Bangko Sentral ng Pilipinas
ECONOMIC Newsletter

No. 09-05
September 2009

Revised Single-Equation Model for Forecasting Inflation: Preliminary Results

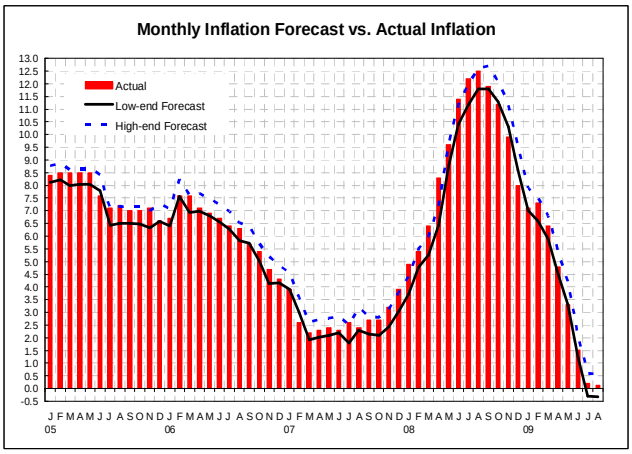
By Amy Doreen S.J. Cruz[1]

Inflation forecasting models have become even more indispensable tools with the BSP's adoption of inflation targeting in 2002. As a forward-looking approach to monetary policy, inflation targeting requires the BSP to be able to forecast inflation over the policy horizon with reasonable accuracy. BSP estimates show that it takes around 1-2 years for changes in key policy interest rates to make their full impact on inflation. For short-term inflation forecasting, the BSP uses its single-equation model (SEM) to generate a two-year ahead monthly path for inflation. The forecasts from the SEM are then combined with the monthly forecasts from the BSP's multi-equation model (MEM) to provide a more comprehensive assessment of the inflation outlook.[2]

THE BSP'S INFLATION FORECASTING PERFORMANCE

The chart comparing monthly inflation forecast with actual inflation shows that over the past few years, the one-month ahead average inflation forecast from the BSP's SEM and MEM tracked actual inflation closely.

To further improve its forecasting ability, the BSP has been continually undertaking refinements to its suite of econometric models. In August 2009, the Department of Economic Research (DER) completed its review of the SEM, the preliminary results of which are presented below. Section I describes the variables and data sources while Section II discusses the estimation and forecast evaluation results.



THE BSP'S REVISED SEM

I. VARIABLES AND DATA SOURCES

The SEM incorporates demand-pull and cost-push factors and captures time dynamics in the month-on-month behavior of inflation. It consists of an ordinary least squares (OLS) equation with the first difference in the logarithm of the Consumer Price Index (CPI) as the dependent variable.

1. CPI

The CPI is a measure of the average price of commodities commonly purchased by households reckoned from a base year (i.e., year 2000), weighted by the consumption pattern indicated by the Family Income and Expenditure Survey (FIES) of the National Statistics Office (NSO). Monthly data on the CPI are published by the NSO every first week of the month.

[1] Bank Officer V, Department of Economic Research
[2] The MEM is a combination of behavioral, bridge and identity equations modeled on monthly data. It provides a view of the various transmission channels and allows policy simulations and analysis of inflationary shocks.

2. Nominal Wage Rate (NWAGE)

NWAGE refers to the nominal minimum wage rate of non-agricultural workers in the National Capital Region (NCR), as obtained from the National Wages and Productivity Commission (NWPC) of the Department of Labor and Employment (DOLE). As of this writing, other indicators for nominal wages are being explored as substitutes for NWAGE to capture wage trends across a broader group of occupations, industries and regions. Substantial hikes in nominal wages tend to be positively related to inflation through increased demand for goods and services, and higher production costs.

3. Weighted Domestic Price of Petroleum Products (WOILPR)

WOILPR is the CPI-weighted average price of gasoline, kerosene, diesel and liquefied petroleum gas (LPG) based on data from the Department of Energy (DOE). Higher WOILPR tends to raise production costs which could translate to elevated consumer prices. A sustained increase in domestic oil prices could also generate second-round effects on inflation in the form of hikes in transport fares and other energy-related commodities and services.

4. Domestic Retail Price of Rice (RICEPRICEWTD)

RICEPRICEWTD is the CPI-weighted domestic retail price of ordinary, special and NFA rice, which together account for a significant 9.4 percent of the CPI basket. Data on retail rice prices are from the Bureau of Agricultural Statistics (BAS) of the Department of Agriculture (DA).

5. Price Index for Non-Oil Imports (PNONOIL)

PNONOIL represents the price index for the country's non-oil imports as derived from the quarterly National Income Accounts (NIA) published by the National Statistical Coordination Board (NSCB). The inclusion of PNONOIL in the SEM aims to capture the impact on domestic inflation of movements in the prices of non-oil commodities bought abroad. The actual value of PNONOIL is computed using the following formula:

$$PNONOIL = (TOTMN-MOILN)/(TOTM-MOIL)$$

where TOTMN is the total merchandise import value at current prices; MOILN is the import value of mineral fuels, lubricants and related materials at current prices; TOTM is the total merchandise import value at constant prices; and MOIL is the import value of mineral fuels, lubricants and related materials at constant prices. Faster growth in PNONOIL is often associated with higher domestic inflation.

6. Domestic Liquidity (M3)

M3 or domestic liquidity is equivalent to the sum of currency in circulation, demand deposits, savings deposit, time deposits, and deposit substitutes. Domestic liquidity data are generated and published by the BSP every month. The coefficient of M3 growth in the revised SEM is expected to be positive: sustained, rapid growth in domestic liquidity pushes up inflation by boosting the demand for goods and services.

7. Market Interest Rates (TBILL)

Market interest rates are represented in the revised SEM by secondary market yields on 91-day Treasury bills. In contrast to the previous SEM which utilized purely primary market rates, the re-specified SEM makes use of secondary market rates to better capture interest rate movements especially when there is no auction or bids for T-bills in the primary market are rejected.

8. Real GDP (GDPR)

Gross Domestic Product (GDP) measures the total output within the geographic boundaries of the country, regardless of the nationality of the entities generating the output. GDPR is the value of all the goods and services produced within the Philippines expressed in constant 1985 prices as reported in the NIA. The growth in GDPR is treated in the SEM as a source of demand-side inflationary pressures—with inflation expected to rise as growth in GDPR accelerates—tentatively standing in for the output gap, the estimation of which is being refined by the BSP.

9. Exchange Rate (ER)

ER refers to the peso equivalent of one US dollar as published by the BSP. Movements in the foreign exchange rate are a key determinant of inflation through their impact on the landed cost of imported commodities.

10. Fiscal Balance (NGBAL)

NGBAL is the National Government fiscal balance as reported by the Bureau of the Treasury (BTr) of the Department of Finance (DOF) every third week of the month. Expressed as a ratio to Nominal Gross Domestic Product (GDPN) in the revised SEM, NGBAL is expected to be inversely proportional to inflation: inflationary pressures build up with growing and persistent fiscal deficits, and ease with positive fiscal balances.

11. Expected Inflation (EXPINF)

Inflation expectations affect the price- and wage-setting behavior of economic agents. For instance, producers anticipating inflation to accelerate might decide to immediately reflect in their selling prices higher future costs to protect profit margins. High expected inflation could also lead to a wage-price spiral whereby an outlook of rapid price increases could prompt workers to demand wage adjustments which could in turn elevate production costs and selling prices if passed on to consumers. If not managed well, high inflation expectations could thus become self fulfilling.

In the revised SEM, the spread between the secondary market yields of selected T-bill tenors was used as proxy for expected inflation. Compared to other available measures of inflation expectations, term spread data are sufficiently long and frequent for model estimation.[3]

[3] For a survey of the various measures of inflation expectations in the Philippines, see box article "Measuring Inflation Expectations in the Philippines" from the Second Quarter 2008 BSP Inflation Report.

II. ESTIMATION RESULTS

Prior to running the regression, all variables were tested for unit roots and transformed to stationary series as necessary. Based on ordinary least squares (OLS) regression of monthly data from January 1990 to June 2009, inflation was found to be a function of contemporaneous changes in the nominal wage rate, the weighted domestic price of petroleum products, domestic retail rice prices, and market interest rates. Explanatory variables which were found to significantly affect inflation with a lag include changes in the following: the non-oil import price index, domestic liquidity growth, real GDP growth, the foreign exchange rate, the fiscal balance-to-GDP ratio and expected inflation. All coefficients are significant at the 5 percent level and have the expected signs—negative for NGBAL and positive for the rest of the explanatory variables.

Revised SEM

Sample (adjusted): 1990M03 2009M06

Included observations: 232 after adjustments

$$CPI = -0.005 + \underset{(2.442)}{0.129}*CPI_{-1} + \underset{(5.838)}{0.062}*NWAGE + \underset{(6.315)}{0.033}*WOILPR + \underset{(6.165)}{0.075}*RICEPRICEWTD + \underset{(2.436)}{0.033}*RICEPRICEWTD_{-1} + \underset{(2.014)}{0.036}*PNONOIL + \underset{(4.141)}{0.055}*M3 + \underset{(3.870)}{0.003}*TBILL + \underset{(3.259)}{0.011}*GDPR + \underset{(2.480)}{0.031}*ER - \underset{(-2.680)}{0.057}*NGBAL + \underset{(2.235)}{0.001}*EXPINF$$

R-squared	0.624618
Adjusted R-squared	0.604050

Note: T-statistics in parentheses

In-sample forecast evaluation statistics indicate that the re-specified SEM is able to forecast CPI closely, with the one-month ahead mean absolute percent error (MAPE) at 0.3 percent.

Other statistics indicate good forecasting capability of the revised SEM, with the Theil inequality coefficient, bias proportion and

variance proportion close to zero, and the covariance proportion nearly one.[4]

Revised SEM Forecast Evaluation Statistics	
Forecast sample: Jan 1990-Jun 2009	
Adjusted sample: Mar 1990-Jun 2009	
Included observations: 232	
Root Mean Squared Error	0.376949
Mean Absolute Error	0.272729
Mean Absolute Percent Error	0.283100
Theil Inequality Coefficient	0.001826
Bias Proportion	0.000294
Variance Proportion	0.014539
Covariance Proportion	0.985167

In terms of year-on-year inflation, the re-specified SEM performs better than the previous SEM, with an average[5] mean absolute error (MAE) of 0.3 percentage point and root mean squared error (RMSE) of 0.4 percentage point compared to the previous SEM's MAE of 0.5 percentage point and RMSE of 0.6 percentage point.[6]

	Revised SEM one-step ahead forecast	Actual Inflation
Year-on-year inflation		
2002	3.0	3.0
2003	3.4	3.5
2004	5.8	6.0
2005	7.8	7.7
2006	6.2	6.3
2007	2.7	2.8
2008	9.2	9.3
Jan-Jun 2009	5.3	5.1
RMSE	0.4	
MAE	0.3	

[4] The bias proportion indicates how far the mean of the forecast is from the mean of the actual series. The variance proportion indicates how far the variation of the forecast is from the variation of the actual series. Thus, zero or near-zero values for bias and variance proportion are ideal. Meanwhile, the covariance proportion measures the remaining unsystematic forecasting errors. The better the forecast, the closer is the covariance proportion to one. The bias, variance and covariance proportions sum up to one.

[5] Average from January 2002 to June 2009

[6] Moreover, recursive least squares estimates of the revised SEM suggest stability in the parameters of the equation, with one-step ahead forecast errors settling within the standard error bands for nearly all subsets of the sample data.

SOME FINAL REMARKS ON INFLATION FORECASTING

While results indicate that the revised SEM has promising forecasting capability, it bears emphasizing that in practice, many central banks utilize a suite of econometric models and approaches for forecasting and policy simulation.[7] Models vary from simple single-equation models (akin to the revised SEM) to multiple-equation structural macroeconomic models, to vector autoregression (VAR) models and micro-founded dynamic stochastic general equilibrium (DSGE) models, among others. In the case of the BSP, in addition to the SEM and MEM, the bank maintains the Long-Term Macroeconomic Model (LTMM) and a preliminary DSGE model. This is in line with the BSP's continuing efforts to develop a broad suite of models to help guide policymaking.

Rummel (2009) argues that because of the uncertainty regarding the true structure of the economy and the shocks faced by it, and being gross simplifications of a complex reality, no single model can answer all relevant questions for monetary authorities. As such, most models are designed to address a set of specific questions or problems that need to be investigated.

For the same reasons, some amount of judgment or discretion inevitably enters various stages of the forecasting process. Federal Reserve Chairman Ben Bernanke may have summed it up best:

> "…the forecasts of inflation (and of other key macroeconomic variables)…are developed through an eclectic process that combines model-based projections, anecdotal and other "extra-model" information, and professional judgment. In short, for all the advances that have been made in modeling and statistical analysis, practical forecasting continues to involve art as well as science."

[7] See Nelson (2008) for a summary of the various models and econometric approaches used by the surveyed central banks.

References:

Bernanke, Ben. 2007. Inflation Expectations and Inflation Forecasting. Speech delivered at the Monetary Economics Workshop of the National Bureau of Economic Research Summer Institute, July 10, in Cambridge, Massachusetts, USA.

Guinigundo, Diwa. 2005. "Inflation targeting." In The Bangko Sentral and the Philippine Economy, ed. Dr. Vicente B. Valdepeñas, Jr., 346-391. Manila: Bangko Sentral ng Pilipinas.

Nelson, William. 2008. Monetary Policy Decisions: Preparing the Inputs and Communicating the Outcomes. BIS Papers, no. 37(February), http://www.bis.org/publ/bppdf/bispap37.htm (accessed September 9, 2009).

Rummel, Ole. 2009. Issues in Macroeconomic Assessment and Forecasting. Presentation at the 2nd SEACEN-CCBS/BOE Advanced Course on Macroeconomic and Monetary Policy Management, March 22-27, in Manila, Philippines.

Bangko Sentral ng Pilipinas ECONOMIC Newsletter

Department of Economic Research
Monetary Stability Sector