European countries.
- Country within the world.

The macroeconomics on-line course assumes absolute convergence for the states of the U.S. For your student project, use the relativity of the state per capita income to countrywide per capital income.

Economists believe this relativity is slowly mean reverting – about 2% per annum. The macroeconomics on-line course call this absolute convergence.

*Illustration:* If State W's per capita income is 150% of countrywide in 20X7, it is expected to be 149% in 20X8.

For any one state, the relation is hard to see, since political changes may raise or lower per capita income.

*Illustration:* An increase in the state income tax or more onerous state regulation (New York, New Jersey, California) may slowly reduce average personal income over the next 40 years, whereas more business-friendly taxes and regulation may increase average personal income (Florida and other Southern states).

You may examine how state fortunes, such as the decline of the auto industry (Michigan in the 1970's) or the high immigration into California and Texas in the past two decades have affected relative personal income.

An ARIMA process in one state does not capture these political effects. A single state may not have a stationary time series. Start your student project with one state. You can fit an ARIMA process to each state, but you probably won't get  $\phi_1 = 98\%$ . Instead, you may model all the states. Use the Excel built-in functions for a linear trend, regressing each state's income relativity on the relativity one year back. With 77 years and 48 states in the Excel work-sheet, you have enough data to estimate the  $\phi_1$  parameter.

*Take heed:* Estimating the  $\phi_1$  parameter can be difficult. Instead, your student project can assume  $\phi_1 = 98\%$  and test if the residuals from the ARIMA process are white noise.

Each state has 77 time series observations. An AR(1) process leaves out the multi-year effects. You may compare AR(1), AR(2), and ARMA(1,1) processes.