Government Revenue Forecasting in Nepal

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Abstract

This paper attempts to identify appropriate methods for government revenues forecasting based on time series forecasting. I have utilized level data of monthly revenue series including 192 observations starting from 1997 to 2012 for the analysis. Among the five competitive methods under scrutiny, Winter method and Seasonal ARIMA method are found in tracking the actual Data Generating Process (DGP) of monthly revenue series of the government of Nepal. Out of two selected methods, seasonal ARIMA method albeit superior in terms of minimum MPE and MAPE criteria. However, the results of forecasted revenues in this paper may vary depending on the application of more sophisticated methods of forecasting which capture cyclical components of the revenue series. The prevailing forecasting method based particularly on growth rate method extended with discretionary adjustment of a number of updated assumptions and personal judgment can create uncertainty in revenue forecasting practice. Therefore, the methods recommended here in this paper help in reducing forecasting error of the government revenue in Nepal.

Key words: Data generating process, forecast bias, seasonal pattern, under-or-over estimation, government revenue, seasonality

JEL Classification: H2, O23

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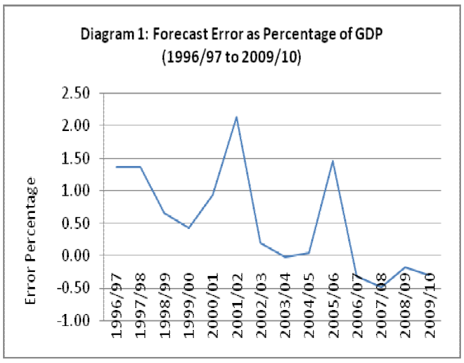
I. INTRODUCTION

The revenue forecasts by the national government are carried out in course of budget preparation. An accuracy of revenue forecasts is one key issue in the design and execution of fiscal policies (IMF, 2001). Under or over-prediction of revenue forecast creates budget planning vulnerable. Revenue forecast provides necessary discipline for negotiations between the executive and legislative branches of the government. It helps in setting up performance targets for revenue departments and agencies (Auerbach, 1999, Danninger, 2005). One of the major sources of error (or bias) in revenue forecasting is the methods adopted in forecasting revenue in addition to variety of political and institutional factors determining such bias (Golosov and Kind, 2002, Kyobe and Danninger, 2005).

In Nepal, revenue forecasts is an important task of Ministry of Finance (MOF) in the course of budget preparation and specifying performance targets of revenue collection offices. Major institutions involved in forecasting revenue in the country are MOF and Nepal Rastra Bank (NRB) as their work of forecasting is an essential part of the budgetary process. The IMF, especially its Fiscal Affairs Department (FAD) often gives advice for a systematic analysis of forecasting in low-income countries in the context of reforms on the budget planning process (Kyobe and Danninger, 2005). However, forecasting techniques are generally not put down in formal documents, and country practices are often a mix of idiosyncratic budget practices and influences from legacy systems. Too much reliance on few methods in forecasting revenue of the government of Nepal is considered to be less efficient in capturing true DGP of revenue sequence. Not a remarkable exercise has been carried out in identifying appropriate methodology of revenue forecasting from those institutions involved in revenue forecasting at present and there is a lack of private institutional forecaster of revenue in the economy.



As a result, there is an over-estimation or under-estimation of the revenue of the government. The forecast error as percentage of GDP shows downward trend with erratic movement as represented by forecast error or bias as shown in Diagram 1. Revenue forecast shows upward biased before FY 2001/02 and downward biased thereafter in Nepal. Realizing the facts that any misspecification of appropriate forecasting techniques that leads to much error in revenue forecasting as motivating factor of this study. In light of this fact, the objectives of this paper is to identity appropriate methods for revenue forecasting using monthly total revenue sequence and rank the methods under scrutiny based on some statistical criteria.

Following five important methods of forecasting under consideration, this study found two methods namely SARIMA and Winter as the representative methods of revenue forecasting in Nepal. The rest of the paper is organized as follows. Next section presents explanation of each of the five methods under the heading methodology. Section III provides results and analysis. Finally, the last section draws the conclusion.

II. METHODOLOGY

In categorizing forecasting methodologies, two broad approaches can be distinguished. Time series forecasting attempts in predicting the values of a variable from the past values of the same variable. In contrast to the time series approach econometric forecasting is based on a regression model that relates one or more dependent variables to a number of independent variables. The time series approach has generally been found to be superior to the econometric approach when short-run predictions are made (Ramanathan, 2002). In this paper, use is made of time series forecasting approach utilizing level data of monthly total revenue series starting from 1997 to 2012. Last 24 out of total 192 observations are taken to check the accuracy of the forecasting methods employed in this paper. An ex-ante forecasts of 24 observations are presented in the Appendix. Both the cumulative as well as net monthly forecasts are presented utilizing each of the methods of forecasting employed. The initial period of sample in FY 1997/98 has been chosen based on the year when the government of Nepal adopted Value Added Tax as a landmark reform in revenue structure in Nepal. Followings are the explanation of basic characteristics of each of the selected set of methods that are used for forecasting in this paper.

Holt Method : The forecasting method developed by Holt (1957) is one popular smoothing technique of forecasting. The two-parameter exponential smoothing technique developed by Holt is a modified method of simple exponential smoothing formula of $\tilde{y}_t = \alpha y_t + (1-\alpha)\tilde{y}_{t-1}$; where $1 > \alpha > 0$ incorporating average changes in the long-run trend (increase or decline) of the sequence $\{y_t\}$. Here, $\{\tilde{y}_t\}$ is smoothed sequence. Holt methods is superior to exponential smoothing technique that former method incorporates trend in the smoothing series. The smoothed or estimated series is derived by using two recursive equations as given in equation (1) and (2). The smoothness of the series depends on two smoothing parameters, α and β both of which must lie between 0 and 1, that is, the smaller are α and β the heavier is the smoothing (Makridikis, Wheelwright and Hyndman, 1998).

$$\tilde{y}_t = \alpha y_t + (1-\alpha)(\tilde{y}_{t-1} + r_{t-1}) \text{ ;where, } 1 > \alpha > 0 \quad (1)$$

$$r_t = \beta(\tilde{y}_t - \tilde{y}_{t-1}) + (1-\beta)r_{t-1} \text{; where, } 1 > \beta > 0 \quad (2)$$

$$\hat{y}_{t+l} = \tilde{y}_T + l r_T \quad (3)$$

Here, $\tilde{y}_t$ denotes an estimate of the level of the series at time *t* and r_t denotes an estimate of the slope of the series at time *t*. Equation (2) adjusts $\tilde{y}_t$ directly for the trend of the previous period, r_{t-1} by adding it to the last smoothed value $\tilde{y}_{t-1}$. Equation (3) is used to forecast l.

Winter Method: Winter (1960) extended Holt method by treating seasonal effect in the forecasting equation. Winter method is based on three smoothing equations- one for the level, one for trend, and one for seasonality as.

$$\tilde{y}_t = \alpha \frac{y_t}{s_{t-s}} + (1-\alpha)(\tilde{y}_{t-1} + r_{t-1}); \quad \text{where, } 1 > \alpha > 0 \tag{4}$$

$$r_t = \beta(\tilde{y}_t - \tilde{y}_{t-1}) + (1-\beta)r_{t-1}; \quad \text{where, } 1 > \beta > 0 \tag{5}$$

$$s_t = \gamma \frac{y_t}{\tilde{y}_t} + (1-\gamma)s_{t-s} \quad \text{where, } 1 > \gamma > 0 \tag{6}$$

$$\hat{y}_{t+m} = (\tilde{y}_T + r_{Tm})s_{t-s+m} \tag{7}$$

Where, s is the length of seasonality, $\tilde{y}_t$ represents the level of the series, r_t denotes the trend, s_t is the seasonal component, and $\hat{y}_{t+m}$ is the forecast for m periods ahead.

Decomposition Method: Classical decomposition is one of the oldest commonly used forecasting methods. This method is used to decompose a time series into trend, cyclical and seasonal components presented in a time series. An essential part of this method includes the concept of seasonal index. The strong seasonality of some series makes it difficult to measure their trend and cyclical movements (Gujarati, 2004). In the regression decomposition method, dummy (dichotomous) variables are utilized to measure seasonal influences on high frequency data. The seasonal influence can be modeled using either an additive model, or a multiplicative model. The selection of either model depends on the magnitudes of the seasonal peaks and troughs of the level of the series. The formulas for additive and multiplicative models are represented in equations (8) and (9) respectively.

$$y_t = \alpha + \beta_1 T_t + \beta_2 X2_t + \beta_3 X3_t + \ldots + \beta_n Xn_n \tag{8}$$

$$\ln(y_t) = \alpha + \beta_1 T_t + \beta_2 X2_t + \beta_3 X3_t + \ldots + \beta_n Xn_n \tag{9}$$

Where, y_t is level of the series, T_t time value in period t, $X2_t, X3_t + \ldots + Xn_n$ are dummy variables for each period (i.e. monthly), $\ln(y_t)$ is the logarithm of the series to the base of the natural number e. The anti-log form of the multiplicative model of equation (9) is used to transform logarithmic values to level values using formula represented in equation (10).

$$\hat{y}_t = e^{\alpha} + e^{\beta_1 T_t} + e^{\beta_2 X2_t} + e^{\beta_3 X3_t} + \ldots + e^{\beta_n Xn_n} \tag{10}$$

Seasonal Autoregressive Integrated Moving Average (SARIMA) Method: Popularly known as Box-Jenkin (1994) methodology, the ARIMA model building method consists of four steps: identification, estimation, diagnostic checking and forecasting (Gujarati, 2004). ARIMA model contains the use of simple and versatile model notation designated by the level of Autoregressive (AR), Integration (I), and Moving Averages (MA)

(DeLurgio, 1998). The standard notation identifies the order of AR by *p*, I by *d* and MA by *q*. An extension of seasonal influence in ARIMA model is represented by SARIMA specification. A mixture of AR, I and MA formulation is known as ARMA *(p,d,q)* where difference (*d*) is done before ARMA is specified. The general form of ARIMA model is:

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_p y_{t-p} + \varepsilon_t - \phi_t \varepsilon_{t-1} - \phi_t \varepsilon_{t-2} - \ldots - \phi_q \varepsilon_{t-q} \quad (11)$$

Seasonality in a time series is a regular pattern of changes that repeats over S time periods, where S defines the number of time periods until the pattern repeats again. The ARIMA notation can be extended readily to handle seasonal aspects, and the general shorthand notation is ARIMA (p,d,q) (*P,D.Q*)*s* (Pindyck and Rubinfeld (1997). In a seasonal ARIMA model, seasonal AR and MA terms predict y_t using data values and errors at times with lags that are multiples of S (the span of the seasonality). With monthly data (S=12), and seasonal first order autoregressive model would use y_{t-12} to predict y_t. Variance nonstatinary in the time series is handled by logarithmic transformation before SARIMA method is adopted.

Growth Rate Method: Revenue forecasting based on year-on-year growth rate is supposed to capture seasonal influence. The forecast of period t+s is calculated based on average of past five years (year-on-year) growth rates from period t. The increase/decrease of the forecasted revenue determines increase/decrease of forecast revenue from period t, that is, conditional forecasts. The formulas for growth method are presented in equation (11) and (12).

$$\bar{r} = \frac{1}{n} \sum_{i=1}^{n} \left(\frac{y_t - y_{t-n}}{y_{t-1}} \right) * 100 \quad (12)$$

$$\hat{y}_{t+1} = y_t + (y_t * \bar{r}) / 100 \quad (13)$$

Measures of accuracy for forecasting which are free of scale of the data are adopted in this paper. Two popular relative measures as frequently used in measuring accuracy of forecast are Mean Percentage Error (MPE) and Mean Absolute Percentage Error (MAPE) where Percentage Error (PE) is calculated using the formula

$$PE = \left(\frac{Y_t - F_t}{Y_t} \right) * 100 \quad (14)$$

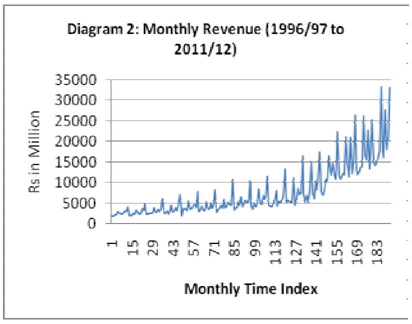
$$MPE = \frac{1}{n} \sum_{t=1}^{n} PE_t \quad (15)$$

$$MAPE = \frac{1}{n} \sum_{t=1}^{n} |PE_t| \quad (16)$$

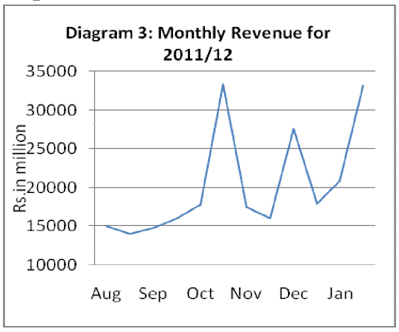
The methods explained above are considered appropriate to capture data generating process of total historical revenue series in this paper. While selecting appropriate methods, due emphasis will be given to those methods that incorporate trend and seasonal component in a time series analysis. The cyclical component has not been decomposed from trend component in this analysis.

III. RESULTS AND ANALYSIS

In the present paper, I have conducted short-term revenue forecast of the government of Nepal for 24 months starting from August 2012 to August 2014 (i.e. two years) based on 192 historical monthly revenue series beginning from August 1997 to July 2012. A visual inspection of revenue series in Figure 2 reveals some stylized facts that the data generating process of monthly revenue series clearly shows upward trend accompanied with monthly seasonal pattern. Revenue series shows also time varying variance over the period.



The seasonal pattern is not clearly visible in the Diagram 2 as the diagram covers whole sample period. In order to be more specific, the seasonal pattern is displayed by the monthly data for the FY 2011/12 reveals clear seasonal pattern in the month of January (six month), April (nine month) and July (twelve month). Such seasonal pattern can be applicable for the inference of monthly seasonal pattern for other FYs as depicted in Figure 3. The reason for such seasonal influence of revenue mobilization in those months is that the corporate entities in Nepal are directed to pay declared tax into three-installment each year including 40% till mid-January (six month), 70% till mid-April (nine month) and 100% till mid-July (Twelve month).



I have utilized five equally competitive methods that are applicable for forecasting in case of a time series data characterizing period-to-period upward trend, seasonal pattern and time-varying variance. Those methods include (a) Holt method, (b) Winter method, (c) decomposition method (d) SARIMA method, and (e) growth rate method.

Among those methods, Holt and Winter are the smoothing methods of forecasting time series. The estimated values of the smoothing parameters of α , β and γ determine the forecast values in these methods. As α , β and γ represent smoothing, trend and seasonal parameters respectively, the estimated values of those parameters utilizing whole sample data of present analysis are presented in Table 1. The criterion for the selection of those parameters is the minimum mean sum of squared error.

Table 1: Estimated Smoothing and Seasonal Parameters (1996 August to 2012 July)

Smoothing and Seasonal Parameters	Holt's two parameter (no seasonal)	Winter's Three Parameter (Seasonal)
α	0.04	0.08
β	0.15	0.08
γ	-	0.65

Substituting the values of smoothing parameters in the corresponding equations of Holt and Winter methods for revenue forecasting looks like:

Holt Method:

$$\tilde{y}_t = 0.04y_t + (1-0.04)(\tilde{y}_{t-1} + r_{t-1}); \quad \text{where, } 1 > \alpha > 0 \quad (17)$$

$$r_t = 0.15(\tilde{y}_t - \tilde{y}_{t-1}) + (1-0.15)r_{t-1}; \quad \text{where, } 1 > \beta > 0 \quad (18)$$

Forecasting for l period ahead as: $\hat{y}_{t+l} = \tilde{y}_T + lr_T$ (19)

Winter Method:

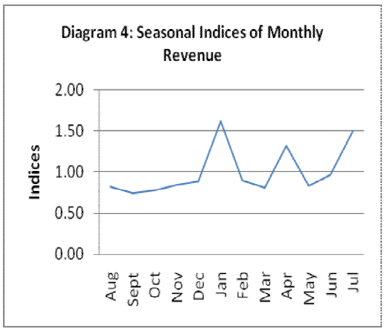
$$\tilde{y}_t = 0.8\frac{y_t}{s_{t-s}} + (1-0.8)(\tilde{y}_{t-1} + r_{t-1}); \quad \text{where, } 1 > \alpha > 0 \quad (20)$$

$$r_t = 0.8(\tilde{y}_t - \tilde{y}_{t-1}) + (1-0.8)r_{t-1}; \quad \text{where, } 1 > \beta > 0 \quad (21)$$

$$s_t = 0.65\frac{y_t}{\tilde{y}_t} + (1-0.65)s_{t-s} \quad \text{where, } 1 > \gamma > 0 \quad (22)$$

Forecasting for m period ahead as: $\hat{y}_{t+m} = (\tilde{y}_T + r_{Tm})s_{t-s+m}$ (23)

The monthly revenue forecasts using Holt and Winter methods for the FY 2012/13 and the FY 2013/14 are presented in Table 1 of Appendix I. As shown in Diagram 1 of Appendix II, Holt method could not capture true data generating process of government of Nepal as revenue series of the government characterizes seasonal effect. Winter method includes seasonal parameter γ, the notable seasonal picks are found in the months of January, April and July as shown in Diagram 4. The ex-ante revenue forecasts under this method are found more accurate than that of Holt method as displayed in Diagram 2 of Appendix II.



Under decomposition method, regression method of decomposition has been used to decompose revenue series into trend and seasonal component in this paper. The variant of multiple decomposition formula is considered plausible here because the revenue series under review characterizes variance non-stationarity. Twelve monthly dummies are introduced to capture seasonal influence. Except the dummy for the second month, all other coefficients of monthly dummies including constant term and trend component are found statistically significantly different from zero. Substituting the values of estimated parameters in the corresponding regression equaton looks like:

$$\ln(\mathrm{Re}v) = 7.33 + 0.01T + 0.01D2 + 0.09S2 + 0.11D4 + 0.16D5 + 0.66D6 + 0.14D7$$
$$\text{t} = (145.9)\ (47.38)\ \ (0.17)\ \ (1.54)\ \ (4.81)\ \ (2.80)\ \ (9.61)\ \ (2.1)$$
$$0.13D8 + 0.40D9 + 0.23D10 + 0.34D11 + 0.89D12 \qquad (24)$$
$$(1.98)\ \ (6.26)\ \ (3.63)\ \ (5.30)\ \ (13.8)$$

As shown in Diagram 3 of Appendix II, ex-post forecasts of revenue are tracking well to the actual revenues from this method too. The revenue forecasting under this method are presented in Table 1 of Appendix I.

The ARIMA method extended with seasonal components represented by SARIMA has been utilized in this paper by assuming that the revenue series under review characterizes seasonal influence. While using SARIMA method, revenue series has been converted into logarithm to the base 'e' before its use in the analysis to capture variance nonstationary. The SARIMA $(0,0,0)(1,0,0)_{12}$ is the final specification based on identification and diagnostic checking of the method. As such the logarithmic 12th order difference without constant term is the robust representation of the model as:

$$\ln(\mathrm{Re}v)_t = 1.02 * \ln(\mathrm{Re}v)_{t-12} \qquad (25)$$
$$\text{t} = (688.55)$$

Above specification yields very good tracking of revenue forecasts to actual revenue as shown in Diagram 4 of Appendix II.

Applying the growth rate method, revenue forecasting is determined by the increase/decrease of five years average of year-on-year growth rates of monthly revenue. The ex-ante forecast for consecutive months in the future date are considered conditional forecast based on the forecasted revenue at the same month last year, that is, it is the iterative process. Based on this method, the forecasted revenue during the in-sample period is found satisfactory as depicted by the forecast revenues that are well tracking the actual revenues as shown in the Diagram 5 of Appendix II.

The basis for the selection of appropriate methods of revenue forecasting in this paper, as quantitative measure, is the minimum values of MPE and MAPE statistics for each method. For this purpose, MPE and MAPE have been calculated based on latest 24 observations of forecast errors derived from the difference of actual and estimated values. The method that obtains values of MPE and MAPE close to zero is considered the best method. The MPE and MAPE for each method are presented in Table 2.

Table 2: Statistical Measures of Model Accuracy (1996 August to 2012 July)

S. No.	Statistical methods	Mean Percentage Error (MPE)	Mean Absolute Percentage Error (MAPE)
1.	Holt Method	-11.51	25.35
2.	Winter Method	-1.27	6.24
3.	Regression Decomposition Method	14.31	15.78
4.	SARIMA Method	-0.74	6.22
5.	Growth Rate Method	-7.50	11.14

Out of five competing methods, two methods including Holt method, Decomposition method are found less satisfactory methods in terms of minimum MPE and MAPE criteria. On the remaining three methods, growth rate method is ranked third. SARIMA method and Winter methods rank first and second position respectively. The MPE and MAPE for SARIMA method are -0.74 and 6.22 respectively whereas for Winter mehod they are -1.27 and 6.24 respectively. As both the Winter and SARIMA methods have built-in character to capture the seasonal influence in forecasting, these methods can be the representative methods of forecasting government revenue in Nepal.

Both the monthly net and monthly cumulative forecasts for the FY 2012/13 and FY 2013/14 are presented in Table 1 and 2 of Appendix I. The cumulative forecast revenues for the FY 2012/13 and FY2013/14 incorporating all the five methods are dragged in Table 3 from Table 2 of Appendix I to interprete some interesting conclusions. As SARIMA method is ranked first among the five alternative methods under trial, the cumulative revenue forecasts accounts to Rs.280.19 billion and Rs. 324.21 billion respectively in the FY2012/13 and FY2013/14. It yields year-on-year growth rates of 14.8 percent and 15.7 percent respectively in FY 2012/13 and FY2013/14.

Table 3: Cumulative Revenue Foecasts and Growth Rates

FY	Cumulative Forecast (Rs in Million					Percentage Change				
	Holt	Winter	Decomp-osition	ARIMA	Growth Rate	Holt	Winter	Decomp-osition	ARIMA	Growth Rate
2011/12	244148.7	244148.7	244148.7	244148.7	244148.7					
2012/13	286241.9	279383.1	270179.0	280191.4	307917.3	17.2	14.4	10.7	14.8	26.1
2013/14	328128.1	308535.7	295603.0	324205.8	380028.0	14.6	10.4	9.4	15.7	23.4

Similarly, the cumulative forecast revenues using Winter method, as it is found second best method in this paper, are Rs.279.38 billion and 308.54 billion for the FY2012/13 and FY2013/14 respectively. The growth rate is projected to be increased by 14.8 percent in FY 2012/13 and 15.7 percent in FY2013/14 according to this method.

Last but not the least, what it can be concluded in this paper is that Growth rate method is found overly optimistic whereas Decomposition method underestimates the forecasts. Holt method is ruled-out because it does not capture seasonal influence. Therefore, among the five competitive methods under scrutiny in this paper, Winter and ARIMA are found suitable for revenue projection based on statistical criteria specified in this paper.

However, the conclusion drawn in this paper depends on the use of five methods of forecasting only. Complex forecasitng mehtods which capture cyclical influence in revenue mobiliation are out of perview in this paper. Since the motivation of the study is to use time series analysis in revenue forecsting as against the conditional foecasts mehtod, latter method may obtain different results.

IV. CONCLUSION

Government revenue forecasting is an important aspect in the design and execution of sound fiscal policies. The forecast error as percent of GDP over the study period is downward trending. As a consequence, there is an over-estimation of revenue followed by under-estimation. Further, there is an erratic movement of forecast error too. As the existing methods of revenue forecasting in Nepal is limited to growth rate basis and hence miss the target, the objective of the paper is to identify appropriate methodology of revenue forecasting. This paper utilizes monthly revenue series including 192 observations starting from 1997 to 2012 or the analysis. Out of the five popular techniques scrutinized in this paper, two competing methods including Winter and SARIMA methods are found to be appropriate for the revenue forecasting in Nepal. However, SARIMA method is found albeit superior than Winter method in term of minimum MPE and MAPE criterion. Using SARIMA method, total revenue is forecasted to be increase by 15.7 in FY 2012/13 and 14.8 percent in FY 2013/14. The results of revenue forecasting in this paper may vary depending on the use of methods that capture cyclical component of revenue series. Further, the methods of conditional forecasting are not applied here and hence may give different results. Therefore, in light of these limitations, the forecasting attempts in this paper have opened an avenue for the systematic analysis of revenue forecasting using several methods rather than depending on existing growth rate method.

REFERENCES

Auerbach, A J. 1999. "On the Performance and Use of Government Revenue Forecasts." University of California, Berkeley and NBER, USA.

Box, G.P.E. and G. M. Jenkins. 1994. *"Time Series Analysis, Forecasting and Control."* 3rd ed. Englewood Cliffs, NJ: Prentice-Hall.

Danninger, S. 2005. "Revenue Forecasts as Performance Targets." *IMF Working Paper* No. WP/05/14, IMF, Washington, D.C.

DeLurgio, S.A. 1998. *"Forecasting Principles and Applications."* Irwin McGraw-Hill Book Co., Singapore.

Gujarati, D.N. 2004. *"Basic Econometrics"* 4th edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Holt, C.C. 1957. "Forecasting Seasonal and Trends by Exponentially Weighted Moving Averages, *Office of Naval Research*, Research Memorandum No.52.

Golosov, M. and J. King. 2002. "The Revenue Forecasts in IMF-Supported Programs." *IMF Working Paper* No.WP/02/236, Washington D.C., USA.

International Monetary Fund. 2001. *"Revised Manual of Fiscal Transparency."* Washington D.C. USA.

Kyobe A, and S. Danninger. 2005. "Revenue Forecasting-How is it Done? Results from a Survey of Low-Income Countries." *IMF working paper* No.WP/05/24, IMF, Washington D.C., USA

Makridikis, S., Wheelwright, S.C., and R.J. Hyndman. 1998. *"Forecasitng Mehtods and Applications.*" John Wiley and Sons (Asia) Pte.Ltd. Singapore.

Pindyck, R.S. and D.L. Rubinfeld. 1997., *"Econometric Models and Economic Forecastings."* 4th Edition, McGraw-Hill, International Edition, Singapore.

Ramanathan R. 2002. *"Introductory Econometrics with Applications.*" 5th Edition, Thomson Asia Pte Ltd., Singapore.

Winters, P.R. 1960. "Forecasting sales by exponentially weighted moving averages." Management Science- 6, p.p.324-342.

Appendix I: Tables

Table 1: Monthly Revenue Forecasts for 2012/13 and 2013/14

(Rs in million)

Mid-Months	Holt Method	Winter Method	Decomposition Method	ARIMA Method	Growth Rate Method
Net Forecasted Revenue for the FY 2012/13					
August	22253.7	17513.8	13358.1	17883.9	18849.0
September	22544.6	16143.2	13664.4	16136.3	17052.2
October	22835.4	17087.8	15083.9	16918.6	18196.0
November	23126.3	18622.4	15526.2	18650.0	20846.7
December	23417.2	19818.4	16406.0	18851.2	22854.9
January	23708.1	36627.4	26192.7	36458.9	41654.9
February	23998.9	20639.7	16430.9	22353.9	23452.1
March	24289.8	18795.0	16408.7	20988.6	20300.2
April	24580.7	30900.8	21842.4	31285.5	35087.3
May	24871.6	19550.3	18657.5	18109.7	21869.4
June	25162.4	23018.3	21001.6	23126.8	25886.4
July	25453.3	35925.3	36709.4	35055.3	38459.5
Net Forecasted Revenue for the FY 2013/14					
August	25744.2	19816.6	15283.7	20922.7	23075.3
September	26035.1	18242.7	15634.1	18847.0	21716.8
October	26325.9	19286.3	17258.2	19775.7	22331.8
November	26616.8	20993.0	17764.3	21833.6	28381.8
December	26907.7	22314.7	18771.0	22072.9	28215.5
January	27198.6	41193.1	29968.5	43143.5	51161.3
February	27489.5	23186.1	18799.4	26245.9	30331.3
March	27780.3	21090.1	18774.0	24617.9	26636.1
April	28071.2	34636.3	24991.0	36930.9	45136.1
May	28362.1	21890.1	21347.1	21191.1	26872.4
June	28653.0	25745.9	24029.0	27168.1	30858.0
July	28943.8	40140.7	42001.1	41456.5	45311.7

Table 2: Monthly Revenue Forecast (Cumulative) for 2012/13 and 2013/14

Rs in million

Mid-Months	Holt Method	Winter Method	Decomposition Method	ARIMA Method	Growth Rate Method
Monthly Revenue Forecast (Cumulative) for 2012/13					
August	22253.7	22254.7	22255.7	22256.7	22257.7
September	44798.2	38397.8	35920.1	38393.0	39309.9
October	67633.7	55485.6	51003.9	55311.6	57505.8
November	90760.0	74108.0	66530.1	73961.6	78352.5
December	114177.1	93926.3	82936.1	92812.8	101207.4
January	137885.2	130553.7	109128.8	129271.7	142862.4
February	161884.1	151193.4	125559.7	151625.6	166314.5
March	186173.9	169988.4	141968.4	172614.1	186614.7
April	210754.6	200889.2	163810.8	203899.6	221701.9
May	235626.2	220439.6	182468.3	222009.3	243571.4
June	260788.6	243457.9	203469.9	245136.2	269457.7
July	286241.9	279383.1	270179.0	280191.4	307917.3
Monthly Revenue Forecast (Cumulative) for 2013/14					
August	25744.2	19816.6	15283.7	20922.7	23075.3
September	51779.3	38059.3	30917.8	39769.7	44792.1
October	78105.2	57345.6	48176.0	59545.4	67123.9
November	104722.0	78338.6	65940.4	81379.0	95505.7
December	131629.7	100653.3	84711.3	103452.0	123721.2
January	158828.3	141846.4	114679.8	146595.4	174882.5
February	186317.7	165032.5	133479.2	172841.3	205213.8
March	214098.1	186122.6	152253.2	197459.2	231849.9
April	242169.3	220758.9	177244.2	234390.1	276986.0
May	270531.4	242649.1	198591.3	255581.2	303858.4
June	299184.3	268395.0	222620.3	282749.3	334716.4
July	328128.1	308535.7	295603.0	324205.8	380028.0

Appendix II: Diagrams