Economic Forecasting with Least-Squares in Econometrics

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Introduction

Economic forecasting is associated with making predictions about the economy of a region or of the entire nation. However, the ability to consistently and accurately forecast the economy eludes even the best economists. Generally, it is said that there are two types of economic forecaster, those that don't know and those that don't know that they don't know. But the value of economic forecasts cannot be denied, otherwise the billions of dollars spent on economic forecasts would not exist. Forecasts reduce uncertainty and lead to better decisions. There are various methods used to forecast such as economic indicators, time series techniques, econometric modeling and consensus forecasting. We will use simple linear regression under econometric modeling to determine regression parameters and then assume values of government spending and interest rate to forecast consumer and business spending

Method

The data is collected quarterly from the Department of Commerce, Bureau of Economic Analysis website from the fourth quarter of 1999 to 2009. A simple econometric model uses the following four equations:

(1) $C = b_1 + b_2 \times Y$

(2) $I = b_3 + b_4 \times R + b_5 \times Y_{t-1}$

(3) $G = G$

(4) $Y = C_a + I_a + G_a$

Eq. (3) and (4) contain no parameters, but eq. (1) and (2) contain the regression parameters b_1 – b_5. First, to define the other variables:

$$C_a = \sum_{a=q12000}^{q42009} c_a \qquad I_a = \sum_{a=q12000}^{q42009} i_a \qquad G_a = \sum_{a=q12000}^{q42009} g_a$$

$$Y = \begin{bmatrix} y_{q42009} \\ \vdots \\ y_{q12000} \end{bmatrix} \quad Y_{t-1} = \begin{bmatrix} y_{q32009} \\ \vdots \\ y_{q11999} \end{bmatrix} \quad I = \begin{bmatrix} i_{q42009} \\ \vdots \\ i_{q12000} \end{bmatrix} \quad R = \begin{bmatrix} r_{q42009} \\ \vdots \\ r_{q12000} \end{bmatrix} \quad C = \begin{bmatrix} c_{q42009} \\ \vdots \\ c_{q12000} \end{bmatrix}$$

Where 'C' is consumer spending, 'G' is government spending, 'I' is business spending, 'Y' is total spending, 'R' is interest rate and b_1-b_5 are regression parameters.

Eq. (1) poses: $C = \begin{bmatrix} 1 & Y \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$

The general least-squares problem is to find $\begin{bmatrix} b_1 \\ b_2 \end{bmatrix}$ in the column space such that the length $\left\| C - \begin{bmatrix} 1 & Y \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} \right\|$ is minimized. Similarly, for eq. (2):

$$\left\| I - \begin{bmatrix} 1 & R & Y_{t-1} \end{bmatrix} \begin{bmatrix} b_3 \\ b_4 \\ b_5 \end{bmatrix} \right\|$$

Because of the free variables b_1 and b_3, there are multiple solutions and each solution, by orthogonal decomposition theorem, is orthogonal to the column space and takes the form:

$$A^T A \hat{x} = A^T b$$

The regression parameters are calculated with data from the fourth quarter of 1999 to 2009 using the least-squares solution.

For eq. (1): $\begin{bmatrix} 1 & Y \end{bmatrix}^T = \begin{bmatrix} 1 \\ Y \end{bmatrix}$ $\qquad \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \left(\begin{bmatrix} 1 \\ Y \end{bmatrix} \begin{bmatrix} 1 & Y \end{bmatrix} \right)^{-1} \begin{bmatrix} 1 \\ Y \end{bmatrix}$

For eq. (2): $\begin{bmatrix} 1 & R & Y_{t-1} \end{bmatrix}^T = \begin{bmatrix} 1 \\ R \\ Y_{t-1} \end{bmatrix}$ $\qquad \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = \left(\begin{bmatrix} 1 \\ R \\ Y_{t-1} \end{bmatrix} \begin{bmatrix} 1 & R & Y_{t-1} \end{bmatrix} \right)^{-1} \begin{bmatrix} 1 & R & Y_{t-1} \end{bmatrix}$

We can then use solved regression parameters to forecast given Y_{t-1} and assuming R and G.

Results

Using the data from quarter four of 1999 through 2009, the regression parameters are calculated to be:

$b_1 = 273.711$ $\quad b_2 = 0.642$ $\quad b_3 = -66.953$

$b_4 = 35.77$ $\quad b_5 = 0.156$

Parameter b_2 is positive but less than unity because according to Keynesian economic theory says that when income increases, consumer spending increases, but not by as much as the increase in income. Parameters b_4 and b_5 should have a negative relationship because high interest rates mean high finance costs and, therefore, less plant and equipment are acquired, but the positive relationship may indicate the current period's financial troubles. Parameter

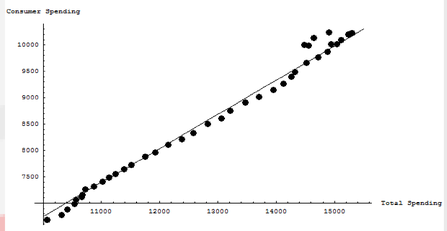

Figure 1. Least-squares fit of Consumer Spending versus Total Spending using Eq. (1) of the Simple Econometric Model

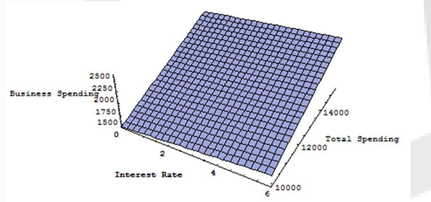

Figure 2. Least-squares plane of Business Spending versus Interest Rate and Total Spending using Eq. (2) of the Simple Econometric Model

b_5 is often called the accelerator because it reflects the relationship between total spending last period and business spending. Theoretically, a large increase in spending last period would stimulate production and the need for more plant and equipment this period. This relationship between business spending and last period's total spending is called the accelerator. Using government spending from quarter four of 2009, R = 0.12 and G = $2,959.20 (billions), we obtain C = $9841.6938 (billions) and I = $2262.2698 (billions). Consumer spending decreases from $10236.40 in Q4 2009 but business spending increases from $1707.80 in Q4 2009.

Summary

Using data from quarter four of 1999 through 2009, we used the least-squares method to solve for the regression parameters and graphed Eq. (1) and (2). Forecasted consumer and business spending will be $9841.6938 (billions) and $2262.2698 (billions) given an interest rate of 0.12 and government spending of $2,959.20 (billions).

Conclusion

Through the use of least-squares of linear algebra, we were able to approximate regression parameters by inputting large amounts of previous data into matrices. Using these parameters, we were able to graph a line and make a forecast about consumer and business spending that will reduce uncertainty and lead to better decisions.

Acknowledgements and References

Mathematica

Elia Kacapyr (1996). *Economic Forecasting: The State of the Art*. Armonk, NY: M.E. Sharpe

Department of Commerce, Bureau of Economic Analysis Website. (2010, April 24). *National Income and Product Accounts Table*.