CHAPTER IV
METHODOLOGY

This chapter discusses the problem of inflation in Nepal along with hypotheses, specification of models, testing of the hypotheses. It also discusses the selection of test statistics and data and period of analysis of this study.

1. PROBLEM OF INFLATION

The overall inflation during 1975-2003 was at an average annual rate of 8.5 percent. Inflation increased in double digits for nine years out of twenty-eight. The rates of growth in individual years range from 21 percent in FY1991/92 to negative 0.6 percent in FY1975/76. On balance, it appears that inflation in Nepal has remained high rather than hyper.

In Nepal, the factors attributable to the highest rate of inflation seem to be both internal and external. Excess money supply over demand is one of the major factors in rising inflation. The peaked rate of inflation is attributable to the highest rate of growth of money supply combined with more or less constant growth in output of the economy. Inflation results due to widening of budget deficits financed through the central bank. Since government spending is a major component of aggregate demand, a rise in such spending leads to inflation under full employment situation. Inflation, particularly in developing economies, is determined not only by monetary variables as mentioned above, but also by structuralist variables. The degree of openness of an economy, particularly world rate of inflation, has a significant influence on domestic inflation. Domestic inflation is therefore, an outcome of several attributing factors as explained by the Monetarist, Keynesian and the Structural models.

2. HYPOTHESES

The hypotheses relate to three different schools of thought are given below

Monetarist Hypothesis:

A) Null Hypothesis (Ho): Inflation in Nepal is not a monetary phenomenon and is not determined by growth of monetary aggregates, income and expected rate of inflation.

B) Alternative Hypothesis (H1): Inflation is a monetary phenomenon.

Keynesian Hypothsis:

C) Null Hypothesis (Ho): Inflation in Nepal is not a non-monetary phenomenon and is not determined by budget deficit, and interest rate.

D) Alternative Hypothesis (H1): Inflation in Nepal is a non-monetary phenomenon.

Structuralist Hypothesis:

E) Null Hypothesis (Ho): Inflation in Nepal is not determined by structural factors-such as import price, agricultural non-agricultural GDP ratio, relative price of food to general price level, and export to GDP ratio.

F) Alternative Hypothesis (H1): Inflation in Nepal is determined by structural factor.

3. MODELS AND HYPOTHESES TESTING

The coefficients of regression equation of inflation models are estimated by using Ordinary Least Square (OLS) method. The variables are used in various combinations; sometimes the monetary variables are used alone and sometimes used jointly with structuralist variables. The inflation (dependent variable) is regressed on different monetary and structuralist variables (independent variables). Variables are transformed to logarithm before running regression to eliminate variability of the variables as well to apply linear regression model, so those coefficients estimated are interpreted as elasticity coefficients. The statistical significance of the estimated coefficients will be tested either at 1 percent, or at 5 percent or at 10 percent significant level.

(A) Monetarist model

$$\pi_t = \beta_0 + \beta_1 M_t - \beta_2 Y_t + \beta_3 \pi_t^* + \varepsilon_t \quad \ldots\ldots\ldots\ldots (1)$$

Where, π_t = inflation; M_t= monetary aggregates; Y_t= real gross domestic product at factor cost; π_t^*= expected rate of inflation; ε_t= disturbance term with zero mean and constant variance.

There are three monetary aggregates (M_t) that are computed by the Nepal Rastra Bank (the central bank of Nepal) viz, narrow money (M1), broad money (M2), and reserve money (RM). Narrow money consists of currency held by the public and demand deposits of commercial banks. Similarly, broad money consists of M1 plus time deposits of commercial banks. Reserve money consists of currency held by the public plus reserve money of commercial banks in their vault, and held in the Nepal Rastra Bank. In order to confirm the pure monetarist hypothesis, different monetary aggregates (M_t) will be taken as argument in inflation equation (1). The null hypothesis for β_1=0 implying changes in money supply does not lead to changes in inflation. If null hypothesis is rejected, then the alternative hypothesis is accepted for β_1>0 implying that money supply positively affects inflation.

The rate of growth in real gross domestic product (Y_t) is also used as an additional variable in the pure monetary model to test the fact that money supply changes are not inflationary to the extent that they are absorbed by real output changes (Argy, 1970). In a full employment economy, changes in money supply affect changes in inflation directly and proportionately. Since the effect of changes in money supply (M_t) is distributed into inflation (π_t) and real income (Y_t), the theoretical sign of the β_2<0 coefficient is negative. If the null hypothesis of β_2=0, it is inferred that GDP has no impact on inflation. If the hypothesis is rejected and the alternative hypothesis β_2<0 is accepted, it implies that the effect of money supply is distributed into inflation and real income. Similarly, the expected rate of inflation (π_t^*) is hypothesized β_3>0 positive. A rise in the expected rate of inflation motivates the public to substitute financial assets for real assets resulting in higher demand for consumer durables which, in turn, leads to rise in inflation. The expected rate of inflation series is derived from the adaptive expectation procedure where parameters of interest are fixed by searching for minimization of sum of square of actual and simulated series.

(B) Keynesian model

$$\pi_t = \alpha_0 + \beta_1 D_t + \beta_2 R_t + \varepsilon_t \qquad \text{-------------- (2)}$$

D_t= budget deficit, R_t= rate of interest; and ε_t= disturbance term with zero mean and constant variance.

The theoretical expected sign of β_1>0 is positive. It implies that inflation and budget deficit are positively related. Since budget deficit is one of the basic sources of rise in money supply, it can be used as a proxy of money supply. Similarly, the theoretical expected sign of rate of interest (R_t) is assumed positive i.e. β_2>0. An increase in rate of interest declines holding of money balance, and hence increase in velocity. There is a positive relationship between inflation and velocity. Therefore, inflation is hypothesized as being positively affected by the rate of interest.

(C) Structuralist model

$$\pi_t = \alpha_a + \beta_1 IP_t - \beta_2 (\frac{IM}{GDP})_t - \beta_3 (\frac{AG}{NAG})_t + \beta_4 FPR_t + \beta_5 (\frac{EX}{GDP})_t + \varepsilon_t \text{-------------- (3)}$$

IP_t = Indian price; IM/GDP is import/GDP ratio, AG/NAG_t = agriculture/non-agriculture GDP ratio; FPR_t= food price relatives; EX/GDP_t = export/GDP ratio; ε_t= disturbance term with zero mean and constant variance.

Import price is hypothesized as affecting the domestic rate of inflation positively. Therefore, the theoretical expected sign for β_1>0 is positive. Since India is Nepal's largest trading partner, a change in the prices of goods and services in India increases the import price of goods and services in Nepal. Most commodity transactions with India are on a wholesale price basis. Indian wholesale price index is proxied for the import price. The coefficient of Import/GDP ratio is hypothesized as negative, that is, β_2<0. The null hypothesis for β_2=0 implies that there is no negative relationship between rate of inflation and import/GDP ratio. Success in rejecting the null hypothesis signifies that a degree of openness reduces the domestic rate of inflation. This is because domestic demand shocks spill over into the balance of payment. An increase in import substitute domestic goods cause less pressure on inflation in domestic economy.

The theoretical sign for β_3<0 is negative. This implies that there is a negative relationship between the rate of inflation and agricultural/non-agricultural sector GDP ratio. This is because of the inelasticities in agricultural products in relation to non-agricultural products. However, theoretical sign of food price relative is expected to be (β_4>0) positive. The reason for the positive expected sign of β_4 is that the pressure on fixed supply of agricultural food by the continuous rising population and development of the non-agricultural sector results into an increase in relative price of food as well as general price. The greater the export/GDP ratio, the larger will be the foreign exchange reserve, causing supply of money to increase, and hence rise in prices of goods and services. Therefore, the theoretical sign for β_5>0 is hypothesized to be positive.

4. TEST STATISTICS

The test statistics, such as, t, F, DW test, R^2 etc, will be performed for the statistical validity of different aspects of the models. The response to unsatisfactory test leads to necessary improvement and modification of the equation in some way, which helps to make coefficients unbiased and consistent. t-test is a parametric test. The partial coefficients of the regression equation are supposed to follow t-distribution. The statistical significance of regression coefficients are tested by t-test. If the computed value of the t statistic is greater than the tabulated value, null hypothesis is rejected, it means, the variation of the particular independent variables in the regression coefficients are considered to be insignificant to explain the variation of dependent variable. Alternative hypothesis is accepted in the reverse case. Since theoretical distribution is highly sensitive to sample size, t-distribution is used in case of less than 30 samples size case. In case of the sample size more than 30, t-distribution follows normal distribution, and hence z-test is applicable.

F test is used to test the significance of the overall model. The null hypothesis for all the coefficients is considered to be zero unless some restrictions are made. If the null hypothesis is rejected, that is, if the entire coefficients are not equal to zero, then model as a whole is considered to be a good fit. Moreover, F test is a stability test of the model. For the present study, Nepal's macroeconomic variables are hypothesized as shifting in structural parameters in the early ninties due to the initiation of different liberalized policies. Therefore, breaking the sample period from the year 1989 into two parts seems relevant. F test, in this context, is used to test whether there are significant changes in coefficients of variables of the inflation model before and after the breakpoint year.

It is quite often that the residual term in an equation is correlated with its lagged values in different orders. This is called the problem of autocorrelation in an equation. In order to test whether the residual term in the regression equation follows first order autocorrelation, DW test statistic is adopted. There is a high possibility of autocorrelation problem in time series data. Moreover, time series data are characterized by time trended, R^2 value possesses around 99 percent showing a model's perfect fit. Achieving very high R^2 along with very low DW statistic in time series data is thought to be due to spurious relationships between the variables (Gujarati, 2004). Time series data, particularly in level form, attribute spurious relation because of the problem of data being non-stationary.

Time series data, particularly in level form, attribute spurious relation between the variables. Test of stationarity of time series data is examined applying Augmented Dickey Fuller (ADF) test statistics. A standard reduced form random walk model with drift, trend and different lags of difference dependent variable, that is, $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha \Delta Y_{t-1} + \varepsilon_t$ is used to check unit root problem in time series data (Phillips and Perron, 1988). Unit root test is applied for the coefficient 'δ' of the equation to find out whether the data are stationary or not. Null hypothesis of unit root or non-stationary of a time series is δ=0 against the alternative hypothesis $\delta \neq 0$. If δ=0, then there is unit root or non-stationary problem in time series data. The acceptance or rejection of null hypothesis is examined by comparing ADF statistic with MacKinnon critical value. Both the level form and first difference of the series are tested for stationarity.

According to Engle and Granger (1987), a conclusion on the basis of differenced data, though differenced data solve the problem of non-stationary, may mislead the long-run relationship between the variables. Relationship between the variables computed under differenced data, in different orders, shows a short-term relationship, which can be considered as a disequilibrium relationship. However, a long-run relationship between the variables under level form data can be shown only if the variables are co-integrated in the same order while making the data series stationary, however, their linear relationship should be less than the order (Engle and Yoo, 1987). The property of cointegration between the time series holds true when "two time series are said to be co-integrated of order d, b, denoted CI (d, b) if (i) they are both integrated of order d; (ii) but there exists some linear combination of them that is integrated of order b>d"(Engle and Granger (1987).

The estimated residual i.e. $\hat{u}_t = Y_t - \hat{\beta}_1 - \hat{\beta}_2 X_t$ from the cointegration equation i.e. $Y_t = \beta_1 + \beta_2 X_t + u_t$ is tested for the cointegration between the variables. If two variables are co-integrated (that is, if an equilibrium relationship exists), then the short-run "disequilibrium" relationship between the two variables can always be represented by an Error Correction Model (ECM), that is, $\Delta y_t = \alpha_0 + \alpha_1 \Delta x_t + u_{t-1} + \varepsilon_t$ (Enders,2004). If equilibrium relationship does not exist, then we should not use ECM to represent short-run behavior of the variables. The ECM is capable of solving both the long-run and short-run relationship between the variables in one equation. According to ECM argument, both the level form and its first difference representation specified in a single regression equation make sense. In present study, ECM of inflation in Nepal is estimated, and the impact of changes in the exogenous variables on the inflation path is derived by using dynamic structure of ECM.

Forecasting is generally used to predict the future values of the economic phenomenon. An important reason for formulating an econometric model is to generate forecasts of one or more economic variables. There are two forecasting methodologies; the first is econometric forecasting- based on regression model that relates one or more dependent variables to a number of independent variables; and the second is time series forecasting- based on attempts to predict the values of a variable from past values of the same variable. In the present study, both methodologies are applied to forecast inflation in Nepal. Major forecasting methods, such as, trend method, regression method, smoothing method, Box Jenkins ARIMA(p,d,q) methodology, Vector Autoregression (VAR) Methodology, etc. are used in this study. The specification of ARIMA(p,d,q) and VAR methodologies are as follows:

ARIMA(p,d,q) methodology

$$CPI_t = \alpha_0 + \alpha_1 CPI_{t-1} + \alpha_2 CPI_{t-2} + ... + \alpha_p CPI_{t-p} + \varepsilon_t \qquad \text{AR(p) process}$$

$$CPI_t = \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + ... + \phi_q \varepsilon_{t-q} \qquad \text{MA(q) process}$$

$$CPI_t = \alpha_0 + \alpha_1 CPI_{t-1} + \alpha_2 CPI_{t-2} + ... + \alpha_p CPI_{t-p} + \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + ... + \phi_q \varepsilon_{t-q} \qquad \text{ARMA(p,q)}$$

Vector Autoregression (VAR) Methodology

$$CPI_{1t} = \alpha + \sum_{j=1}^{k} \beta_j CPI_{t-j} + \sum_{j=1}^{k} \gamma_j M1_{t-j} + u_{1t} \qquad (1)$$

$$M1_{1t} = \delta + \sum_{j=1}^{k} \beta_j CPI_{t-j} + \sum_{j=1}^{k} \gamma_j M1_{t-j} + u_{1t} \qquad (2)$$

Where, CPI stands for consumer price index, M1 stands for narrow money aggregate, $\phi, \alpha, \beta, \gamma$ and δ are coefficients.

The forecastability of inflation models under different methodologies is examined by using Mean Absolute Prediction Error (MAPE). Among the various techniques and methods of deriving core inflation, the measure of core inflation for Nepal in this study is computed following the principles of exclusion methods (Clark, 2001).

5. DATA AND PERIOD OF ANALYSIS

The main sources of data for the present study are Quarterly Economic Bulletin of the Nepal Rastra Bank (the central bank of Nepal), Urban Consumer's Price Index published by Nepal Rastra Bank, Economic Surveys of His Majesty's government, Ministry of Finance, International Financial Statistics, World development indicators 2003. Present study is based on secondary data. The study spans 28 years, starting from FY1975/76 to FY2002/03. Because of the lack of availability of data for new inflation series and other macroeconomic variables, this study uses FY1975/76 as an initial year of the analysis. The whole sample period is divided into two parts since FY1989/90. The rationale of such a division is the assumption of structural shift in the policy regime. Considering the availability of data, two types of analysis are made in this study: the first analysis is based on annual data, and the second analysis is based on quarterly data. However, the quarterly data are available for CPI and different monetary aggregates only. Therefore, analysis of the pure monetarists hypothesis is pursued using quarterly data. However, annual data are used for examining all the hypothesis (monetarist as well as structuralist) of the study.