

# A Macroeconomic Forecasting Model of Lesotho: Preliminary Estimates

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*The aggregate demand model postulated in this paper has been designed to make short-term forecasts of principal macro variables in Lesotho. A major element of the multi-equation model is the exogeneity of private investment expenditure and export of goods and services. The estimated structural equations are satisfactorily verified. The dynamic character of the model can be seen from the structure of lags in the consumption function and the equilibrium GNP equations. Thus, the model is driven by these two variables as well as the two exogenous variables (private investment and exports). However, the predictive accuracy of the model in its present form is modest.*

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## Introduction

The economy of the Kingdom of Lesotho has since the 19th century been largely defined not only by the peculiar circumstances of its geography but also by its history. Completely circumscribed by the Republic of South Africa (RSA), Lesotho's geographical landscape is in many places prominently straddled by rugged mountain ranges and deep valleys. In essence, primary economic activities, especially of the crop-farming variety, are feasible mostly within a restricted band of low-lying vegetational belts. As a result of the country's historical experience under the apartheid system and its enclosure within the RSA, the economy of Lesotho has been heavily dependent not only on economic activities within the Republic but also on the wider international community.

The objective of this paper is to model the structure of aggregate demand in Lesotho since the early 1970s and to use the postulated relationships to make short to medium-term projections of principal macroeconomic variables. The policy significance of the simple forecasting procedure adopted in this paper can be gauged from its potential usefulness in national economic planning.

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There is little doubt that the foreign trade sector is the dominant moving force of the economy. This is clearly manifested in the country's heavy dependence on the international environment not only for the supply of a wide variety of imports but also for investment in capital stock. It will therefore be instructive to see how exogenous changes in these macro variables affect the levels of aggregate output, consumption and other key endogenous variables. The theoretical basis of the postulated model and some existing research work on the subject are discussed in section II of the paper while the methodological procedure adopted in the present work is explained in section III. Moreover the macroeconomic forecasting model is specified and explained in section IV while the results of the study and the conclusions are presented in the final two sections.

### **Theoretical Framework and Existing Evidence**

A macroeconomic model is a system of interlocking simultaneous equations designed to represent the structural linkages between the various components of the economy. Such models can range in complexity from as few as two or three equations to as large as several hundreds, depending on the degree of disaggregation desired and the use to which the model will be put. Several of the existing large-scale macroeconomic forecasting models have been based on the general principles of Keynesian and post-Keynesian theory of economic management. Unlike its classical antecedent, Keynesian analysis postulates that reasoned government intervention in the economy would lead to sustained expansion of aggregate output and to full-employment. The main focus of Keynesian analysis is the aggregate demand for goods and services and it is the control (management) of this vital variable through appropriate monetary and fiscal instruments which determines the optimal levels of output and employment.

One of the earliest and most widely-cited and analyzed macroeconomic models in the literature is the Klein Model I, a six-equation Keynesian income-expenditure model of the US economy constructed by Klein (1950). The model consists of three behavioural equations and three identities and was estimated on data over the 1921-41 period. A detailed discussion of the main features of the model is not possible within the limited scope of this paper but suffice it to say that in spite of the small size of the model, it has ample scope for use in forecasting and policy analysis. Macroeconomic modelling has

widened scope and complexity since the construction of Klein Model I and large economy-wide models have been developed especially in many industrial countries as a means of policy planning and monitoring of the performance of the economy<sup>1</sup>. The quarterly Wharton Econometric Forecasting Model<sup>2</sup>, the Brookings Institution model<sup>3</sup> and the St. Louis model<sup>4</sup> are some of the most influential macroeconomic forecasting models in the USA.

### Overview of the Forecasting Framework

Quite unlike purely statistical forecasting techniques, econometric forecasting takes its root from the behavioural and technical relationships suggested by relevant theories and hypotheses. Two variants of such forecasting approaches have often been used in the literature : Type I and Type II. The former is based on a set of relationships in which the values of the independent variables are known with certainty, eg., as in equation 1 :

$$(1) \quad Y_{t+1} = X_t B + U_t$$

where

$Y$  is  $n$ -element vector of observations on the dependent variable,  
 $X$  is  $n \times k$  nonstochastic design matrix of rank  $k$ ,  
 $B$  is  $k$ -dimensional fixed vector of unknown parameters; and  
 $U$  is  $n$ -element vector of unobservable random variable.

On the other hand, the Type II forecast, which is also referred to as a conditional forecast, is predicated on a behavioural relationship as in equation (2) such that at least one of the variables in the regressor set is not known with certainty :

$$(2) \quad Y_{t+1} = X_{t+1} B + U_t$$

Evidently, forecasting the value of variable  $Y$  in period  $t+1$ , from a base period  $t$ , using the value of  $X$  also in period  $t+1$  (which is not yet known), is a much more difficult and risky procedure than that of equation(1). Type II forecasts are generally more prone to errors of accuracy than those of Type I because two stages of approximations are involved: a predicted value of  $X$  represents the first stage while forecasting the value of  $Y$  with the assumed

value of  $X$  is the second. This means that the accuracy of the forecasted value of  $Y$  is contingent upon the relative accuracy of the exogenous variable  $X$ .

The forecasting procedure adopted in this paper is a combination of both the *ex post* and *ex ante* forecasts. The methodological procedure is to specify a four-equation simultaneous equations model which consists of four endogenous variables, two exogenous variables, two predetermined variables, three behavioural equations, and one identity. Using 18 annual observations between 1970 and 1987, the model equations are estimated by the 2SLS and 3SLS methods, each corrected for serial correlation. The next stage in the analysis was to use the estimated model to make *ex post* forecasts of the endogenous variables between 1988 and 1992 and to evaluate the predictive accuracy of the model using the root-mean-square (RMS) criterion. In the next phase of the analysis which is based on the assumption that the model has fairly accurately predicted post-sample relationships, we attempt to make *ex ante* projections of the endogenous variables. The starting point of the analysis was to calculate the average growth rate of the exogenous variables between 1987 and 1992 and assume that the 1993 levels of these variables would exceed their 1992 levels by that growth rate. The same procedure is adopted in estimating the values of the exogenous variables for subsequent years up to 1995. This means that the mean or expected growth rate for each exogenous variable for each year between 1993 and 1995 is a moving average of the levels of the preceding five years.

In order to make allowance for deviations in the values of the exogenous variables from their expected or *mean* levels, the analysis makes provisions for *pessimistic* and *optimistic* growth rate scenarios. The *optimistic* growth rates of the exogenous variables are estimated at 10 per cent above the *mean* growth rate while the *pessimistic* growth scenarios are 10 per cent below the expected or *mean* rates.

### The Model

The aggregate demand model postulated in this paper is a simple one. It consists of three behavioural equations and one identity. Structurally, the model contains three endogenous variables, two exogenous and two predetermined variables :

$$\begin{aligned}
 (3) \quad C_t &= \alpha_1 + \beta_2 C_{t-1} + \beta_3 Y_{t-1} + \mu_{1t} \\
 (4) \quad G_t &= \alpha_4 + \alpha_5 Y_t + \mu_{2t} \\
 (5) \quad M_t &= \gamma_6 + \gamma_7 Y_t + \mu_{3t} \\
 (6) \quad Y_t &= C_t + I_t + G_t + X_t - M_t
 \end{aligned}$$

where notations are defined as follows :

Y denotes GNP in year t, C is private consumption expenditure, I is private investment, G represents government spending, X is total exports of goods and services, and M denotes total imports. The stochastic error term  $\mu_{it}$  ( $i=1,2,3$ ) is assumed to follow the first-order autoregressive structure such that

$$(7) \quad \mu_{it} = \rho \mu_{it-1} + v_{it}, \quad 0 \leq \rho \leq 1$$

The AR1 structure of wit is a realistic assumption in view of the fact that  $\mu_{it}$  time-series macroeconomic variables often move in unison and are therefore prone to the phenomenon of serial correlation.

The consumption equation (3) postulates private consumption expenditure in any given year as a linear function of previous year's consumption and income. It should be pointed out that a range of alternative theoretically consistent specifications of the function were considered and estimated before equation (3) was adopted as the most appropriate description of aggregate consumption behaviour in Lesotho. A combination of theoretical and empirical considerations guided the ultimate choice of the consumption equation. Equation (3) employs the habit persistence model in capturing the adjustment or ratchet effect of previous consumption patterns and past levels of affluence on current consumption expenditures.

Real government expenditure {equation(4)} is postulated as a linear function of current income while the import function is similarly specified. Foreign trade plays a major part in the macro economy of Lesotho which is highly dependent on a wide variety of imports. While the real export/GNP ratio shows a declining trend over the past decade, the country's import/GNP ratio has been rising monotonically over the same time period. In order to investigate the underlying processes of import demand, we specified a preliminary import function whose argument was not income but Basotho migrant remittances over time. However, while a very strong statistical fit was obtained (with  $R^2 =$

0.93), the simulation result was highly unstable and in fact significantly understated the forecasted value of GNP.

### **The Exogenous Variables : X and I**

In the final forecasting model, exports of goods and services (X) and real aggregate private investment (I) are treated as exogenous to the economic system. One of the major macroeconomic policy issues which have confronted Lesotho over the past decade is the chronic imbalance between total exports and imports of goods and services. Basotho mineworkers' remittances from the RSA accounts for a substantial part of Lesotho's total foreign exchange earnings. In turn, foreign exchange remittances, in quantitative terms, are a function not only of employment outlets for Basotho job seekers in the Republic but also of prevailing wage rates, particularly in the mines. These two critical variables are outside the control of policy-makers in Lesotho. Even though the country has over the years been an exporter of textile fibre, hides and skins, mohair, as well as clothing and apparel, these commodities combined account for a significantly small proportion of total trade, relative to the export of labour services. It therefore seems realistic to treat the export variable as exogenous to the postulated model system.

The other exogenous variable in the forecasting model is real private fixed investment (I). In a preliminary specification of the model, the investment variable was treated as an endogenous variable. The multiplier-accelerator relationships postulated, with alternative lag structures, are shown in equations (8) and (9):

$$(8) \quad I_t = \theta_1 + \theta_2 (Y_t - Y_{t-1}) + v_{1t}$$

$$(9) \quad I_t = \theta_3 + \theta_4 (Y_{t-1} - Y_{t-2}) + v_{2t}$$

where  $v_{1t}$  and  $v_{2t}$  are the stochastic error terms. These equations were estimated separately within the framework of the four-equation model but they performed very poorly under all verification criteria, with the  $R^2$ , e.g., as low as 11 per cent. Moreover, model simulations incorporating the estimated multiplier-accelerator equations were widely off target and in some periods turned up negative forecasted values of income and investment. In addition to empirical considerations, the exogeneity of the investment variable was also based on the reality of the ownership structure of industrial production in

Lesotho. Private investment activities in the country has, to a large extent, been dominated by South African investors and to a lesser extent by Asians and Europeans.

### **Analysis of Results**

The postulated model was estimated using annual data series between 1970 and 1987. The behavioural equations (3), (4), and (5) are over identified and they were estimated using the 2SLS and 3SLS methods, with error correction options. In particular, the Hatanaka first-order autoregressive technique was used to transform the data to achieve an acceptable degree of serial independence of the disturbances. Moreover, the model was estimated with the LIMDEP software package and the results of the estimation are shown in equations (10) - (12).

According to the postulated consumption function, private consumption expenditure in Lesotho is determined by past levels of income and consumption.

As has been indicated earlier, the one-period lag on consumption and income are intended to 'explain' the extent to which past consumption habits and an established standard of affluence determine current patterns of consumption. As equation (10) clearly shows, these two variables indeed produce statistically significant explanatory influence on current consumption patterns over the sample period. Overall, the two variables account for 99 per cent of variations in current consumption while the value of the DW statistic (2.058) shows that the error correction procedure used to transform the data had been quite effective. Moreover, the estimated government expenditure function shows that GNP is a major determinant of government spending, accounting for 93 per cent of variations in the regressand. The model equation (11) indicates that a million Maloti increase in real GNP would cause government spending to rise by M0.13 million. Furthermore, the estimated import equation (12) reveals that a statistically significant high correlation exists between import expenditure and GNP. The equation shows that the marginal propensity to import out of current income is 0.66. This means that out of every million Maloti increase in national income, about M660,000.00 is spent on the import of a wide variety of goods and services.

One of the most obvious features of the macromodel, simple though it is, is that it is satisfactorily verified. First, the estimated behavioural equations are theoretically consistent with *a priori* expectations. Second, the signs of the estimated parameters are logically consistent with theory and the magnitudes of the parameters are quite reasonable. Third, the summary statistics (particularly the  $R^2$  and the Student's t-ratios) are statistically significant. This means that, on balance, the model largely satisfies the basic conditions for use for forecasting and policy analysis. The dynamic character of the model can be seen from the structure of lags in the consumption function and the equilibrium GNP equation. Lagged consumption and income along with the exogenous variables (I and X) provide the driving force of the model.

### Model Estimation Results

$$(10) \quad C_t = 28.38 + 0.79C_{t-1} + 0.25Y_{t-1}$$

(2.13)\* (4.93)+      (2.09)\*,  $R^2=0.993$ ,  $se=25.551$ ,  
DW = 2.058,  $\rho = 0.016$

$$(11) \quad G_t = 4.38 + 0.13Y_t$$

(0.35) (7.45)+,  $R^2 = 0.928$ ,  $se = 15.125$ ,  $DW = 1.711$ ,  
 $\rho = 0.484$

$$(12) \quad M_t = 17.68 + 0.66Y_t$$

(0.38) (11.80)+,  $R^2 = 0.975$ ,  $se = 45.44$ ,  $DW = 2.080$ ,  
 $\rho = 0.639$

Student's t-ratios are shown in parentheses

\* denotes parameter is significant at the 10 per cent level

+ denotes parameter is significant at the 1 per cent level

The reduced-form parameters for the model are shown in table 1 and the impact multipliers for the policy instrument variables are indicated in columns 2 and 3 of that table. The table shows that the immediate current period impact of a million Maloti increase in private investment(I) is to raise real GNP by M1.35million and to reduce private consumption expenditure, government expenditure and imports by M20,000, M60,000 and M230,000 respectively. One of the anomalous results from the table is the negative export multiplier with respect to GNP. The immediate impact export multiplier indicates that

increasing exports by one million Maloti would be expected to lead to an increase in private consumption expenditure to the tune of M0.7m.

Corresponding estimates for government expenditure and imports are M0.4 million and M1.74 million respectively.

**Table 1: Reduced-form parameter estimates**

Endog. Var.	Policy Instruments		Lagged Endogenous Variables	
	I	X	C <sub>t-1</sub>	Y <sub>t-1</sub>
Y	1.35	-1.69	1.04	0.09
C	-0.02	0.70	0.70	0.28
G	-0.06	0.40	0.29	-0.07
M	-0.23	1.74	0.72	0.19

### Dynamic Simulation of the Model

The next stage in the analysis is to use post-sample observations on the exogenous variables (I and X) and the predetermined variables (C<sub>t-1</sub> and Y<sub>t-1</sub>) to solve for outside-sample estimates of the four endogenous variables for specific years. The simulation period covers the years 1988 - 1992 for which published official statistical data on the variables are available. This, in essence, means that aside from the basic values of consumption and income in 1987, the projected values of Y, C, G and M between 1988 and 1992 are based entirely on earlier forecasts of the endogenous variables as well as the current values of the exogenous variables. The simulation results which are presented in table 2 shows the root-mean-square (RMS) error and the RMS per cent error for each of the four endogenous variables. The essence of the error calculations is to evaluate the predictive accuracy of the postulated model and hence the extent to which the forecasted values of the endogenous variables mirror actual (measured) observations on these variables.

**Table 2: Model simulation (1988 - 1992)**

Endogenous Variable	RMS Error*	RMS % Error
Y	831.43	31.59
C	512.15	22.31
G	47.04	15.93
M	840.79	39.12

\* million Maloti

As can be expected from a rather small and aggregated macromodel of this nature, the RMS figures show that the model produces only a limited measure of success in replicating the historical time paths of most of the endogenous variables. For example, while the errors associated with the GNP and import expenditure forecasts are as high as M831.43 million (31.59%) and M840.79 million (39.12%) respectively, those of government expenditure and private consumption expenditures are comparatively low at M47.04 million (15.93%) and M512.15 million (22.31%). While the model fails to capture most of the short-term cyclical movements in the variables it can nevertheless be quite useful, as a first approximation, in making short-term forecasts of the relevant macro variables.

### Ex ante forecasts under alternative scenarios

Within the context of the modest success of the model, attempt has been made in this paper to make *ex ante* projections of the endogenous variables over a short-term horizon and under alternative export and investment scenarios. The objective of the forecasting exercise is to throw some light on possible developments in the macroeconomic structure of the economy over the 1993-96 period, assuming that no fundamental changes occur in the historical pattern of economic and social behaviour in the system.

The procedure adopted in making the forecasts is to make three sets of assumptions about the likely behaviour of the exogenous variables (I and X) in the post-1992 period. The first scenario assumes that export and investment would grow over the 1992-95 period at the average of the yearly rates for the

preceding five years (the mean growth rate). Thus, each yearly entry in the column headed "Mean Growth Rate" in tables 3a and 3b is a moving average of the annual growth rates for the previous five years. The second scenario (the pessimistic growth rate) makes allowance for a 10 per cent decline (below the mean growth rate) in the levels of exports and private investment. This assumption is based on the possibility that the end of the apartheid system and the on-going democratization process in the RSA may cause some diversion of private investments, especially by transnational enterprises, away from Lesotho and into the Republic. Finally, the third scenario (the optimistic growth rate) stems from the possibility that the exact opposite of the second scenario happens. That is, cheaper labour costs in Lesotho, relative to the Republic, may serve to boost private investment in Lesotho at a 10 per cent rate above the average for the previous five years.

**Table 3a: Export growth projections (1993 - 1996) M (million)**

Year	PGR(%)	$X_p$	MGR(%)	$X_m$	OGR(%)	$X_o$
1993	26.89	394.51	29.88	403.81	32.87	413.11
1994	22.72	495.56	25.24	505.73	27.76	515.91
1995	23.81	626.14	26.46	639.55	29.11	652.95
1996	30.54	834.87	33.93	856.55	37.32	878.23

PGR = pessimistic growth rate;  
MGR = mean growth rate;  
OGR = optimistic growth rate

It is on the basis of the foregoing assumptions that the forecasts in table 4 are made. The projections, for example, indicate that if the assumptions are valid then the country's real GNP in 1995 should lie within the interval M4128.06 million and M4257.32 million. In the same year, private consumption expenditure would be expected to lie between M2592.44 million and M2633.98 million. Of course, this forecast should be taken as indicative only rather than one around which rigorous policy analysis should be made. Obviously, the need for caution is based on the magnitude of forecast errors associated with each endogenous variable in the *ex post* forecasts made earlier.

**Table 3b: Investment growth projections (1993 - 1996) (M) million**

Year	PGR(%) I <sub>p</sub>	MGR(%)	I <sub>m</sub>	OGR(%) I <sup>o</sup>	
1993	31.19	1868.15	34.66	1917.56 38.13	1966.97
1994	28.81	2470.00	32.01	2531.37 35.21	2592.73
1995	23.09	3115.86	25.65	3180.67 28.22	3245.72
1996	20.47	3831.75	22.74	3903.95 25.01	3976.16

(Note : abbreviations are as defined below table 3a)

**Table 4: Ex ante forecast under alternative investment and export scenarios (M) million**

Year	Y			C			G			M		
	Y <sub>p</sub>	Y <sub>m</sub>	Y <sub>o</sub>	C <sub>p</sub>	C <sub>m</sub>	C <sub>o</sub>	G <sub>p</sub>	G <sub>m</sub>	G <sub>o</sub>	M <sub>p</sub>	M <sub>m</sub>	M <sub>o</sub>
1993	2808	2846	2885	1840	1840	1840	369	374	379	1879	1896	1922
1994	3355	3407	3460	2184	2194	2203	440	447	454	2232	2266	2301
1995	4128	4193	4257	2592	2613	2634	541	549	558	2742	2785	2828
1996	5069	5151	5234	3108	3141	3174	663	674	685	3363	3417	3472

### Notations

Y = GNP

C = private consumption expenditure

G = government expenditure

M = aggregate import of goods and services

Subscripts are defined as follows :

p = pessimistic forecast scenario

m = mean forecast scenario

o = optimistic forecast scenario

(Estimates have been rounded off to the nearest integer)

## Conclusions and Policy Recommendations

The objective of this paper has been to construct a model of the structure of aggregate demand in Lesotho and to use the model for short-term forecasting of principal macroeconomic variables. A major element of the postulated four-equation model is the exogeneity of private investment and export of goods and services, both of which have been assumed to make vital contributions to the overall economic landscape of Lesotho. The estimated consumption function shows that current private consumption expenditure in the country was, over the sample period, heavily influenced not only by past consumption habits but also by immediate past incomes. Moreover, real government expenditure and imports of goods and services are highly correlated with real GNP. Furthermore, while the model produces a rather unexpected negative export multiplier, the investment multiplier shows that increasing private investment expenditure by M1 million would result in an increase in real GNP to the tune of M1.35 million in the current period. The final analytical procedure adopted by the paper was to make *ex ante* forecasts of the endogenous variables over the 1993 - 96 period under different behavioural scenarios of the exogenous variables.

While the paper certainly highlights interesting issues about the structure of aggregate demand in Lesotho, the results should be interpreted with caution, especially as far as using them for policy planning and analysis are concerned. For one thing, the model is an aggregate one which does not take into account developments in the financial sector of the economy as well as independent changes in the structure of production (agriculture, manufacturing, mining, etc.). On the other hand, much as preliminary modelling attempts were made to capture the effects of labour market developments on the economic system, the model ultimately failed to incorporate export of labour services as a separate variable. There is no denying the importance of migrant remittances in the economy and any refinements to the present model should take explicit account of this.

**Notes**

1. In the United Kingdom, such regularly updated models include, among others, those of the National Institute for Economic and Social Research [see NIESR (1979)], the London Business School [see LBS (1979)] and the Bank of England.
2. See Evans and Klein (1968).
3. See Duesenberry, et al. (1965).
4. See Calson (1978).

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