Addis Ababa University
Office of Graduate Program
Faculty of Science
Department of Statistics

A Comparison of Alternative Estimators of Macroeconomic Model in Ethiopia

By

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Abstract

During the past 5 decades a number of econometric techniques were developed and applied to a variety of econometric relationships to deal with the problem of single equation estimation as well as simultaneous equations bias. These days, such methods have very wide applications especially in more developed countries. However, there has been very little attempt to apply these techniques to empirical relationships describing the macroeconomic sector of developing countries in general and Ethiopia in particular. In this study, a small macro econometric model of Ethiopia is used to identify the best estimation techniques that will produce accurate forecast of the economy of Ethiopia. In this study six econometric methods were considered. The prediction accuracy of these estimators of economic model was examined using time series data covering the period 1970 to 2004. The results indicated that considerable gain in forecasting accuracy can be achieved by using 2SLSAUT01 and 2SLSAUT02 than simple ordinary least squares or two stage least squares to estimate macroeconomic models. Moreover, the results do indicate that series attempts should be made to estimate models by techniques other than ordinary least squares or two-stage least squares.

1.2 Statement of the problem:

Policy analysis in Ethiopia currently faces daunting challenges that will not be solved unless policy analysts and economic advisors are equipped with tools to help them analyze and present policy makers with a number of policy options and likely scenarios of various policy decisions. Many African countries in general and Ethiopia in particular face difficulty in building full-fledged macroeconomic models and in training, in a relatively short time, qualified modellers and forecasters who would provide governments with concise and timely forecasts.

Recent budgetary practices in most African countries demand forecasting the government resource envelope three to five years ahead. The invariant coefficients of the equations in a macroeconometric model are estimated from observed data with econometric methods. However, the Ministry of Finance and Economic Development of Ethiopia did not use any of these estimation techniques; rather it uses prior information and experience to fix the values of the parameters for forecasting purposes. But, there are more formal ways of estimating the model than by adjusting coefficient terms for forecasting purposes. The purpose of this study, therefore, is to fill this gap of identifying the best estimation techniques that will produce accurate forecast.

1.3 Research Objectives

General Objective:

The overall objective of this study is to identify the best estimation techniques that will produce good forecast of the macroeconomic variables of the Ethiopian economy.

Specific Objectives:

Specifically this study tries to empirically carry out the following objectives:

- ✓ apply various econometric methods to the macro model;
- ✓ generate forecast estimates from each technique;
- ✓ measures forecast accuracy of the techniques and make comparisons.

1.4 Significance of the Study:

Forecasting economic variables is an important element in policy design and analysis. The knowledge about the operation of the economy is one of the key aspects in designing and/or evaluating alternative policies. Hence this study will eventually help the policy makers to develop a better understanding of the structure of the economy and how it works. This in turn can result in improved model building as well better policy formulation and forecasting using individual equations techniques and examines how they perform. We may be interested in forecasting the values of some variables either to assess how they respond to given policy changes or evaluate necessary policy responses to a given change in these variables. For example, if we consider a certain increase in government expenditure needed to finance the Millennium Development Goals (MDGs), then the change in government expenditure affects a range of variables such as budget deficit, money supply, the price level and output. To trace the impact of the shock in the expenditure on important economic variables, we need to forecast the variables of interest using a structural model and carry out various simulation experiments.

Generally the output of this research will help the relevant government institutions in designing and revising appropriate techniques for forecasting the economy of the country. Besides its use in budget preparation, policy analysis and simulation exercises, the study provides the foundation for building full-fledged macro model in Ethiopia and as a basis for further research.

1.5 Organization of the Study

The study has six chapters. The first chapter contains the backgrounds, the statement of the problem, and objectives of the study and the significance of the study. Chapter two presents the research methodologies and revises related literatures on the existing basic theories in relation to estimators of macroeconomic models from different sources. The third chapter deals with the data and the model where as the fourth chapter deals with application of the econometric methods in the estimation of model. Chapter five deals with forecasting of macroeconomic variables and the last chapter makes a concluding remark to the study and draw recommendations and policy implications emerging from the study findings.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Review of Empirical Literature

This section provides a review of some empirical studies of a comparison of alternative estimators of macroeconomic model.

2.1.1 A Comparison of Alternative Estimators of Macroeconometric Model

In a survey of US macroeconometric models, it was found that, of ten major models examined, five were estimated by Ordinary Least Squares (OLS), three by OLS and Two Stage Least Squares (2SLS), one by 2SLS, and one by 2SLS and Limited Information Maximum Likelihood (LIML). Still, single equation estimation techniques appear to be the most common estimation methods, and system methods of estimation are not that much in use. In light of the available results, this is rather unfortunate (Theil and Clements, 1980).

Egwaikhide (1997) constructed a small demand driven macroeconometric model for Nigeria with the objective of analyzing the effect of budget deficit on the current account. The model has eight behavioural equations with nine definitions and identities. Nevertheless, the estimation of the model suffers from simultaneity bias since the equations in the model are estimated by OLS that does not take care of the contemporaneous correlation between the endogenous variable and the disturbance term in the system. Moreover, the results may also be spurious as there is no test for the time series properties of the variables.

Fair (1973) analyzed a comparison of alternative estimators of macroeconomic model using the macroeconomic model of the US economy. The model is quarterly and consists of eight equations. He considered ten estimators: Ordinary least squares (OLS), Two-stage least squares (2SLS), Ordinary least squares plus first-order serial correlation (OLSAUTO1), Two-stage least squares plus first-order serial correlation (2SLSAUTO1), Ordinary least squares plus first- and second-order serial correlation (OLSAUTO2), Two-stage least squares plus first-and second-order serial correlation (2SLSAUTO2), Full-information maximum likelihood (FIML), Full-information maximum likelihood plus first-order serial correlation(FIMLAUT01), Full-information maximum likelihood plus first-and second-order serial correlation(FIMLAUT02), and accounting for the dynamic nature of the model (DYN) for the basic1960 quarter I to 1970 quarter III sample period predictions. Fair (1973) concluded that first-order serial correlation tended to be fairly pronounced in most of the equations, whereas second-order serial correlation tended to be much less pronounced. The FIMLAUTO1 and FIMLAUTO2 estimates tended to differ from the other estimates more than the other estimates tended to differ from each other. In addition he concluded that considerable gain in forecasting accuracy can be achieved by the use of more advanced estimation techniques than simple ordinary least squares or two-stage least squares to estimate macroeconomic models. Certainly, accounting for first-order serial correlation is important, and even more gain appears possible by accounting for second-order serial correlation and by using a two-stage least squares technique as opposed to its ordinary least squares counterpart. The results of Fair (1973) also indicate that considerable gain can be achieved by using Full-information maximum likelihood estimators. Given the success of the Full-information maximum likelihood estimators, if practical ways can be found to implement full-information procedures, a significant increase in forecasting accuracy may result. Because of the increased feasibility of using more advanced estimation techniques, there is now less need for model builders to limit themselves to simpler techniques if more advanced techniques lead to improved results. The performance of each of the estimators will, of course, depend on the characteristics of the data to which they are applied.

Teklewold (1988), in his study of Statistical Methods in Estimating the demand for and Supply of Money in Ethiopia, concluded that, the money supply, among other variables, depends on the rate of change of price and this is revealed in the 2SLS, LIML, & Three Stage Least Squares (3SLS) estimates and not in the OLS estimate. This could be due to simultaneous equations bias in the latter.

Chow (1964) analyzed a comparison of alternative estimators for simultaneous equations. He considered five estimators: OLS, 2SLS, LIML, 3SLS, and Full Information Maximum Likelihood (FIML). According to Chow as far as large sample properties of the estimators for simultaneous equations are concerned, full-information maximum likelihood estimates are known to be asymptotically efficient.

2.1.2 Macroecnometric Modelling in Ethiopia

A Macroeconometric modelling (MEM) is a set of behavioural equations, as well as institutional and definitional relationships representing the main behaviours of economic agents and the operations of an economy. The equations, or behavioural relations, can be empirically validated to capture the structure of a macroeconomy, and can then be used to simulate the effects of policy changes. Therefore, it is clear that macroeconometric modelling is multi-dimensional and both a science and an art. However, as a summary of these definitions, a MEM can be defined as a quantitative analysis of an economy via the estimation or computation of an interrelated system of equations using economic theory, data and a good knowledge of econometrics to achieve three objectives, *viz.,* structural analysis, forecasting and policy evaluation. These three purposes correspond, respectively, to the descriptive, predictive, and prescriptive uses of econometrics. Macroeconometric modelling has an interesting history of more than half a century. Macroeconometric modelling in developing countries has been subject to criticisms on a greater scale because of the presence of an additional adverse factor of data unreliability. Apart from data problems which are inevitable, however, there are some specific modifications which should be implemented in constructing a MEM for each individual developing country to capture its specific structural peculiarities.

A comprehensive survey of African macro models by Harris in the mid 1980s and other recent reviews (see Alemayehu 2002, Alemayehu and Daniel 2003) show that macro modelling in Africa is still in its infancy (Harris, 1985)[1]. Although the development of macroeconomic models has reached a stage were a number of models are now being used on regular basis for forecasting purposes, Ethiopia no longer uses its direct planning approach to manage its economy. On the other hand, the government has no other instrument of economic management either. Thus, the government lacks a macro model that could have facilitated macroeconomic policy analysis for a long period of time. This problem was severe when the effects of proposed policies are not tractable by simple reasoning alone. Nowadays, few models are emerging which contribute towards such end, a detail of which is given as under.

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[1] This section relies on Alemayehu and Daniel (2004) and readers are advised to refer this for the citation of macro model authors given below.

Asmerom and Kocklaeuner (1985) constructed a supply side macroeconometric model for Ethiopia. As sited in Daniel (2001), the supply side of the model disaggregates GDP by the production sectors: agriculture, other commodities, construction and distributive service and other services. From the expenditure side, the consumption function (for both private and public), sectorial investment functions, export and import functions are specified. The export function is disaggregated in to coffee and non-coffee and imports are also disaggregated in to capital goods, intermediate goods, consumption goods, fuel, and service imports. Savings are disaggregated in to private and public and specified accordingly. Finally, the saving and the trade gap equations, assuming the trade gap is binding, close the model. The model is fairly disaggregated. But the sectorial equations are not interconnected to capture the simultaneity in the system and hence an exogenous shock in one variable would fail to have any impact on the rest of the system. Moreover, because of the absence of price equation, the effect of any disequilibrium between aggregate demand and supply would completely spills-over to the foreign balance and hence it over or under estimates the foreign exchange gap.

Lemma (1993) also constructed a macroeconometric model for Ethiopia. As sited in Daniel (2001), the model has 53 equations (of which 14 are behavioural and the rest 39 are identities) with four major blocks: production sector and investment block, foreign trade block, public finance block and the price block. The model is essentially supply driven and has two productive sectors-agriculture and non- agriculture. The agricultural sector is related to the real relative price the farmers receive, the supply of manufactured goods to the farming sector and other exogenous variables like rainfall. The value added in the non-agricultural sector is specified as a function of the level of monetary investment. The aggregate level of investment, in turn, is a function of major source of funding such as government savings, credit from banking system and foreign capital inflow. The foreign trade block contains three export supply functions (private export functions for pulse and hide; and public coffee export functions) and two import demand functions (capital goods import and raw material imports, and consumers good import is assumed exogenous). The government sector consists of two behavioural government revenue functions (direct and indirect taxes revenue function and import tax function) and an identity export tax revenue function. The government current expenditure and export tax rates are treated as policy instruments. Finally, the price block identifies two price equations based on consumer price index (CPI) and industrial sector price deflator. The change in CPI is related to excess domestic demand (a pure monetarist formulation) and rate of inflation for imported goods. Price in the industrial sector follows a mark-up rule and is indexed to the CPI in the structuralist tradition. The model, by large, describes the structural and institutional peculiarities of the Ethiopian economy and its policy-making institutions of the socialist era (post 1974/75). However, a significant part of the data(10 observations out of 18) used for the period of pre-1974/75 which cannot be described by the above explained model due to a clear institutional and structural differences between the two periods. In addition to this, some of the assumptions in which the model rested constrained the wider use of the model. For instance, the exogeneity assumption on government current expenditure and agricultural price is questionable. In the case where the economy is for external shocks such as war, drought and terms of trade fluctuations, the exogeneity assumption on government recurrent expenditure will not be a fair assumption. Moreover, to the extent that peasants in Ethiopia had been marketing a considerable part of their produce (after fulfilling the levied quota by Agricultural Marketing Corporation) in the flexible price market, treating agricultural price as purely exogenous is not acceptable. The exclusion of the monetary sector and the formulation of CPI equation can also stand in the negative side of the model. Above all, the result of the model suffers from simultaneity bias as each equation in the model is estimated by OLS.

Daniel (2001) also constructed a macroeconometric model for Ethiopia. The model is set up in aggregate demand and supply framework. The model has 30 equations of which 14 are behavioural and the rest are identities and technical relationships. This model is designed to capture the peculiar structure of the Ethiopian economy such as its supply-constrained nature. Thus, total output is disaggregated into agricultural and non-agricultural (industry, services and other distributional activities) sectors. Moreover, the economy is characterized by a general capacity under utilization, and an attempt is made to capture this phenomenon. On the demand side, private and public consumption and private investment functions are specified. Public investment is assumed to be exogenous. The domestic demand for imports (disaggregated into consumption, intermediate and raw material imports) and foreign demand for export are included on the demand side. The monetary sector comprises a money demand equation and an endogenously money supply equation. The latter is believed to capture the monetization of deficit. Price and the real exchange equations are specified as endogenous in the model.

2.2 Theoretical Literature

2.2.1 The Estimators

There are various econometric methods with which we may obtain estimates of the parameters of macroeconometric models[2]. However, we will consider only the most appropriate estimation methods which may be classified in two main groups, single equation and system-equation techniques. As their names indicate, the main difference between these system estimation methods relates to the information content of the estimator. Another important difference is that single equation estimation techniques involve estimation of the stochastic equations one at a time while system estimation methods all the stochastic equations are estimated simultaneously.

Six estimators are considered. The "least squares method" is the starting point for econometric methods. Each estimator is first used to estimate the twelve stochastic equations of the model. The reduced form of the model is then solved for each set of estimates, and within-sample predictions (both static and dynamic) of the endogenous variables of the model are generated over the sample period. The estimators are compared in terms of the accuracy of the within-sample predictions.

The general model to be estimated is

$$\mathbf{AY} + \mathbf{BX} = \mathbf{U} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where **Y** is an hxT matrix of endogenous variables, **X** is k x T matrix of predetermined (both exogenous and lagged endogenous) variables, **U** is an h x T matrix of error terms, and **A** and **B** are h x h and h x k coefficient matrices respectively.

T is the number of observations. The i^{th} equation of the model will be written as

$$y_i = -A_i Y_i - B_i X_i + u_i, \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

$$i=1, 2, 3\ldots h,$$

[2] A model is a group of structural equations describing relationships between economic phenomenon.

where y_i is a 1 x T vector of values of y_{it} (at time t=1,…,T), Y_i is an h_i x T matrix of endogenous variables (other than y_i) included in the i-th equation, X_i is a k_i x T matrix of predetermined variables included in the i-th equation, u_i is a 1 x T vector of error terms, and A_i and B_i are 1 x h_i and 1 x k_i vectors of coefficients corresponding to the relevant elements of A and B respectively.

The error terms in U are assumed to follow a second-order auto-regressive process:[3]

$$U = R^{(1)}U_{-1} + R^{(2)}U_{-2} + E, \qquad \text{………………….(3)}$$

where the R matrices are hxh coefficient matrices, E is an hxT matrix of error terms, and the subscripts denote lagged values of the terms of U. The error terms in E are assumed to have zero expected values, to be contemporaneously correlated but not serially correlated, and to be uncorrelated in the limit with the predetermined, lagged predetermined, and lagged endogenous variables.

Many estimators could have been considered, but in order to limit the size and cost of this study, the following six estimators were chosen as some of the more important ones to consider.

2.2.1.1. Ordinary least squares (OLS)

The first estimator considered was ordinary least squares applied to each equation of (2).

2.2.1.2. Two-stage least squares (2SLS)

The second estimator considered was two-stage least squares applied to each equation of (2). Two-stage least squares produce consistent estimates if and only if the error term u_i in (2) is not serially correlated or if there is no lagged endogenous variable in X. With a large sample size, all of the variables in X should be used as regressors in the first-stage regression for each equation. In practice, however, it is usually necessary to use only a subset of variables in X as regressors or to use only certain linear combinations of all of the variables in X as regressors. A necessary condition for 2SLS to produce consistent estimates is that the included predetermined variables in the equation being estimated be in the set of regressors. Otherwise there is no guarantee that 2SLS will produce consistent estimates even if the error term is not serially correlated or if there are no lagged endogenous variables

[3] The process in (3) can easily be generalized to higher-order processes, but that will not be done here since only processes up to second order are considered in the empirical work.

among the predetermined variables. For this study, therefore, the variables in X_i were always included in the set of regressors when the i^{th} equation of (2) was estimated by 2SLS.

2.2.1.3. Ordinary least squares plus first-order serial correlation (OLSAUTO1)

The third estimator considered accounts for first-order serial correlation of the error term u_i in (2), but not for simultaneous-equations bias. The estimator is based on the assumption that the error term in each equation is first-order serially correlated:

$$u_i = r_{ii}^{(1)} u_{i-1} + e_i , \qquad i=1,2, \ldots,h, \qquad \ldots\ldots\ldots\ldots (4)$$

which means that $R^{(1)}$ in (3) is assumed to be a diagonal matrix and $R^{(2)}$ in (3) to be zero. Under this assumption, equations (2) and (4) can be combined to yield:

$$y_i = r_{ii}^{(1)} y_{i-1} - A_i Y_i + r_{ii}^{(1)} A_i Y_{i-1} - B_i X_i + r_{ii}^{(1)} B_i X_{i-1} + e_i , \; i=1,2,..,h, \qquad \ldots\ldots\ldots\ldots (5)$$

Ignoring the fact that Y_i and e_i are correlated, equation (5) is a simple nonlinear equation in the coefficients $r_{ii}^{(1)}$, A_i and B_i and can be estimated by a variety of techniques. Two of the most techniques are the Cochrane-Orcutt iterative technique and the Hildreth-Lu scanning technique, but any standard technique for estimating nonlinear equations can be used. The technique used for this study was the Cochrane-Orcutt technique. This is because Cochrane-Orcutt technique converges to a stationary value (Sargan, 1964).

2.2.1.4. Two-stage least squares plus first-order serial correlation (2SLSAUTO1)

The fourth estimator considered is two-stage least squares applied to each equation of (5). This estimator accounts for both first-order serial correlation and simultaneous-equations bias and produces consistent estimates if $R^{(1)}$ is diagonal and $R^{(2)}$ is zero in (3). In this estimator the following variables must be included as regressors in the first stage regressions in order to ensure consistent estimates of equation (5): y_{i-1}, Y_{i-1}, X_i, and X_{i-1}. For this study, these variables were always included in the set of regressors. Any standard nonlinear technique can be used for the second-stage regression of equation (5), and the technique used in this study was the Cochrane-Orcutt technique.

2.2.1.5. Ordinary least squares plus first- and second-order serial correlation (OLSAUTO2)

The fifth estimator considered accounts for first- and second-order serial correlation of the error term u_i in (2), but not for simultaneous-equations bias. The estimator is based on the assumption that the error term in each equation is determined as:

$$u_i = r_{ii}^{(1)}u_{i-1} + r_{ii}^{(2)}u_{i-2} + e_i \,,\ i=1,2,\ldots,h, \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

which means that $R^{(1)}$ and $R^{(2)}$ in (3) are assumed to be diagonal matrices. Under this assumption, equations (2) and (6) can be combined to yield:

$$y_i = r_{ii}^{(1)}y_{i-1} + r_{ii}^{(2)}y_{i-2} - A_iY_i + r_{ii}^{(1)}A_iY_{i-1} + r_{ii}^{(2)}A_iY_{i-2} - B_iX_i + r_{ii}^{(1)}B_iX_{i-1} + r_{ii}^{(2)}B_iX_{i-2} + e_i,\ i=1,2,..,h. \quad \ldots \text{(7)}$$

Again, ignoring the fact that Yi and ei are correlated, equation (7) is a simple nonlinear equation in the coefficients $r_{ii}^{(1)}$, $r_{ii}^{(2)}$, A_i, and B_i, and can be estimated by a variety of techniques. The Cochrane-Orcutt technique can be extended in an obvious way to the second-order case, and the extended Cochrane-Orcutt technique was the one used in this study. The technique converged quite rapidly in almost all cases.

2.2.1.6. Two-stage least squares plus first-and second-order serial correlation (2SLSAUTO2)

The last estimator considered is two-stage least squares applied to each equation of (7). This estimator is an extension of the estimator discussed in (6) to the second-order case and produces consistent estimates if $R^{(1)}$ and $R^{(2)}$ are diagonal in (3). It is easy to show, following the analysis in (6), that the following variables must be included as regressors in the first-stage regressions in order to insure consistent estimates of equation (7): y_{i-1}, y_{i-2}, Y_{i-1}, Y_{i-2}, X_i, X_{i-1}, and X_{i-2}. For this study, these variables were always included in the set of regressors. The nonlinear technique used for the second-stage regressions was the extension of the Cochrane-Orcutt technique to the second-order case.

CHAPTER THREE

MATERIALS AND METHODS

A comparison of alternative estimators based on macroeconomic model of Ethiopia was carried out. To realize the objectives of the study, the following four steps were followed in this regard:

i. Specification of the model.
ii. Estimation of the model.
iii. Evaluation of the estimates.
iv. Comparison of forecasting performance of the various estimators.

The E-VIEWS, STATA and Excel were the main statistical software employed for estimation. The study was conducted in four stages, a detail of which is given as under:

3.1 The Model

3.1.1 Specification of the Model

The model used in this study was constructed by Daniel (2001). This model was chosen because of the advantages mentioned in the literature review. It avoids many of the problems observed on other models. The model is yearly and consists of fourteen equations and seven identities. The fourteen components are private consumption, private investment, tax revenue, government expenditure, export, import of consumers' goods, intermediate import, agricultural production, non-agricultural production, capacity utilization rate, price, demand for real money balance, money supply and exchange rate. The model is set up in aggregate demand and supply framework. The equations used in this model are as follows.

Aggregate Demand

Aggregate demand for domestic output is the sum of domestic absorption and the trade balance.

$$Y = A + (X - Z) \quad (1)$$

where A is domestic absorption and X and Z are export and import, respectively.

Domestic absorption is in turn the sum of private consumption (C), investment (I) and government expenditure on domestic goods (G).

Private Consumption

The economic meaning of consumption is the using-up of economic resources so that they are not available in the future.

Consumption is specified as a function of income and price:

$$\text{Log } RC_{pt} = \beta_{10} + \beta_{11} P_t + \beta_{12} \log RCp_{t-1} + \beta_{13} \log RY_t + \beta_{14} \log RY_{t-1} \quad (2)$$

where RCpt is real private consumption, P_t is the price level and RY is real income at a time t=1,…T.

Private Investment

Investment is defined as spending which is not for current consumption but for future consumption or to increase the capacity to produce in the future. In other words investment is total spending minus consumption. So investment in the macroeconomic sense is spending on factories and machinery, the development of new mines, increase in the herds of cattle, the building of roads, the building up of the national stock of maize, the building up of foreign exchange reserves and so on. It is specified as:

$$\text{Log}I_{pt} = \beta_{20} \Delta \text{Log}RY_t + \beta_{21} \text{Log}I_{gt} + \beta_{22} \text{Log}Z_t + \beta_{23} \text{Log}PB_t \quad (3)$$

Where PB_t is level of public debt, Z_t is the level of imports; and I_{gt} is the first difference of government capital stock which is public investment expenditure.

Government Sector

The government sector is modeled from both the revenue and expenditure sides. From the revenue side, tax revenue is modeled as a function of total output and foreign financial flows and the non-tax revenue is assumed to be exogenous. The expenditure function is also explicitly specified to avoid using it as exogenous policy variable. Assuming expenditure as exogenous is not realistic in Ethiopia since the economy is vulnerable to external shocks such as increase in foreign inflation, foreign interest rate, and an increase or decrease in foreign financial flows.

Tax Revenue

There are many ways of meeting the cost of government services. In a modern economy, taxation is normally by far the most important way of providing resources to the government, but other methods do exist.

Tax revenue is defined to be a function of economic activity proxied by GDP (Y), level of foreign trade and foreign capital flow (F). This is given as

Log TR = β_{30} + β_{31} logRY $_t$ + β_{32}log (X+Z) +β_{33} logF $_t$ Where $\beta_{3i} > 0$ and i = 1…3, …...(3)

Government Expenditure

In the national accounts, government consumption expenditure is defined to include spending by local authorities as well as by the central government, on the provision of services. The national accounting definition of government consumption spending excludes 'transfer payments'. These include the payment of pensions, and subsidies to parastatal organizations. The reason for this distinction is that such transfer payments are not direct purchases of services and so should not be counted as part of the national income.

The government current expenditure (G) is assumed to be positively related to total revenue (TR) and foreign inflow (F). Foreign inflation rate, proxied by import price (p^m), is also included in the specification and expected to have a positive coefficient. The lagged value of G is also included to capture possible path-dependent nature of public expenditure:

$$\text{Log } G_t = \beta_{50} + \beta_{51}\log TR_t + \beta_{52}\log F_t + \beta_{53}\log P^m + \beta_{54}\log G_{t-1} \qquad (4)$$

where $\beta_{5i} > 0$ for i = 1…4

The fiscal block of the model also obeys to the following identities:

Total government revenue (TGR) = TR + other government revenue (OGR)

Total government expenditure (TGE) = G + Capital expenditure (CE)

Fiscal deficit (FD) = TGE – TGR

The External Sector

Exports and Imports

Exports are goods and services that earn foreign exchange. Imports are goods and services that have to be paid for in foreign exchange.

Export

Export (X) is specified as a function of real exchange rate (RER), capacity utilization rate (CUR) and real income (RY) as:

$$\text{Log } X_t = \beta_{60} + \beta_{61}\log RER_t + \beta_{62}\log CUR_t + \beta_{63}\log RY_t \quad (5)$$

Where $\beta_{6i} > 0 \quad i = 1, 2 \,\&\, 3$

Import

The import function is disaggregated into two parts: consumers and intermediate goods.

$$\text{Log } Zcons_t = \beta_{70} + \beta_{71}\log RY_t + \beta_{72}\log RER_t + \beta_{73}\log R_{t-1} + \beta_{74}\log Zcons_{t-1} \quad (6)$$

where Zcons is import of consumer goods, RY_t is real income, RER is real exchange rate and R is total foreign exchange reserves.

$$\log Zrac_t = \beta_{80} + \beta_{81}\log RY_t + \beta_{82}\log RER_t + \beta_{83}\log R_{t-1} + \beta_{84}\log ZRac_{t-1} \quad (7)$$

where Zrac is intermediate import (raw material and capital).

In both import equations lagged dependent variables used to show partial stock adjustment behavior.

Total import (Z) will then be the sum of consumer, intermediate other imports:

$$Z = Zcons + Zrac + Zother$$

External Sector Closure

The external sector is closed by the reserve flows identity in which the accumulation or de-accumulation of reserves take place. Except for the trade balance, the other components of the external sector are exogenous in the model. We will use the identities,

BOP = CA + Transfer payments + capital account balance + net errors and omissions

Change in Reserve = BOP + change in arrears + debt relief

$\text{Reserve}_{(t)} = \text{Reserve}_{(t-1)} + \text{Change in reserve}_{(t)}$

where BOP is the balance of payment and CA (current account) is given as the sum of trade balance + net services + net private transfer payments.

Aggregate Supply

Total production is disaggregated into agricultural and non-agricultural, the specification of each being informed by stylized facts about the economic structure of the country.

Agricultural Production

The agricultural production function is assumed to be positively related to labour in the agricultural sector, good rainfall, and relative price of agricultural products. The function is given as:

$$\text{Log Yagr} = \beta_{90} + \beta_{91}\,\text{logLagr}_t + \beta_{92}\text{logRF}_{t-1} + \beta_{93}\log\left(\frac{P_{agr}}{P_{nagr}}\right)_t + \beta_{94}\text{logYagr}_{t-1} \qquad (8)$$

Where Yagr is agricultural GDP, Lagr is labour force in agricultural sector[4], RF is rainfall, and P_{agr}/P_{nagr} is the ratio of agricultural GDP deflator to non agricultural GDP deflator.

Non-Agricultural Production

The non-agricultural sector refers to both manufacturing and service sectors. Output in this sector is determined by labour, change in capital stock, intermediate import and capacity utilization. This production function is given as

$$\text{Log Ynagr} = \beta_{100} + \beta_{101}\log \text{Lnagr}_t + \beta_{102}\log\Delta K_t + \beta_{103}\text{logZrac}_t + \beta_{104}\,\text{logCUR} \qquad (9)$$

Where Lnagr is labour force in non-agricultural sector, ΔK_t is change in capital stock, Zrac is intermediate imports, and CUR is capacity utilization rate in the economy. The total production is given by:

$$\text{RY} = \text{Yagr} + \text{Ynagr}$$

Capacity Utilization Rate (CUR)

Capacity utilization is defined as actual to potential ratio. It is derived as a ratio of actual GDP to potential GDP. Capacity under utilization may refer to both the agricultural and the non-agricultural sectors. This in the agricultural sector could be due to drought (whose proxy is rainfall). In the non-agricultural sector the main cause of capacity under utilization is shortage of imported inputs. Thus, CUR can be assumed to depend on the level of imports, and rainfall.

$$\text{Log CUR}_t = \beta_{110} + \beta_{111}\text{logRF}_{t-1} + \beta_{112}\text{logZrac} \qquad (10)$$

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[4] The data for labour force is adjusted using the capacity utilization rate in the agricultural sector to proxy employed labour force in the sector since the data for employed labour force is not available.

$\beta_i > 0$ where i = 1 & 2; RF is rain fall and Zrac is intermediate imports.

Prices

The domestic price level is determined by the real excess demand (RED) over the supply in the domestic economy, excess money supply over the money demand (EMs), and import prices (P^m). In addition, capacity utilization rate (CUR) is also related to the rate of inflation which in turn is related to a mark-up pricing system common in many African industries. Thus, price is specified as:

$$P_t = \beta_{120} + \beta_{121} EMs + \beta_{122} \log RED_t + \beta_{123} \log CUR_t + \beta_{124} \log P^m \quad (11)$$

Money Market

The money supply equation is partly endogenous from the side of the balance of payments and the fiscal deficit. Following the flow of funds approach, the domestic money supply (Ms) can be given as

$$Ms = (TGR\text{-}TGE) - G^s{}_p + DC_p + \Delta R \quad (12)$$

where (TGR – TGE) is the budget deficit, $G^s{}_p$ is net sales of government interest bearing assets to the non-bank private sector, DC_p is domestic credit to the private sector, ΔF is change in foreign financial flows, and ΔR is change in foreign exchange reserve.

The demand for real money balance (M/P) is positively related to real income (RY) and negatively related with the opportunity cost of holding money, and given as:

$$\text{Log } (M/P)_t = \beta_{140} + \beta_{141} \log RY_t - \beta_{142} r_t + \beta_{143} \pi_t + \beta_{144} \log(M/P)_{t-} \quad (13)$$

Where r and π are interest rate and inflation rate, respectively, that are used to proxy the opportunity cost of holding money.

Exchange Rate

Since the nominal exchange rate had been fixed for long in the country (only being liberalized in the 1990s), we, rather chose to specify the real exchange rate (RER).

$$\text{Log } RER = \beta_{150} + \beta_{151} \log TOT_t - \beta_{152} \log(OPEN)_t + \beta_{153} \log F_t + \beta_{154} EMs \ldots\ldots\ldots(14)$$

where TOT is terms of trade, OPEN = [(X+Z)/ Y] is the trade (export, X, & Import, Z) to GDP, Y, ratio; F is foreign financial flows, and EMs is excess money supply, measured as the difference between money supply and money demand.

Identities of the Model

ΔLogRY = LogRY - LogRY(-1)

RAD = RCp + RCONSg + RIp + RIg

RED = RAD - RY

FD = G + Ig - TR - NTR

TB = X – Z

INFLATION = LogP - LogP(-1)

$$TOT = \frac{P_X}{P_Z} x100$$

Dummy Variable Included in the Model

In regression analysis, a dummy variable (also known as indicator or bound variables) is one that takes the values 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome. An attempt was made to improve the results by using dummy to the model. The dummy variable, Dmy, is included in the model to capture Ethiopia's pre- and post-revolutions period. It is a dummy policy change with value unity after 1992 and zero otherwise.

$$\text{i.e. Dmy} = \begin{cases} 1, \textit{for post} - \textit{revolution years}, 1992 \\ 0, \textit{otherwise} \end{cases}$$

Thus the model contains fourteen structural equations in which the private consumption, private investment, tax revenue, government expenditure, export, consumers import, intermediate import, agricultural production, non-agricultural production, price, capacity utilization rate, money demand and real exchange rate are endogenous and the remaining including dummy variable are exogenous.

Table 3.1 The Fourteen Equation Model

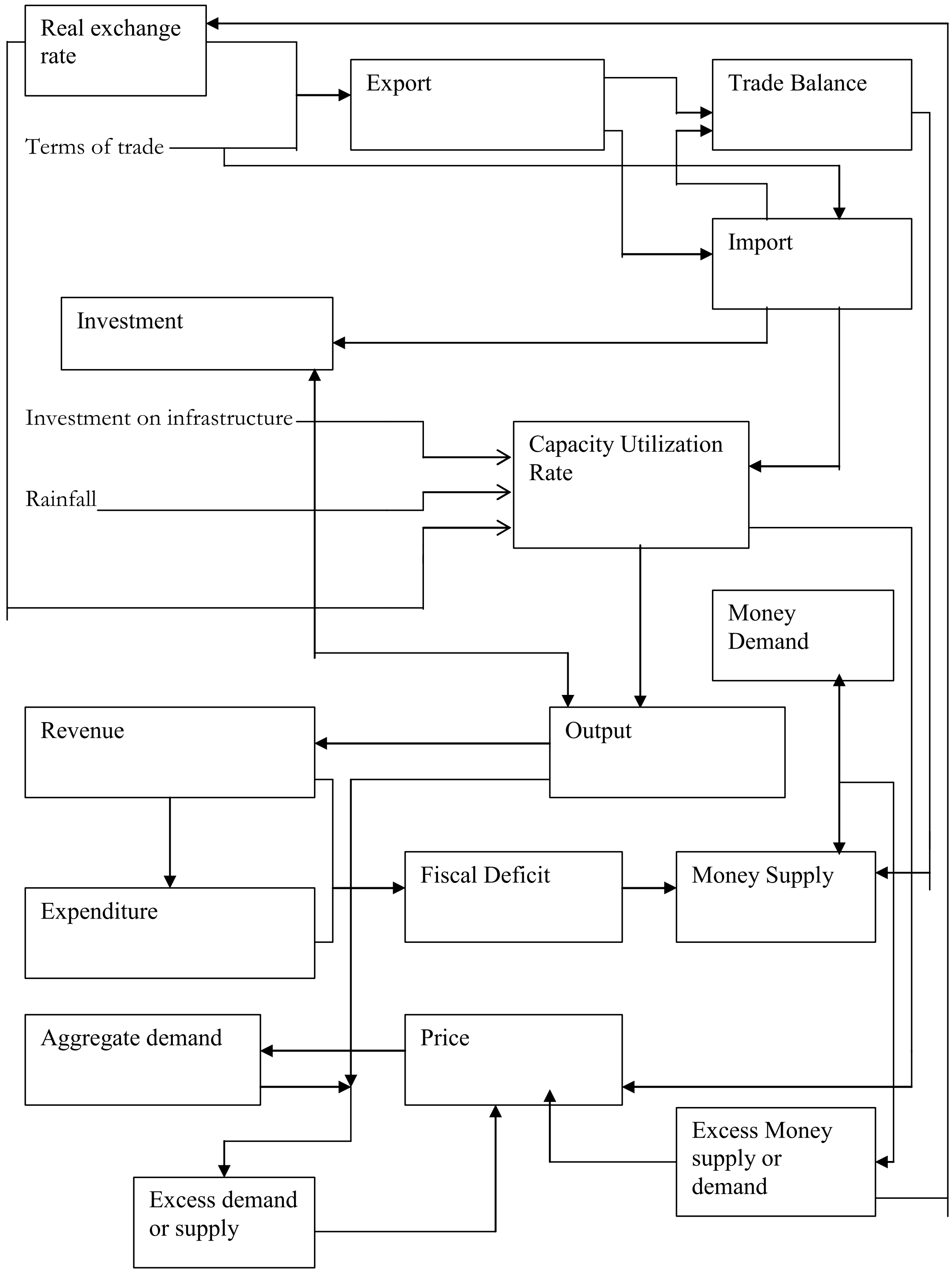
Endogenous Variable	Predetermined Variables					
1. LogRCp	Const.	P	LogRCp_{-1}	LogRY	LogRY_{-1}	
2. LogI_p		ΔLogRY	LogI_g	LogZ	LogPB	Dmy
3. LogTR	Const.	LogRY	Log(X+Z)	LogF		
4. LogG	Const.	LogTR	LogF	logP^m	logG_{-1}	
5. LogX	Const.	LogRER	LogCUR	logRY		
6. LogZcons	Const.	LogRY	LogRER	LogR_{-1}	LogZcons_{-1}	
7. LogZrac	Const.	logRY	LogRER	LogR_{-1}	LogZRac_{-1}	
8. LogYagr	Const.	LogLagr	LogRF_{-1}	$\log(\frac{P_{agr}}{P_{nagr}})$	LogYagr_{-1}	
9. LogYnagr	Const.	LogLnagr	LogΔK	LogZrac	LogCUR	
10.LogCUR	Const.	LogRF_{-1}	LogZRac			
11.P	Const.	EMs	LogRED	LogCUR	logP^m	
12.Log(M/P)	Const.	LogRY	r	Π	Long(M/P)_{-1}	
13.LogRER	Const.	LogTOT	Log(OPEN)	LogF	EMs	
14. Ms		TGR-TGE	$-G^s_p$	DCp	ΔR	

(See Appendix A for symbols used and their definition and subscript -1 after a variable denotes the one year lagged value of the variable).

3.1.2 The Model Main Relationships

The model's main relationships are shown in Diagram 1. As sited in Daniel (2001), the value of export together with foreign financial inflows (i.e. foreign exchange availability), terms of trade and real exchange rate determine the level of imports. Imports, in turn, affect the level of private investment and determine, along weather and infrastructure condition, the capacity utilization rate of the economy. The capacity utilization rate is assumed to have a direct impact on output which in turn affects government revenue and expenditure and hence the fiscal deficit. The fiscal deficit has a feed back effect on prices through its effect on money supply. Excess demand in the goods market is assumed to be financed by foreign financial flows. However, for a given level of foreign financial flows, the disequilibrium between aggregate demand and aggregate supply is assumed to spillover to the domestic price, thus the goods market eventually clearing through adjustment in price.

Diagram 1: The Workings of the Model



Source: Daniel (2001).

3.1.3 The Identification Problem

For an econometrician wishing to use the model of simultaneous equations there are two major problems to be resolved. First is the problem of identification. Identification is a problem of model formulation, rather than of model estimation or appraisal. A function belonging to a system of simultaneous equation is identified if it has a unique statistical form, that is if there is no other equation in the system, or formed by algebraic manipulation of the other equations of the system, which contains the same variables as the function in question. If a model is not identified then estimates of parameters of relationships between variables measured in samples may relate to the model in question or to another model, or to mixture of models. The appropriate techniques for estimating an equation in a simultaneous system depends on the identification status of that equation: if an equation is not identified then its parameters can not be estimated.

After the model has been specified in the form of structural equations, with parameters β and γ, it is capable of explaining the relations between the endogenous variables and the predetermined variables through the reduced form which can be observed. Let there be a sample of T observations (y_t,x_t) (t= 1,2,...,T), which can be used to estimate the parameter π of the reduced-form. It is possible to infer from (π) the structural parameters (β,γ). This is the problem of identification. We discuss the problem of identification in this section. Second, given that a certain subset of the structural parameters can be identified, how should they be estimated using the observations available? This is the problem of estimation and was discussed in the theoretical literature.

Returning to a discussion of the identification problem, we consider conditions for the identifications of the parameters of one structural equation. One basic idea is that for a set of structural parameters to be identifiable they must be uniquely determined if the reduced form parameters are known. To investigate the conditions for the identifiability of the parameters of one structural equation, one may ask under what conditions the parameters of this equation can be inferred uniquely from the parameters of the reduced form through the relation $\beta\ \pi=-\ \gamma$.

To establish the identification we have two sets of conditions to be checked: the order condition and the rank condition.

a. Order condition

The order condition is only a necessary condition and is not sufficient, that is, if the order condition is not satisfied, the model is not identified. While the order condition is likely to be satisfactory rule of thump for identification, there is a possibility that it will fail on occasion, that is, it is possible for the order condition to be satisfied and for the equation to be unidentified. The order condition can be stated, for the order condition of identifiability, as: The number of variables excluded from an equation must be greater than or equal to G-1, where G is the number of structural equations. This model is mathematically complete in the sense that it contains as many equations as endogenous variables. As Table 3.2 indicates, all equations in our model pass the order condition.

b) **Rank condition**

For the fact that the order condition is satisfied does not guarantee the models identifiability, we need some more conditions which ensures that there is exactly one solution for the structural parameters given the reduced form parameters. This condition is referred to as rank condition.

The rank condition states that: in a system of G equations any particular equation is identified if and only if it is possible to construct at least one non-zero determinant of order (G-1) from the coefficients of the variables excluded from that particular equation but contained in the other equations of the model. To apply the rank condition we follow some steps:

Step 1: Write the parameters of all the equations of the model in a separate table; noting that the parameter of a variable excluded from an equation is equal to zero.

Step 2: Strike out the row of coefficients of the equation which is being examined for identification.

Step 3: Strike out the columns in which a non-zero coefficient of the equation being examined appears. By deleting the relevant row and columns we are left with the coefficients of variables not included in the particular equation, but contained in the other equations of the model.

Step 4: Form the determinant (s) of (G-1) from the table of parameters of excluded variables and examine their values. If at least one of these determinants is non-zero the equation is identified. If all the determinants of order (G-1) are zero, the equation is under identified. A structural equation is identified if it is either just identified or over identified.

Step5 To see whether the equation is exactly identified or over identified we use the order condition:

If (K-M) = (G-1), then the equation is exactly identified.

If (K-M) > (G-1), then the equation is over identified.

Going through these steps all equations in our model passes the rank condition and we conclude that all equations in the model have unique statistical form. Hence the model is identified. To see whether the equations are just or over identified we compare (K-M) with (G-1), thus for each equation in the model (K-M) > (G-1), which suggests that all equations are over identified.

Let G= total number of equations (total number of endogenous variables)

K= total number of variables in the model (endogenous and predetermined)

M= number of variables, endogenous and exogenous, included in a particular equation.

There are fifty eight variables in the model (K=58) and thirteen equations (G=13).

TABLE 3.2 Identifiability Status of the Structural Equations

No	Equation	Number of	Number of	Rank	Order Status

		Equation in the model (G)	Excluded variables (K-M)	Status	
1	Private Consumption	13	53	Identified	Over identified
2	Private Investment	13	52	Identified	Over identified
3	Tax Revenue	13	54	Identified	Over identified
4	Government Expenditure	13	53	Identified	Over identified
5	Exports	13	54	Identified	Over identified
6	Import of Consumer goods	13	53	Identified	Over identified
7	Intermediate Import	13	53	Identified	Over identified
8	Agricultural Production	13	53	Identified	Over identified
9	Non-Agricultural Production	13	53	Identified	Over identified
10	Capacity Utilization Rate	13	55	Identified	Over identified
11	Prices	13	53	Identified	Over identified
12	Money Demand	13	53	Identified	Over identified
13	Exchange Rate	13	53	Identified	Over identified

3.2 Description of the Data

3.2.1 Data Type and Sources

To compare the Alternative Estimators of Ethiopian Macroeconomic Model, the study period spans from 1970 to 2004. The length of the sample period is determined by the availability of relevant data. Since the reliability of any econometric analysis depends among other things, on the size and quality of the data employed, it is essential to discus the nature and sources of the data used for the study. The sources have been secondary, solicited from a number of organizations and by computations. List of variables and their sources are summarized in Table3.3.

TABLE 3.3: List of Variables by Sources

No	Sources of Data	List of variables

1	Ministry of Finance and Economic Development (MoFED)	Foreign financial flows, Fiscal deficit, Government expenditure, Inflation rate, Real output, Total government expenditure, Agricultural output, Non-agricultural output
2	Ethiopian Economic Association (EEA)	Change in capital stock, Openness measured as export and imports as a ratio of GDP, Import price, Price level measured by the CPI, Real deposit interest rate, Real aggregate demand, Real government consumption, Real private consumption expenditure, Real excess demand, Real private investment
3	Central Statistical Agency (CSA)	Government non-tax revenue, Total government revenue, Government tax revenue, Exports, Total imports, Import of consumers' good, intermediate imports
4	National Bank of Ethiopia (NBE)	Money supply, Net sales of government interest bearing assets to the non-bank private, Public borrowing (domestic), Real exchange rate
5	World Bank country office (WB)	Labor force
6	Ethiopian Investment Agency	Private investment, Nominal government investment
7	National Meteorological Services Agency of Ethiopia	Rainfall

3.2.2 Limitation of the Data

Even though the findings of the study has important implications, there are, however some limitations regarding the data used for this study. The data compiled in most developing countries, including Ethiopia, has problem both in quantity and quality and may therefore bias the empirical results. The result of the econometric analysis of this study may be limited by the quality and quantity of the data series available. Thus there was difficulty in obtaining consistent and reliable data series from one source, sometimes more than one source is employed to get the data. It is worth nothing to mention that remarkable discrepancies are witnessed in the data series reported by different institutions.

The data for labor force is adjusted using the capacity utilization rate in the agricultural sector to proxy employed labor force in the sector since the data for employed labor force is not available.

The quality and availability of consistent data set determine the output of the analysis by large. Some important variables were missing and found to be extremely difficult to get either from domestic or international sources. With this regard, data could not be sourced for money demand, excess money demand over money demand, terms of trade, and price ratio of agricultural and non-agricultural product for the entire period under consideration. As a result of this, money demand equation is excluded from the model. In addition, the sample size of the study may limit the predicting performance of the estimators. All these problems render me to use system estimation techniques, as they are more sensitive to misspecifications.

Moreover, the model used in this study is not very disaggregated; therefore, it may not take all the necessary elements into account.

3.3 Preliminary Analysis

3.3.1 Unit Root Test Results

Since the study uses time series data, handling time series economic data, particularly in regression analysis is nowadays becoming almost mandatory to test variables for stationary. In estimating a time series data, the concept of stationarity[5] is very important. Following the seminal works of Nelson and Plosser (1982) and the recognition by most macroeconomists that, "most macroeconomic time series variables exhibit a unitary time series structure; the view that most time series economic variables are characterized by stochastic, rather than deterministic, testing for non stationary of variables has become prevalent in econometrics"

[5] A time series is stationary, if it's mean, variance and autocovariances (at various lags) are independent of time (Gujarati, 1995 and Harris, 1995).

(Bodman, 1995). It has recently come to light that the presence of unit roots in economic variables in the regression would yield time dependent results, which may be spurious[6]. The results of spurious regression yield very high R^2 value, significant t-ratio even without true relationship among the variables and inconsistent OLS estimates. Therefore, no inference can be made since the standard statistical tests like the F-distribution and t-distribution are invalid. Hence before estimating a time series data, it is important to test for stationary through conducting a unit root test for each variable involved in the model. One popular test of detecting stationarity of variables in time series econometrics is the unit root test. There are various ways of conducting a unit root test like the non-parametric tests developed by Phillips and Perron which is based on Phillips (1987), Z-test, Saragan-Bhargava (1983) Cointegration regression Durbin-Watson (CRDW) test and Dickey-Fuller (DF) approach. Among these, Augmented Dickey–Fuller (ADF) and Phillips-Perron tests of unit root are employed. Particularly Augmented Dickey–Fuller test is the most popular due to its simplicity or more general nature (Harris, 1995).

Unit root test helps to detect whether a variable is stationary or not. It also provides the order of integration at which the variable can be stationary. If a variable is stationary in level, i.e. without running any differencing, then that variable is said to be integrated of order zero or I(0). Similarly, if it becomes stationary by differencing once, then the variable is said to be an I(1) variable. In order to test stationarity of all variables included in our model, we employ the standard Augmented Dickey-Fuller and Phillips-Perron tests for all variables at levels and first difference. Appendix B & C reports the unit root test results for all variables included in our equations, in levels, and in first-difference. Both tests show that all variables entering the analysis are found to be stationary at levels and at first difference. The results are summarized in the following table.

Table 3.4 Stationary Tests, Summary

I(0)	I(1)

[6] The term spurious results was first coined by Newbold and Granger (1974) to describe the regression results done on levels involving economic time series that "look good" in the sense of having high R squared and significant t statistic, but which in fact are meaningless(Griffiths, 1993, pp.696).

Change in foreign exchange rate	Domestic credit to the private sector
Log(Capacity utilization rate)	Fiscal deficit
Log(Foreign financial flows)	Log(Change in capital stock)
Log(Government expenditure)	Log(Labor force in agriculture)
Log(Nominal government investment)	Government non-tax revenue
Log(Nominal private investment)	Price level measured by the CPI
Log(Openness measured as export and imports as a ratio of GDP)	Real aggregate demand
Log(Public borrowing, domestic)	Log(Real private investment)
Log (total foreign exchange rate)	Trade balance
Real deposit interest rate	Log(Government tax revenue)
Real government consumption	Log(Exports)
Log(Real private consumption expenditure)	Log(Total imports)
Log(Real excess demand)	Log(Intermediate import)
Log(Real exchange rate)	Log(the sum of total import & export)
Log(Rainfall)	Real private investment
Log(Real government investment expenditure)	Money supply
Log(Real output)	Net sales of government interest bearing assets to the non-bank private sector
Log(Agricultural output)	Log(labor force in non-agriculture)
Log(Non-agricultural output)	
Log(Import of consumers' good)	
Log(import price)	
Real government investment expenditure	

3.3.2 Normality Tests and Transformations

Many statistical procedures work best when applied to variables that follow normal distributions. A skewness-kurtosis test, making use of the skewness and kurtosis statistics can more formally evaluate the null hypothesis that the sample at hand came from a normally-distributed population. Endogenous variables, which are not normal, are transformed to normality. The following table reports normality test result. Appendix E also reports the same result.

Table 3.5 Skewness/Kurtosis tests for Normality

Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
logRCp	0.666	0.272	1.49	0.4756*
logIp	0.437	0.001	9.59	0.0830*
logTR	0.245	0.011	6.94	0.0811*
logG	0.800	0.000	13.87	0.1000*
logX	0.032	0.843	4.67	0.0970*
LogZcons	0.204	0.137	4.03	0.1333*
logZrac	0.597	0.150	2.53	0.2827*
logYagr	0.136	0.315	3.50	0.1736*
logYnagr	0.994	0.940	0.01	0.9972*
logCUR	0.224	0.487	2.11	0.3483*
P	0.587	0.000	15.27	0.3795*
logRER	0.000	0.979	10.42	0.055*

* accepts the null hypothesis that the sample at hand came from a normally-distributed population.

CHAPTER FOUR

ESTIMATION OF THE MODEL

4.1 Individual Equations Estimation Result

This section considers the OLS, the 2SLS, the OLSAUTO1, the 2SLSAUTO1, the OLSAUTO2, and 2SLSAUTO2 estimates of Ethiopian macroeconomic model. Data for these time-series analyses were obtained from various sources. All data represent January-December calendar year and annual time-series extending from 1970 to 2004, giving a total of thirty five observations and thereby provide empirical results to various equations in the model formulated in part three. The length of the sample period is determined by the availability of the relevant data. The basic data used for this study are available from the author on request. Combinations of econometric software packages used for empirical analysis of this study are EViews (version 3.1) and STATA (version 9).

After confirming the stationarity of the variables at I(0) and I(1), different estimation techniques are applied to estimate the equations and estimation results of the model are given below. The basic set of instrumental variables used for the two-stage least squares estimators are presented at the bottom of Appendix G.

The estimated results of the model using the various estimators are summarized in Table 4.1 through Table 4.6.

Summary Results of Estimates

TABLE 4.1 Estimates of the Model Using OLS Method

Regressors	Coefficient Estimates											
	Equation1 (LogRCp)	Equation2 ($LogI_P$)	Equation3 (LogTR)	Equation4 (LogG)	Equation5 (LogX)	Equation6 (LogZcons)	Equation7 (LogZrac)	Equation8 (LogYagr)	Equation9 (LogYnagr)	Equation10 (LogP)	Equation11 (LogCUR)	Equation12 (LogRER)
Constant	2.4727*		-2.8016	1.3833	3.2210	10.4098**	4.9632	4.2510**	8.3979*	217.39	2.2712**	-0.1880
LogP	-0.0008**											
LogRCp(-1)	0.4662**											
LogRY	0.7166*		0.5927*		0.4094	-0.3645	-0.3515					
LogRY(-1)	0.41745*											
Δ LogRY		0.8505										
LogZrac		1.2593*									-0.0134	
LogPB		0.0104										
Log(X+Z)			0.2566***									
LogF			0.4057*	0.0390								0.0479***
LogTR				0.1060								
LogG(-1)				0.8300*								
$LogP^m$				0.5485						375.2716*		
LogRER					3.7966*	0.2209	0.1709					
LogCUR					-1.0978				2.2898*	-3.6369		
LogR(-1)						-0.4991	0.0231					
LogZcons (-1)						0.8179*						
LogZrac (-1)							0.8279*		-0.5444			

LogLagr								0.2498***				
LogRF(-1)								0.0368			0.3065	
LogYagr(-1)								0.4001**				
LogRED										-87.6684*		
LogOPEN												0.1888*
LogLnagr									0.0397			
LogΔK									0.2261**			
Dmy	0.0739*	-0.3952*	0.1087***	0.0260	1.5409*	0.0994	0.1670	0.0373	-0.1901	43.6834*	0.0237	0.4726*
R^2=	0.9162	0.6812	0.9787	0.9828	0.9205	0.9749	0.9460	0.8355	0.5809	0.9436	0.0672	0.9743
DW=	2.001	1.9518	2.142	1.894	1.956	2.070	2.409	1.801	1.9233	1.846	1.605	1.804
F=	61.234	21.555	333.57	321.46	85.4461	217.80	98.06	36.831	7.8688	121.23	0.7309	378.993

* Significant at 1% level
** Significant at 5% level
*** Significant at 10% level

TABLE 4.2 Estimates of the Model Using 2SLS Method

Regressors	Coefficient Estimates											
	Equation1 (LogRCp)	Equation2 ($LogI_P$)	Equation3 (LogTR)	Equation4 (LogG)	Equation5 (LogX)	Equation6 (LogZcons)	Equation7 (LogZrac)	Equation8 (LogYagr)	Equation9 (LogYnagr)	Equation10 (LogP)	Equation11 (LogCUR)	Equation12 (LogRER)
Constant	2.4710*		-2.8142	1.1958	-1.0713	9.5953**	5.8487*	4.2126*	6.1119*	212.954	0.6495*	-0.0640
LogP	- 0.0008**											
LogRCp(-1)	0.4679**											
LogRY	0.7161*		0.5951*		0.8423***	- 0.2567	-0.4809					
LogRY(-1)	0.4186*											
Δ LogRY		0.8587										
LogZrac		1.2393*									0.0074	
LogPB		-0.0289										
Log(X+Z)			0.2581***									
LogF			0.4027*	0.341**								-0.0347
LogTR				0.825*								
LogG(-1)				0.8590*								
$LogP^m$				-0.4605						386.5348*		
LogRER					2.8780*	- 0.0077	-0.4352					
LogCUR					0.5784				1.5835**	-1.6833		
LogR(-1)						- 0.5396***	0.0762					
LogZcons (-1)						0.8353*						
LogZrac (-1)							0.8132*		0.5512*			
LogLagr								0.2515***				
LogRF(-1)								0.0379			0.1543	

LogYagr(-1)								0.4022**				
LogRED										-89.3737*		
LogOPEN												0.1740**
LogLnagr									0.2957			
LogΔK									0.9824*			
Dmy	0.0735*	- 0.3906*	0.1086***	0.0285	1.0877*	0.1909	0.0563	0.0365	-0.1873**	43.4802*	0.0116	0.4800*
R^2=	0.9162	0.6813	0.9796	0.9838	0.9111	0.97507	0.9462	0.8355	0.5810	0.9456	0.0672	0.9686
DW=	2.0034	1.9379	2.1207	1.8930	2.3890	2.0950	2.3690	1.8040	1.9100	1.8500	1.8040	2.0690
F =	61.2405	21.378	359.85	353.75	76.8466	219.074	98.4742	36.82	8.0434	130.43	0.7206	319.202

TABLE 4.3 Estimates of the Model Using OSLSAUT01 Method

Regressors	Coefficient Estimates											
	Equation1 (LogRCp)	Equation2 ($LogI_P$)	Equation3 (LogTR)	Equation4 (LogG)	Equation5 (LogX)	Equation6 (LogZcons)	Equation7 (LogZrac)	Equation8 (LogYagr)	Equation9 (LogYnagr)	Equation10 (LogP)	Equation11 (LogCUR)	Equation12 (LogRER)
Constant	2.402*		-2.6038	1.8652	0.4243	10.7926**	4.034	4.444	3.9214***	-222.26	-0.0112	17.2355
LogP	-0.0006***											
LogRCp(-1)	0.5418*											
LogRY	0.7131*		0.5894*		0.6896	-0.3549	-0.2634					
LogRY(-1)	-0.4840**											
Δ LogRY		0.9528**										
LogZrac		0.0950									0.008	
LogPB		-1.0704*										
Log(X+Z)			0.2153									
LogF			-0.4325*	0.0610*								0.0290
LogTR				0.1455**								
LogG(-1)				0.7688*								
$LogP^m$				0.7868						68.5760		
LogRER					3.334*	-0.2626	-0.0688					
LogCUR					-0.6242				1.4324**	-22.5534		
LogR(-1)						-0.5363***	0.0278					
LogZcons (-1)						0.8043*						
LogZrac (-1)							0.8906*		0.0903			
LogLagr								0.2958*				
LogRF(-1)								0.0447**			0.029	

LogYagr(-1)								0.3463				
LogRED										-8.357		
LogOPEN												0.0655
LogLnagr									0.037			
LogΔK									0.7410*			
AR(1)	-0.1817	0.8071*	-0.1497	0.1705	0.2744	-0.1164	-0.3574***	0.0964	0.9311	1.011*	0.7716*	0.9999*
AR(2)												
Dmy	0.0635*	-0.0325	0.1207*	0.0282	1.3395*	0.0739	0.1406	0.0368	-0.0844	5.7403***	0.0047	0.3899*
R^2=	0.9235	0.845	0.9790	0.9831	0.9286	0.9759	0.9481	0.8314	0.7686	0.991	0.536	0.995
DW=	2.004	2.340	1.980	2.050	2.174	2.056	1.824	1.837	2.276	1.86	1.70	1.89
F=	52.32	38.114	261.426	261.47	72.803	175.197	79.23	26.632	14.945	652.162	8.10	1500.5

TABLE 4.4 Estimates of the Model Using 2SLSAUT01 Method

Regressors	Coefficient Estimates											
	Equation1 (LogRCp)	Equation2 ($LogI_P$)	Equation3 (LogTR)	Equation4 (LogG)	Equation5 (LogX)	Equation6 (LogZcons)	Equation7 (LogZrac)	Equation8 (LogYagr)	Equation9 (LogYnagr)	Equation10 (LogP)	Equation11 (LogCUR)	Equation12 (LogRER)
Constant	2.4223*		-2.6106	1.8433	0.254	11.0745**	3.5308	4.4967	3.8913***	-224.26	-0.0291	1.1585
LogP	-0.0006***											
LogRCp(-1)	0.5376*											
LogRY	0.7127*		0.590*		0.6044	-0.3924	-0.1943					
LogRY(-1)	-0.4804**											
Δ LogRY		0.9546**										
LogZrac		0.1065									0.0052	
LogPB		-1.0600*										
Log(X+Z)			0.2155									
LogF			-0.4323*	0.0602*								0.0299
LogTR				0.148**								
LogG(-1)				0.7693*								
$LogP^m$				-0.7857						68.551		
LogRER					3.539*	-0.3466	-0.0668					
LogCUR					-0.8084				1.3632***	-22.2292		
LogR(-1)						-0.5224***	-0.0535					
LogZcons (-1)						0.7986*						
LogZrac (-1)							0.8987*		-0.0917			

LogLagr								0.2945**				
LogRF(-1)								0.0428***			0.0322	
LogYagr(-1)								0.3429				
LogRED										-8.2933		
LogOPEN												0.0668
LogLnagr									-0.028			
LogΔK									0.7462*			
AR(1)	-0.1782	0.8058*	-0.1480	0.1691	0.2839	-0.1131	-0.3652***	0.0985	0.9305*	1.0109*	0.7722*	0.9983*
AR(2)												
Dmy	0.0647*	-0.0392	0.1207**	0.0263	1.4354*	0.0387	0.1973	0.0376	-0.0894	5.7440***	0.0071	0.3925*
R^2=	0.9235	0.845	0.9790	0.9831	0.928	0.9758	0.9481	0.8314	0.7684	0.991	0.536	0.995
DW=	2.000	2.345	1.981	2.049	2.199	2.059	1.824	1.834	2.312	1.762	1.996	1.99
F=	52.36	38.118	261.425	261.45	72.928	175.04	79.14	26.644	14.861	652.60	8.095	1500.0

TABLE 4.5 Estimates of the Model Using OLSAUT02 Method

Regressors	Coefficient Estimates											
	Equation1 (LogRCp)	Equation2 (LogI$_P$)	Equation3 (LogTR)	Equation4 (LogG)	Equation5 (LogX)	Equation6 (LogZcons)	Equation7 (LogZrac)	Equation8 (LogYagr)	Equation9 (LogYnagr)	Equation10 (LogP)	Equation11 (LogCUR)	Equation12 (LogRER)
Constant	2.2355*		-2.3994	4.0276**	-1.2105	11.867*	-2.7219	2.3372	3.1382	-10696.29	-0.0197	6.2932
LogP	-0.0004***											
LogRCp(-1)	0.7303*											
LogRY	0.7171*		0.5866*		0.8505	-0.3569	0.3064					
LogRY(-1)	-0.6588*											
Δ LogRY		0.5503										
LogZrac		0.3799									0.0072	
LogPB		-0.7992*										
Log(X+Z)			0.1595									
LogF			-0.4740*	0.0664								0.0224
LogTR				0.3676**								
LogG(-1)				0.4536**								
LogP^m				-1.4550***						60.418		
LogRER					3.1498*	-0.2050	-2.8388**					
LogCUR					0.4517				0.8435	-14.3822		
LogR(-1)						-0.6512**	0.8051***					
LogZcons (-1)						0.8185*						
LogZrac (-1)							-0.0642		0.0952			
LogLagr								0.1528**				

LogRF(-1)								0.0752***			0.0258	
LogYagr(-1)								0.6373*				
LogRED										-0.0913		
LogOPEN												0.0450
LogLnagr									0.0905			
LogΔK									0.8243*			
AR(1)	-0.5745**	0.4411***	-0.24980	0.4306	0.1719	-0.2994	0.5587	-0.0887	0.6261*	1.2566*	0.9084*	1.3114*
AR(2)	-0.4946***	0.3375	-0.1369	0.2233	0.1751	-0.3280	0.2684	-0.5485**	0.2981	-0.2564	-0.1958	-0.3119
Dmy	0.0522*	-0.0115	0.1327**	0.0503	1.2637*	0.0737	-0.7558	0.0232	-0.1342	3.6809	0.0083	0.3897*
R^2=	0.9323	0.853	0.9787	0.9834	0.932	0.9769	0.9581	0.8624	0.7859	0.992	0.549	0.9962
DW=	1.940	1.984	1.997	2.148	1.97	1.979	2.085	1.861	2.033	1.814	1.846	2.08
F=	47.193	30.186	199.09	211.965	59.606	145.58	78.41	26.11	13.111	522.09	6.331	1421.36

TABLE 4.6 Estimates of the Model Using 2SLSAUT02 Method

Regressors	Coefficient Estimates											
	Equation1 (LogRCp)	Equation2 ($LogI_P$)	Equation3 (LogTR)	Equation4 (LogG)	Equation5 (LogX)	Equation6 (LogZcons)	Equation7 (LogZrac)	Equation8 (LogYagr)	Equation9 (LogYnagr)	Equation10 (LogP)	Equation11 (LogCUR)	Equation12 (LogRER)
Constant	2.2358*		-2.4069	3.9912**	0.3149	11.9055*	-2.4688	2.3682	3.1386	-12119.28	0.0321	1.2731
LogP	-0.0004***											
LogRCp(-1)	0.7302*											
LogRY	0.71698*		0.5865*		0.6971*	-0.3624	0.2841					
LogRY(-1)	-0.6586*											
Δ LogRY		0.5461*										
LogZrac		0.3873**									0.0034*	
LogPB		-0.7924*										
Log(X+Z)			0.1615									
LogF			-0.4728*	0.0657								-0.0230
LogTR				0.3695**								
LogG(-1)				0.4563**								
$LogP^m$				-1.4554***						60.6982*		
LogRER					3.4464***	-0.2169	-2.7057**					
LogCUR					-0.6475*				0.8249	-13.2639		
LogR(-1)						-0.6488**	0.7782***					
LogZcons (-1)						0.8178*						
LogZrac (-1)							-0.0311		0.0969*			
LogLagr								0.1525*				

LogRF(-1)								0.0741**			0.0301***	
LogYagr(-1)								0.6349***				
LogRED										-0.0379		
LogOPEN												0.0459
LogLnagr									0.0921			
LogΔK									0.8287*			
AR(1)	-0.4943**	0.438***	-0.2471	0.4262	0.1727	-0.2996	0.5327	-0.0865	0.6205*	1.2449*	0.9127	1.3116*
AR(2)	-0.5742***	0.340	-0.1327	0.22467	0.1426	-0.3273	0.2908	-0.5479	0.3035	-0.2447	-0.2016	-0.3140**
Dmy	0.0522*	-0.0134	0.1321**	0.0475	-1.4035	0.0687	-0.7021	0.0236	-0.1376	3.6746	0.0115	0.3913*
R^2=	0.9323	0.853	0.9787	0.9834	0.932	0.9770	0.9581	0.8624	0.7859	0.9917	0.549	0.9962
DW=	1.740	1.985	1.997	2.15	1.982	1.978	2.074	1.859	2.035	1.897	1.8476	2.07
F=	47.195	30.193	199.08	211.933	59.40	145.579	78.29	26.12	13.112	521.16	6.326	1421.26

4.2 Evaluation of the Estimates

The results of estimating the twelve stochastic equations of the model generally indicate that: The model provide a good fit for the data, that is, the model form generally good approach for explaining variables in most of the equations since R^2 values are uniformly high. The estimation results appear theoretically plausible, and most of the variables are statistically significant and the signs obtained on the estimated parameters of the model, using different estimators, are generally consistent with expectations. Standard errors of the estimates are reasonably low and Durbin-Watson statistics indicate no serial correlation of the residuals.

4.3 Diagnostic Tests

Variables that have been found to be non stationary have been differenced once to ensure stationarity. After ensuring that the variables exhibit the required stationarity properties, we embarked on the empirical estimation of the model. We then subjected our model to a battery of diagnostic tests to further ensure that the results are consistent with our estimation procedure. The results of diagnostic tests show that the model which accounts for endogeneity performs well and satisfy the requirements, in the sense that the residuals are normal, homoscedastic, white noise and they are not autocorrelated. The results also indicate that the model is correctly specified. The diagnostic test results are summarized in Table 4.7.

In addition collinearity diagnostic were carried out to see if there is multicollinearity problem in the data set or if there is linear dependence among the explanatory variables included in the model. As it is suggested in Montgomery and Peck (1992) variance inflation factor (VIF) larger than 10 imply serious problems due to the presence of multicollinearity. As can be seen from variance inflation factor in Appendix F, we do not expect multicollinearity to be a serious problem. However, two of the explanatory variables (nominal government investment and intermediate import) in the private investment equation are relatively highly correlated (see Table 2 of appendix F). This implies that nominal government investment and intermediate import variables cannot appear in a single equation. This calls for the choice of the variables to enter into a single equation. Thus, private investment function is respecified to take into account the presence of multicollinearity in the regressors. This is done by dropping one of the correlated variables. Re-estimation was done excluding the nominal government investment (Ig) based on expected signs of coefficients and statistically stronger results of statistics such as R^2 and adjusted R^2 than excluding intermediate import.

Table 4.7 Summery of Diagnostic Tests

Equations	Breusch-Pagan Test	Durbin's Alternative Test	Ramsey RESET Test
Consumption	0.8452*	0.4167*	0.0824*
Investment	0.2503*	0.1665*	0.0310
Tax Revenue	0.6279*	0.0505*	0.0600*
Government Expend.	0.7541*	0.4555*	0.1692*
Export	0.1096*	0.2863*	0.0890*
Consumers' Import	0.7962*	0.0509*	0.0200
Intermediate Import	0.1787*	0.1400*	0.0301
Agricultural Production	0.5310*	0.1200*	0.0532*
Non-Agricultural Production	0.4043*	0.0777*	0.2773*
Price	0.2019*	0.0586*	0.0510*
Capacity Utilization Rate	0.146*	0.0500*	0.0301
Real Exchange Rate	0.2168*	0.1001*	0.1202*

Breusch-Pagan / Cook-Weisberg test for Heteroskedasticity:

Ho: Constant variance

Durbin's Alternative Test for Autocorrelation:

Ho: no serial correlation

Ramsey RESET Test:

Ho: model has no omitted variables

Correlogram-Q-statistics of Residuals:

Ho: white noise, see Appendix H for correlogram-Q-statistics.

Skewness/Kurtosis Test for Normality:

Ho: sample at hand came from a normally-distributed population (see Table 3.5 and Appendix E).

*accept the null at 5% significant level.

CHAPTER FIVE

FORECASTING

Predictions of macroeconomic aggregates play an important role in the decision making of private enterprises, central banks, and governments. One of the main goals of applied econometric research in connection with the time series analysis is to use the estimated model in order to forecast the value of the dependent variables given the values of the explanatory variables.

5.1 Forecasting Method

Forecasting will be done using either ***Dynamic*** or ***Static*** forecast methods.

5.1.1 Dynamic Forecast

Dynamic calculates dynamic multi-step forecasts starting from the first period in the forecast sample. In dynamic forecasting previously forecasted values for the lagged dependent variables are used in forming forecasts of the current value. This choice will only be available when the estimated equation contains dynamic components (lagged dependent variables or ARMA terms).

5.1.2 Static Forecast

Static calculates a sequence of one-step ahead of forecasts, using the actual rather than forecasted values for lagged dependent variables.

5.2 Within-Sample Forecasting

For each sets of estimates, within-sample predictions of the twelve endogenous variables were generated for the period 1970-2004. Comparison of the estimators is carried out in the context of within-sample predictions. In principle, both within and outside sample (ex-post) forecasts must be used. However, for ex-post forecast to be worth while, the time paths must be reasonable length, about ten sample points as a minimum (Challen and Hagger, 1983). As a result of this long forecast period requirement, the ex-post forecast is not performed.

Two error measures were computed for each set of predictions: mean absolute percent error and Theil's Inequality Coefficient. The mean absolute percent error (MAPE) and Theil's Inequality coefficient (TIC) and its decompositions bias, variance and covariance proportions for each equation are presented in Tables 5.1-5.12 for each set of estimates.

5.3 Evaluation of the Forecasting Power of the Estimators

The accuracy of a forecasting method is determined by analyzing forecast errors experiences. The forecasting performance of the estimators is judged on the basis of the differences between predictions and realizations. The smaller the difference between the predictions and the actual values of the dependent variable is the better the forecasting performance of the estimator. The estimators will be compared in terms of the accuracy of the within-sample predictions. The within-sample forecasting performance of the whole system should be assessed using standard statistical tools such as Root Mean Squared Error, Mean Absolute Error, Mean Absolute Percent Error, and Theil's Inequality Coefficient. The first two forecast error statistics depend on the scale of the dependent variables; and the remaining two statistics are scale invariant (i.e. unit free). In most instances unit-free measures are preferable (Challen and Hagger, 1983). As a result Theil's inequality coefficient (TIC) and mean absolute percent error (MAPE) are used in this study. If the forecast is good, the mean absolute percent error and the Theil's inequality coefficient should be as small as possible. Theil's Inequality Coefficient (TIC) suggested by H.Theil is a measure of the fit of a forecast (H. Theil, 1996). It ranges between zero and one. When it is equal to zero it indicates that the forecast has a perfect fit. TIC=1 indicates a forecast just as accurate as one of "no change" ($\Delta y_t = 0$), and a value of TIC greater than one means that the prediction is less accurate than the simple prediction of no change (J. Kmenta, 1986). The results indicate that the Theil's inequality coefficient is close to zero for 2SLSAUT01 and 2SLSAUT02, implying that the forecast has a good fit in these two estimators than the rest. Theil's inequality coefficient can be decomposed into **Bias, Variance, and Covariance proportions** each showing a different source of forecast error**.**

- 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.

- The covariance proportion measures the remaining unsystematic forecasting errors.

If the forecast is "good", the bias and variance proportions should be as small as possible so that most of the bias should be concentrated on the covariance proportions. On the basis of these aforementioned selection and evaluation criteria concluding remarks have been drawn. The results in the forecast evaluation indicate that in most of the equations the conclusions reached from examining the mean absolute percent error results and Theil's Inequality Coefficient results are the same. The TIC for all equations is below 0.3 and has least value for 2SLSAUT01 and 2SLSAUT02. These figures are in the acceptable range since "TIC less than 0.3 or 0.4 are considered not to be unduly large" (Oshikoya, 1990:101). The results also indicate that the model has small values of the mean absolute percent error, the bias and variance proportions in the 2SLSAUT01 and 2SLSAUT02 than the other estimators, implying a good forecast can be achieved by these two estimators. The bias proportion is less than 1% for 2SLSAUT01 and 2SLSAUT02 in all equations. In most of the equations the variance proportion is well below 10% for 2SLSAUT01 and 2SLSAUT02. The result also shows that the bulk of forecast error is unsystematic and hence captured by the covariance proportion. The model reveals a good feature in terms of mean absolute percent error, Theil's inequality coefficient and its decompositions for 2SLSAUT01 and 2SLSAUT02 than the other estimators.

Higher mean absolute percent error (MAPE) is observed in capacity utilization rate equation, price equation, intermediate import equation, real exchange rate and investment function. This is a common feature for most macroeconometric models in the case of developing countries (Salvatore, 1989). For the MAPE measure in these equations, the OLS & 2SLS estimators continue to perform poorly relative to the others, but for the other four estimators the MAPE results are quite close.

The mean absolute percent error and Theil's Inequality Coefficient for the private consumption variable are presented in Table 5.1 for each set of estimates. The most striking feature of the mean absolute percent error and Theil's Inequality Coefficient results is perhaps the increased accuracy obtained from the 2SLSAUT01 and 2SLSAUT02 estimates for the predictions. The results in Table 5.1 through 5.12 also show that the two stage least squares estimators perform on average better than their ordinary least squares counterparts, that the AUT01 estimators perform on average better than their no-serial correlation counterparts, and that the AUT02 estimators perform on average better than their AUT01 counterparts: 2SLS is better than OLS, 2SLSAUT01 is better than OLSAUT01, 2SLS02 is always better than OLSAUT02, OLSAUT01 is better than OLS, and 2SLS01 is better than 2SLS. The OLS & 2SLS estimators continue to perform poorly relative to the others, and mean absolute percent error and Theil's Inequality Coefficient results indicate that 2SLSAUT02 estimator can be considered as dominating all of the rest.

In Tables 5.2 through 5.12 the mean absolute percent error, Theil's Inequality Coefficient and its decompositions for the remaining variables are presented for each set of estimates. Generally, the basic conclusions reached for private consumption results also hold for the remaining variables.

Table 5.1: Forecast Evaluation for Private Consumption

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.179479	0.001192	0.000020	0.021872	0.978108
2SLS	0.179465	0.001092	0.000000	0.021733	0.978267
OLSAUT01	0.166915	0.001050	0.000000	0.020479	0.979521
2SLSAUT01	0.158079	0.000985	0.000000	0.020001	0.979999
OLSAUT02	0.166888	0.001050	0.000000	0.017665	0.982335
2SLSAUT02	0.158072	0.000985	0.000000	0.017655	0.982345

Table 5. 2: Forecast Evaluation for Private Investment

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	1.546414	0.010311	0.000771	0.181324	0.817906
2SLS	1.553486	0.010312	0.000749	0.180252	0.818999
OLSAUT01	1.132225	0.007097	0.000991	0.000008	0.999001
2SLSAUT01	1.130676	0.007097	0.000973	0.000004	0.999023
OLSAUT02	1.051245	0.006829	0.000881	0.000005	0.999115
2SLSAUT02	1.050842	0.006829	0.000876	0.000015	0.999109

Table 5.3: Forecast Evaluation for Tax Revenue

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.508770	0.003059	0.000120	0.005157	0.994723
2SLS	0.508666	0.003059	0.000000	0.003302	0.996698
OLSAUT01	0.507903	0.003071	0.000000	0.004201	0.995799
2SLSAUT01	0.507790	0.003071	0.000000	0.004227	0.995773
OLSAUT02	0.507829	0.003069	0.000000	0.002900	0.997100
2SLSAUT02	0.507242	0.003069	0.000000	0.002954	0.997046

Table 5.4: Forecast Evaluation for Government Expenditure

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.451402	0.002851	0.001427	0.016209	0.982364
2SLS	0.448561	0.002838	0.000000	0.004066	0.995934
OLSAUT01	0.436705	0.002796	0.000000	0.004355	0.995645
2SLSAUT01	0.415608	0.002796	0.000000	0.004366	0.995634
OLSAUT02	0.435524	0.002643	0.000000	0.010842	0.989158
2SLSAUT02	0.415052	0.002643	0.000000	0.010863	0.989137

Table 5.5: Forecast Evaluation for Export

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.872832	0.005729	0.005533	0.023277	0.971190
2SLS	0.830197	0.005468	0.000001	0.009460	0.990539
OLSAUT01	0.718066	0.004959	0.000000	0.016846	0.983154
2SLSAUT01	0.686221	0.004885	0.000000	0.007438	0.992562
OLSAUT02	0.706792	0.004948	0.000000	0.013134	0.986866
2SLSAUT02	0.676522	0.004866	0.000000	0.008515	0.991485

Table 5.6: Forecast Evaluation for Consumers Import

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.741855	0.004422	0.000000	0.006310	0.993690
2SLS	0.735127	0.004409	0.000000	0.006015	0.993985
OLSAUT01	0.722460	0.004223	0.000000	0.006128	0.993872
2SLSAUT01	0.656031	0.004221	0.000000	0.006098	0.993902
OLSAUT02	0.719400	0.004004	0.000000	0.005767	0.994233
2SLSAUT02	0.655524	0.004004	0.000000	0.005764	0.994236

Table 5.7: Forecast Evaluation for Intermediate Import

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	1.070083	0.006622	0.000000	0.014063	0.985937
2SLS	1.067511	0.006610	0.000000	0.013827	0.986173
OLSAUT01	1.029155	0.006370	0.000000	0.013425	0.986575
2SLSAUT01	0.942334	0.005545	0.000000	0.013316	0.986684
OLSAUT02	1.024878	0.006366	0.000000	0.010068	0.989932
2SLSAUT02	0.938974	0.005543	0.000000	0.011314	0.988686

Table 5.8 Forecast Evaluation for Agricultural Production

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.195787	0.001445	0.000000	0.044908	0.955092
2SLS	0.195720	0.001445	0.000000	0.044630	0.955370
OLSAUT01	0.195331	0.001459	0.000000	0.045746	0.954254
2SLSAUT01	0.183354	0.001459	0.000000	0.045542	0.954458
OLSAUT02	0.184951	0.001317	0.000000	0.036869	0.963131
2SLSAUT02	0.183003	0.001317	0.000000	0.036692	0.963308

Table 5.9: Forecast Evaluation for Non- Agricultural Production

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	0.848822	0.005089	0.000416	0.204303	0.795281
2SLS	0.674695	0.004214	0.000000	0.134912	0.865088
OLSAUT01	0.508417	0.003178	0.000000	0.161972	0.838028
2SLSAUT01	0.483007	0.003091	0.000000	0.154104	0.845896
OLSAUT02	0.503503	0.003177	0.000000	0.190746	0.809254
2SLSAUT02	0.482940	0.003090	0.000000	0.187018	0.812982

Table 5.10: Forecast Evaluation for Price

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	11.07101	0.056434	0.000555	0.0209127	0.978533
2SLS	10.73530	0.056403	0.000000	0.001993	0.998007
OLSAUT01	4.411317	0.021687	0.000000	0.001294	0.998706
2SLSAUT01	3.975568	0.020700	0.000000	0.001292	0.998708
OLSAUT02	4.410876	0.021667	0.000000	0.001929	0.998071
2SLSAUT02	3.972960	0.020682	0.000000	0.01397	0.986023

Table 5.11: Forecast Evaluation for Capacity Utilization Rate

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	4.934658	0.031946	0.000000	0.594863	0.405137
2SLS	4.933835	0.031946	0.000000	0.591935	0.408065
OLSAUT01	3.614183	0.022130	0.000000	0.155915	0.844085
2SLSAUT01	3.620830	0.022132	0.000000	0.157236	0.842764
OLSAUT02	3.633738	0.021993	0.000000	0.135686	0.864314
2SLSAUT02	3.621763	0.021988	0.000000	0.137055	0.862945

Table 5.12: Forecast Evaluation for Real Exchange Rate

Estimator	Mean Absolute Percent Error	Theil's Inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
OLS	8.220448	0.040245	0.005871	0.007965	0.986164
2SLS	7.934232	0.039726	0.000001	0.000329	0.99967
OLSAUT01	2.37092	0.015638	0.000000	0.183827	0.816172
2SLSAUT01	2.0477416	0.013855	0.000000	0.183226	0.816774
OLSAUT02	2.347577	0.015633	0.000000	0.085667	0.914333
2SLSAUT02	2.033071	0.013852	0.000000	0.087638	0.912362

CHAPTER SIX

SUMMARY AND CONCULUSIONS

6.1 Conclusions

This research work is an attempt to select the best and accurate estimator among various estimators which posses high power of predictability (forecasting power). The results in this section indicate that considerable gain in forecasting accuracy can be achieved by the use of more advanced estimation techniques. Certainly, accounting for first- and second-order serial correlation is important, and even more gain appears possible by using a two stage least squares techniques as opposed to its ordinary least squares counterpart. Moreover, the results do indicate that series attempts should be made to estimate models by techniques other than ordinary least squares or two-stage least squares. The results also indicate that considerable gain can be achieved by using 2SLSAUT01 and 2SLSAUT02 estimators. Although a multi-period forecast is not included in this study, the results give an indication of the relative usefulness of the various estimators for multi-period forecasting purposes.

6.2 Recommendations

- More work on this area is needed to see if any of the conclusions need modification when outside-sample predictions are or system estimation techniques are considered. In general, however, the results do indicate that considerable forecasting accuracy can be achieved by using more complicated techniques than simple ordinary least squares or two-stage least squares to estimate macroeconomic models.

- Further researchers who want to work on this topic are advised to estimate the parameters of a macro model either using single equation estimator or systems of equation techniques. When we use systems of equation method, one can not estimate the whole model's parameters in one system. Rather what we can do is to estimate the system block by block, if that is not possible at all. Once all the parameters are estimated, we combine all the equations together to form our full macro model. Now, one practical problem that arises is that even if the single equations or the systems of equation performed quite nicely in the first stage of our estimation, when they are combined together it is possible that they would have different dynamic structure and various interactions which in effect give us very bad overall performance of the model. When such problems arise, what we mostly do is to trace which equation is disturbing the whole relationship and try to re-estimate that particular equation. This process is what is mostly referred as model calibration. In this calibration process, you may combine different single equation estimations techniques to get an overall good fit of your macro model.

6.3 Policy Implications

Based on the finding of this study the following policy implications may be drawn.

- The main contribution of this study lies on the application of econometric methods to identify the best estimation techniques that will produce accurate forecast using macroeconomic model of Ethiopia. Although the model is capable in identifying the best estimation techniques that will produce accurate forecast, the model is in the aggregate form (i.e. further disaggregation is necessary), so it would be more interesting if the model is disaggregated in agricultural, industrial and service sectors. Inclusion of the labor market, disaggregating government expenditures by activities, and disaggregating the production activity in detail would give a better shape for the model. By doing this better performance could be highlighted.

- Well organized and updated data should be available in all organizations and institutions in general and key organizations and institutions like Central Statistical Authority, National Bank of Ethiopia and Ministry of Finance and Economic development, where information about the country is found in particular. These ready made data should be easily available for researchers and hence, concerned bodies should have to take some measures to solve the problem related to availability of data. The same data should be reported to different organizations and institutions. This will reduce the problem of deviations in information from institution to institution.

- Technocrats in ministries of finance and economic development have to focus on the task of macroeconomic forecasting which is of increasing importance in the context of poverty reduction strategies and MTEF preparation. In addition to this, strengthening the existing practice of forecasting in Ethiopia is important by providing these technocrats with an applicable framework of modeling that emphasizes forecasting using familiar software such as STATA and EViews.

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Appendix A : Definition of variables

CUR	Capacity utilization rate
Δ	Change
EMs	Excess money supply over money demand, measured as the difference between money supply and the estimated money supply.
F	Foreign financial flows (grants + loan and credits)
FD	Fiscal deficit
G	Government expenditure
GSp	Net sales of government interest bearing assets to the non-bank private sector
Ig	Nominal government investment
ΔK	Change in capital stock –i.e gross fixed capital formation
Lagr	Labour force in agriculture
Lnagr	Labour in non-agricultural sector
Ms	Money supply
NS	Net service export
NTR	Government non-tax revenue
OGR	other government revenue
OPEN	Openness measured as export and imports as a ratio of GDP
PB	Public borrowing (domestic)
Pm	Import price
Pt	Price level measured by the CPI
Pagr/Pnagr	Price ratio of agricultural and nonagricultural product
π	Inflation rate
r	Real deposit interest rate
RAD	Real aggregate demand
RCONSg	Real government consumption
RCpt	Real private consumption expenditure
RED	Real excess demand
RER	Real exchange rate
RF	Rainfall
RIg	Real government investment expenditure
RIpt	Real private investment
RYt	Real output
TB	Trade balance
TGE	Total government expenditure
TGR	Total government revenue
TOT	Terms of trade
TR	Government tax revenue
X	Exports
Yagr	Agricultural output
Ynagr	Non-agricultural output
Z	Total imports
Zcons	Import of consumers' good
Zothers	Other imports (i.e. Z- Zcons –Zrac)
Zrac	Import raw material and capital goods (intermediate imports)

Appendix B: The Augmented Dickey-Fuller and Phillips and Perron Test (levels) Results

No	Variables	Specification	ADF	PP	Test Critical Values 1%	5%	10%
1	ΔR	WC	-6.924280	-5.574262	-3.6353	-2.9499	-2.6133
		WCT	-6.780661	-5.394086	-4.2505	-3.5468	-3.2056
		WOCT	-7.042992	-5.718008	-2.6321	-1.9510	-1.6209
		WC	-6.162152	-5.472634	-3.6496	-2.9558	-2.6164
2	LogCUR	WCT	-6.557113	-5.727755	-4.2712	-3.5562	-3.2109
		WOCT	-6.241083	-5.554699	-2.6369	-1.9517	-1.6213
		WC	-7.635358	-10.02120	-3.5572	-2.9167	-2.5958
3	LogF	WCT	-7.565378	-9.911424	-4.1383	-3.4952	-3.1762
		WOCT	-6.841790	-9.121412	-2.6064	-1.9468	-1.6190
		WC	-6.273385	-7.578366	-3.5572	-2.9167	-2.5958
4	LogG	WCT	-6.241733	-7.504642	-4.1383	-3.4952	-3.1762
		WOCT	-3.480386	-5.253828	-2.6064	-1.9468	-1.6190
		WC	-4.633463	-5.667312	-3.6496	-2.9558	-2.6164
5	LogIg	WCT	-4.552605	-5.566385	-4.2712	-3.5562	-3.2109
		WOCT	-3.009050	-4.186896	-2.6369	-1.9517	-1.6213
		WC	-4.504012	-12.04505	-3.6496	-2.9558	-2.6164
6	LogIp	WCT	-4.517732	-12.17863	-4.2712	-3.5562	-3.2109
		WOCT	-3.681923	-9.498302	-2.6369	-1.9517	-1.6213
		WC	-4.563264	-5.845794	-3.5973	-2.9339	-2.6048
7	LogOPEN	WCT	-4.542821	-5.799719	-4.1958	-3.5217	-3.1914
		WOCT	-4.502078	-5.819558	-2.6196	-1.9490	-1.6200
		WC	-4.093633	-4.863075	-3.6496	-2.9558	-2.6164
8	LogPB	WCT	-4.468406	-5.084522	-4.2712	-3.5562	-3.2109
		WOCT	-3.063900	-4.046764	-2.6369	-1.9517	-1.6213
		WC	-4.627024	-1.862670	-3.6289	-2.9472	-2.6118
9	$LogP^m$	WCT	-4.495436	-1.873265	-4.2412	-3.5426	-3.2032
		WOCT	-4.248843	-1.720059	-2.6300	-1.9507	-1.6208
		WC	-5.452426	-7.417983	-3.6496	-2.9558	-2.6164
10	π	WCT	-5.386794	-7.345896	-4.2712	-3.5562	-3.2109
		WOCT	-5.534489	-7.531219	-2.6369	-1.9517	-1.6213
		WC	-5.452070	-4.668273	-3.6353	-2.9499	-2.6133
11	LogR	WCT	-5.464567	-4.592972	-4.2505	-3.5468	-3.2056
		WOCT	-5.528678	-4.761680	-2.6321	-1.9510	-1.6209

		WC	-5.507401	-7.239299	-3.6496	-2.9558	-2.6164
12	r	WCT	-5.411595	-7.120925	-4.2712	-3.5562	-3.2109
		WOCT	-5.579766	-7.338133	-2.6369	-1.9517	-1.6213
13	RCONs	WC	-4.569837	-4.005230	-3.6496	-2.9558	-2.6164
		WCT	-4.564491	-3.885024	-4.2712	-3.5562	-3.2109
		WOCT	-4.243646	-3.896324	-2.6369	-1.9517	-1.6213
		WC	-3.802985	-5.609366	-3.6496	-2.9558	-2.6164
14	LogRCp	WCT	-4.469496	-6.116210	-4.2712	-3.5562	-3.2109
		WOCT	-3.843145	-5.661929	-2.6369	-1.9517	-1.6213
		WC	-4.431596	-7.013610	-3.6496	-2.9558	-2.6164
15	LogRED	WCT	-4.810096	-7.329147	-4.2712	-3.5562	-3.2109
		WOCT	-4.476347	-7.110090	-2.6369	-1.9517	-1.6213
		WC	-4.230652	-7.394210	-3.5523	-2.9146	-2.5947
16	LogRER	WCT	-4.487830	-7.672726	-4.1314	-3.4919	-3.1744
		WOCT	-4.084138	-7.248276	-2.6048	-1.9465	-1.6189
		WC	-5.330221	-10.11363	-3.6496	-2.9558	-2.6164
17	LogRF	WCT	-5.341062	-10.26854	-4.2712	-3.5562	-3.2109
		WOCT	-5.445969	-10.30814	-2.6369	-1.9517	-1.6213
18	LogRIg	WC	-5.254117	-4.713386	-3.6496	-2.9558	-2.6164
		WCT	-5.158230	-4.620006	-4.2712	-3.5562	-3.2109
		WOCT	-4.256231	-4.142999	-2.6369	-1.9517	-1.6213
		WC	-4.077855	-6.831539	-3.6496	-2.9558	-2.6164
19	LogRY	WCT	-4.780955	-7.480658	-4.2712	-3.5562	-3.2109
		WOCT	-4.074675	-6.780285	-2.6369	-1.9517	-1.6213
		WC	-7.130183	-6.488560	-3.6496	-2.9558	-2.6164
20	LogYagr	WCT	-7.153358	-6.451555	-4.2712	-3.5562	-3.2109
		WOCT	-6.636959	-6.097517	-2.6369	-1.9517	-1.6213
		WC	-5.042349	-7.150442	-3.6496	-2.9558	-2.6164
21	LogYnagr	WCT	-5.625016	-7.690702	-4.2712	-3.5562	-3.2109
		WOCT	-5.107956	-7.227011	-2.6369	-1.9517	-1.6213
		WC	-4.674885	-5.876095	-3.6353	-2.9499	-2.6133
22	LogZcons	WCT	-4.771310	-6.034600	-4.2505	-3.5468	-3.2056
		WOCT	-3.208595	-4.692427	-2.6321	-1.9510	-1.6209
23		WC	-3.874971	-4.426706	-3.6496	-2.9558	-2.6164
	RIg	WCT	-4.633582	-4.917490	-4.2712	-3.5562	-3.2109
		WOCT	-3.131713	-3.878876	-2.6369	-1.9517	-1.6213

Appendix C: The Augmented Dickey-Fuller and Phillips and Perron Test (first difference) Results for Non-Stationarity of Variables on levels

No	Variables	Specification	ADF	PP	Test Critical Values		
					1%	5%	10%
1		WC	-7.159763	-9.119965	-3.6576	-2.9591	-2.6181
	DCp	WCT	-7.129714	-8.879608	-4.2826	-3.5614	-3.2138
		WOCT	-7.302467	-9.291113	-2.6395	-1.9521	-1.6214
2		WC	-5.418734	-9.330341	-3.6576	-2.9591	-2.6181
	FD	WCT	-5.482676	-9.476205	-4.2826	-3.5614	-3.2138
		WOCT	-5.384863	-9.261261	-2.6395	-1.9521	-1.6214
3		WC	-5.538943	-9.338637	-3.6576	-2.9591	-2.6181
	GSp	WCT	-5.591671	-9.469795	-4.2826	-3.5614	-3.2138
		WOCT	-5.511085	-9.279457	-2.6395	-1.9521	-1.6214
4		WC	-5.427353	-15.50234	-3.6576	-2.9591	-2.6181
	LogΔK	WCT	-5.325295	-15.21846	-4.2826	-3.5614	-3.2138
		WOCT	-5.515159	-15.75002	-2.6395	-1.9521	-1.6214
		WC	-5.494221	-13.21980	-3.6228	-2.9446	-2.6105
5	LogLagr	WCT	-5.715806	-13.98228	-4.2324	-3.5386	-3.2009
		WOCT	-5.571059	-13.39520	-2.6280	-1.9504	-1.6206
		WC	-5.662219	-13.34361	-3.6289	-2.9472	-2.6118
6	LogLnagr	WCT	-5.584383	-13.24303	-4.2412	-3.5426	-3.2032
		WOCT	-5.743694	-13.49990	-2.6300	-1.9507	-1.6208
7		WC	-7.176049	-14.12719	-3.6576	-2.9591	-2.6181
	Ms	WCT	-7.076686	-13.75928	-4.2826	-3.5614	-3.2138
		WOCT	-7.219202	-14.10003	-2.6395	-1.9521	-1.6214
8	NTR	WC	-5.674874	-10.15760	-3.6576	-2.9591	-2.6181
		WCT	-5.586429	-10.00705	-4.2826	-3.5614	-3.2138
		WOCT	-5.774004	-10.35189	-2.6395	-1.9521	-1.6214
		WC	-5.803495	-7.841673	-3.6576	-2.9591	-2.6181
9	P	WCT	-5.701064	-7.691173	-4.2826	-3.5614	-3.2138
		WOCT	-5.860124	-7.930679	-2.6395	-1.9521	-1.6214
10		WC	-4.735508	-12.09259	-3.6576	-2.9591	-2.6181
	RAD	WCT	-4.643364	-11.88656	-4.2826	-3.5614	-3.2138
		WOCT	-4.818548	-12.30476	-2.6395	-1.9521	-1.6214
11		WC	-6.424923	-23.22621	-3.6576	-2.9591	-2.6181
	LogRIp	WCT	-6.307133	-22.82291	-4.2826	-3.5614	-3.2138
		WOCT	-6.538014	-23.63171	-2.6395	-1.9521	-1.6214

		WC	-4.876217	-7.171220	-3.6576	-2.9591	-2.6181
12	TB	WCT	-5.652554	-7.789397	-4.2826	-3.5614	-3.2138
		WOCT	-4.557152	-6.971603	-2.6395	-1.9521	-1.6214
		WC	-5.427353	-15.50234	-3.6576	-2.9591	-2.6181
13	LogTR	WCT	-5.325295	-15.21846	-4.2826	-3.5614	-3.2138
		WOCT	-5.515159	-15.75002	-2.6395	-1.9521	-1.6214
		WC	-6.117124	-13.77900	-3.6576	-2.9591	-2.6181
14	LogX	WCT	-6.007645	-13.50859	-4.2826	-3.5614	-3.2138
		WOCT	-6.219614	-14.01579	-2.6395	-1.9521	-1.6214
		WC	-5.578028	-14.09372	-3.6422	-2.9527	-2.6148
15	LogZ	WCT	-5.474004	-13.84362	-4.2605	-3.5514	-3.2081
		WOCT	-5.630742	-14.18496	-2.6344	-1.9514	-1.6211
		WC	-7.166617	-18.62601	-3.6422	-2.9527	-2.6148
16	LogZrac	WCT	-7.031311	-18.30210	-4.2605	-3.5514	-3.2081
		WOCT	-7.259374	-18.84938	-2.6344	-1.9514	-1.6211
		WC	-5.104904	-9.869227	-3.6496	-2.9558	-2.6164
17	Log(Z+X)	WCT	-5.003510	-9.662223	-4.2712	-3.5562	-3.2109
		WOCT	-5.210040	-10.02795	-2.6369	-1.9517	-1.6213
18		WC	-6.307732	-21.91780	-3.6576	-2.9591	-2.6181
	Rip	WCT	-6.194788	-21.60318	-4.2826	-3.5614	-3.2138
		WOCT	-6.413307	-22.27275	-2.6395	-1.9521	-1.6214

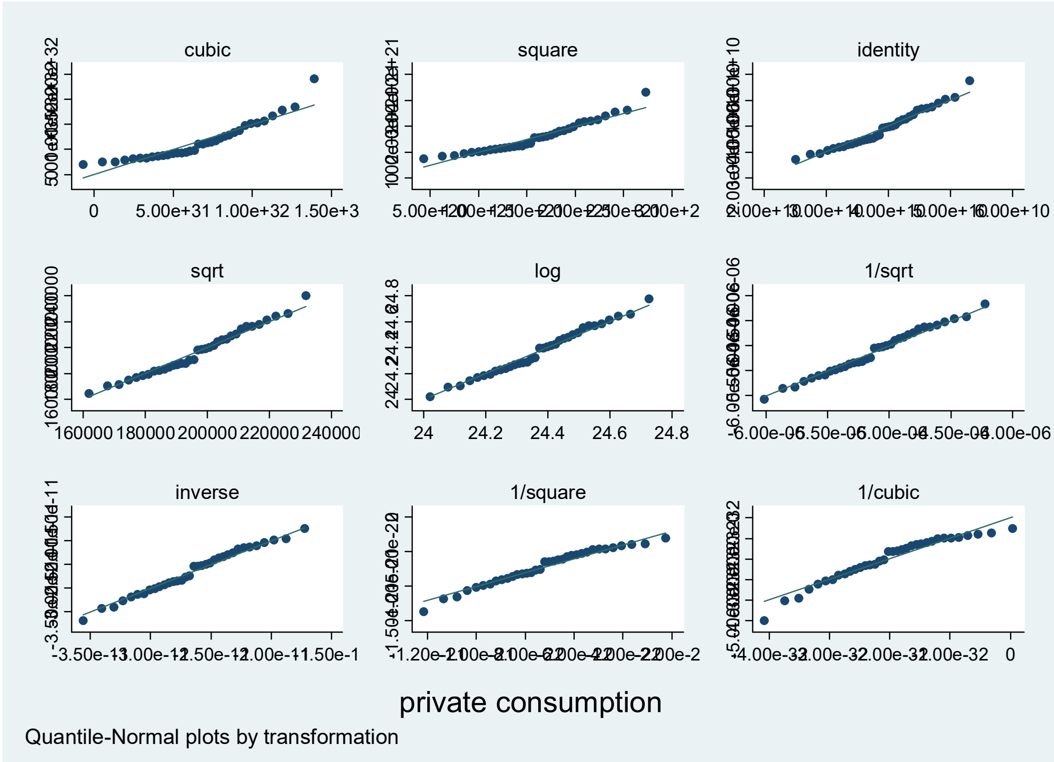
Where WC = with constant

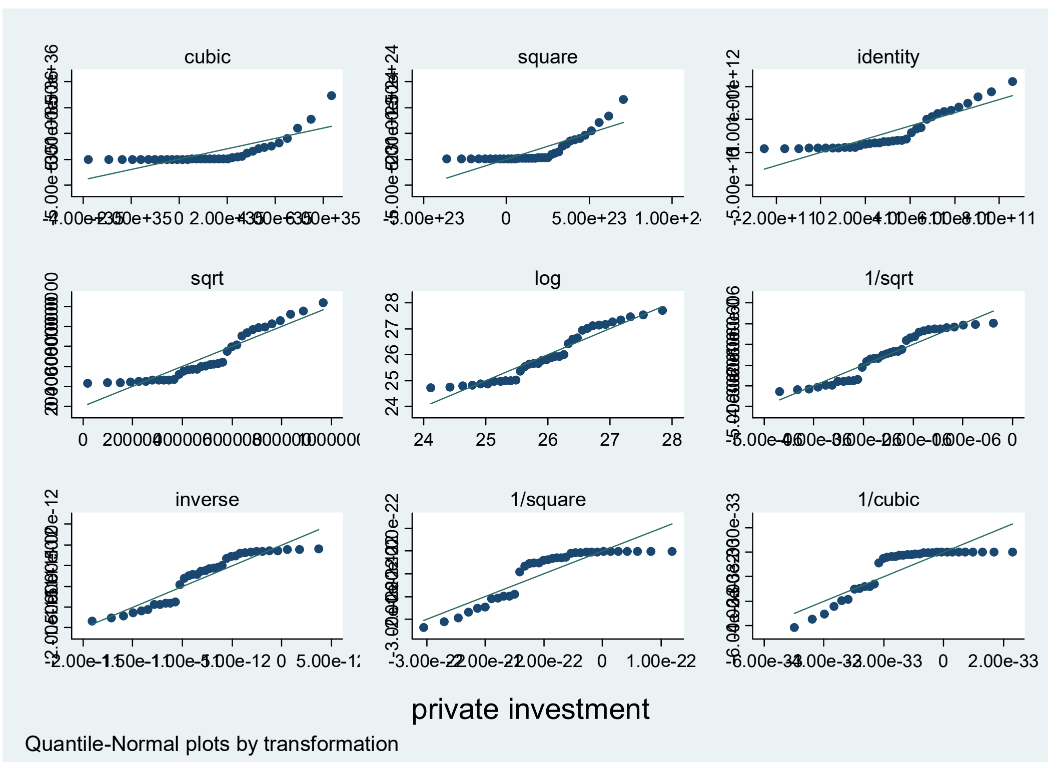
WCT = with constant and trend

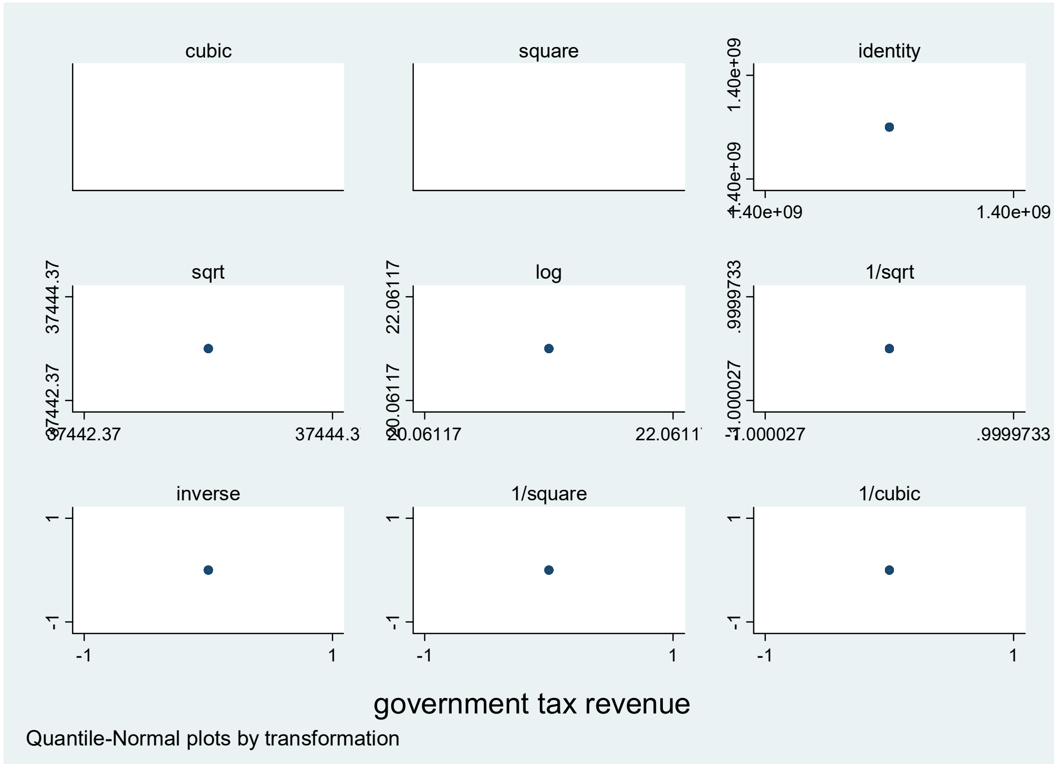
WOCT = with out constant and trend

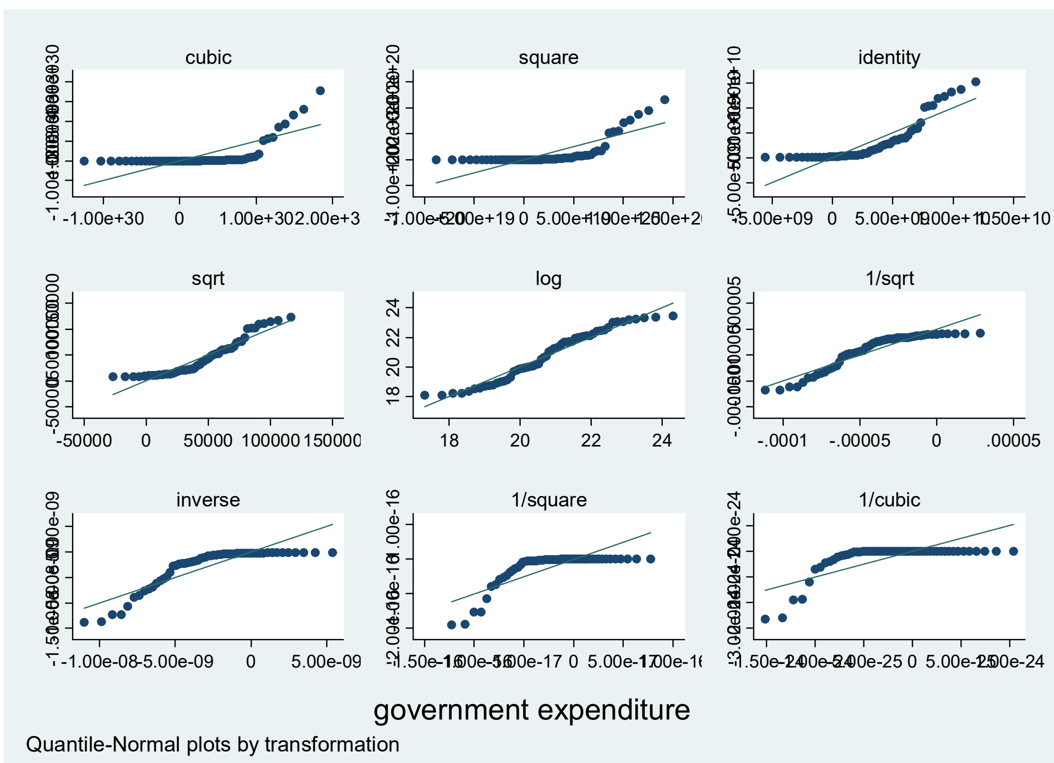
Δ = Difference operator

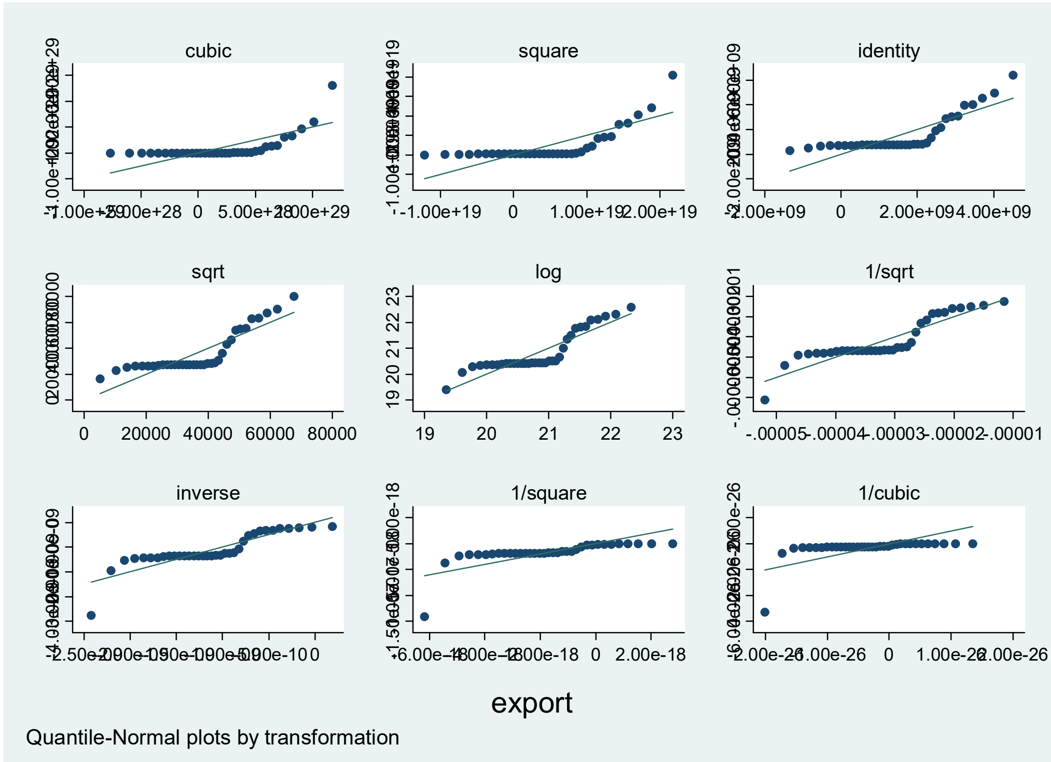
Appendix D : Normality Transformation

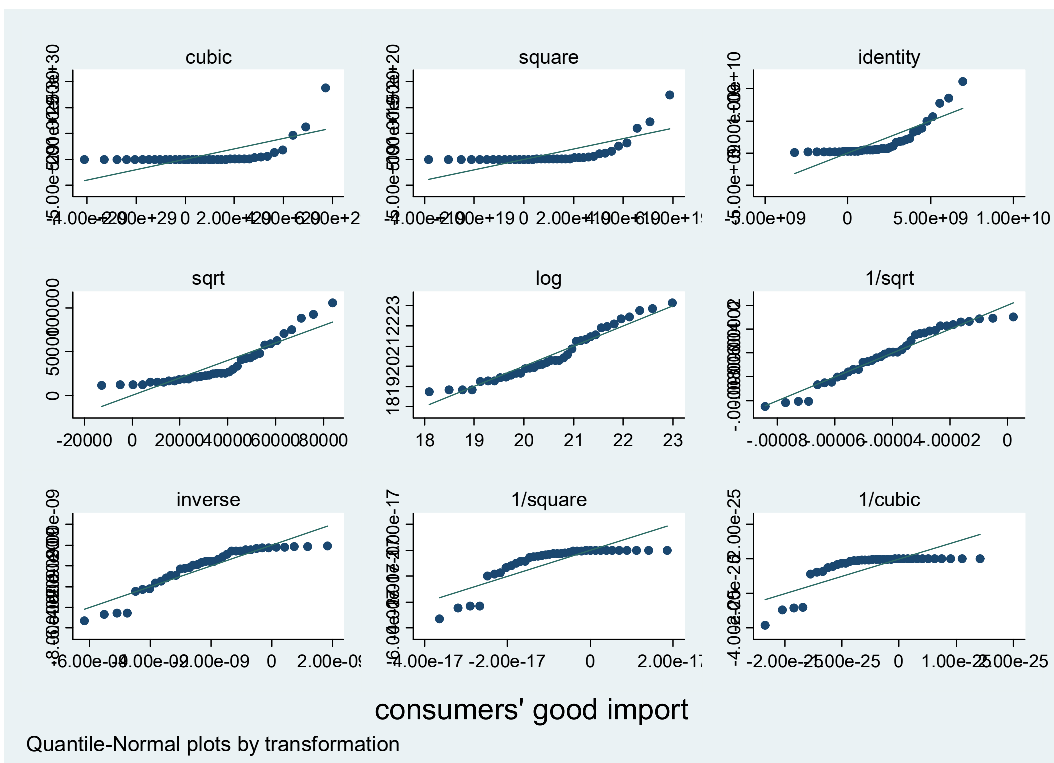


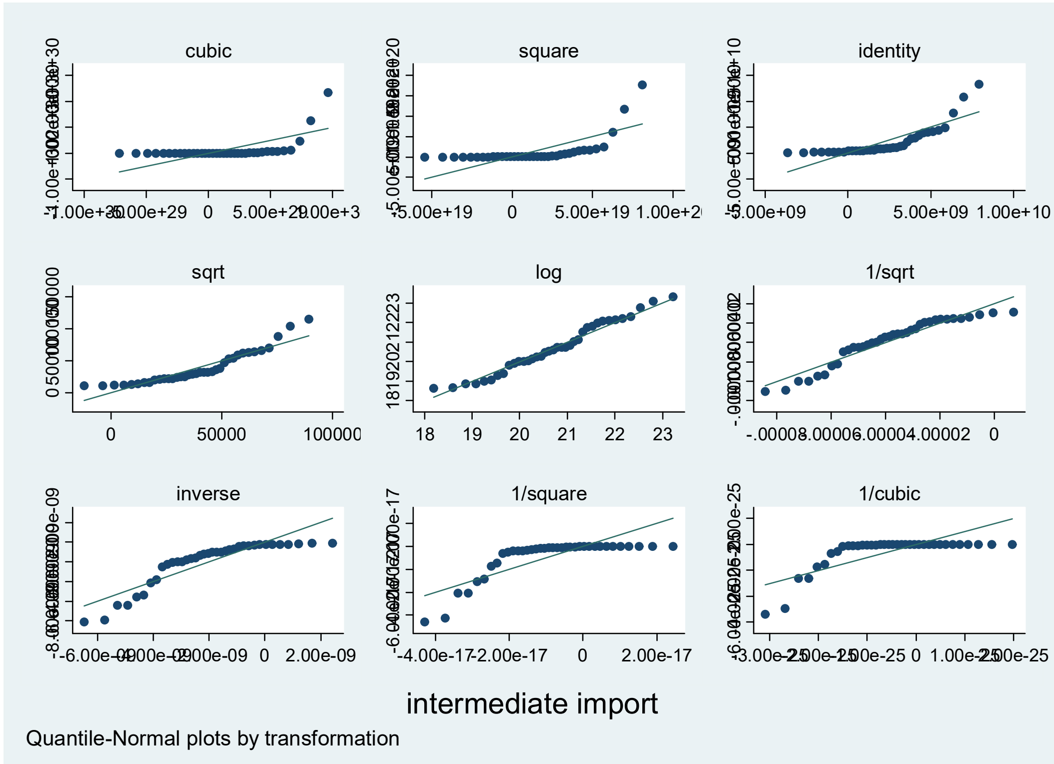


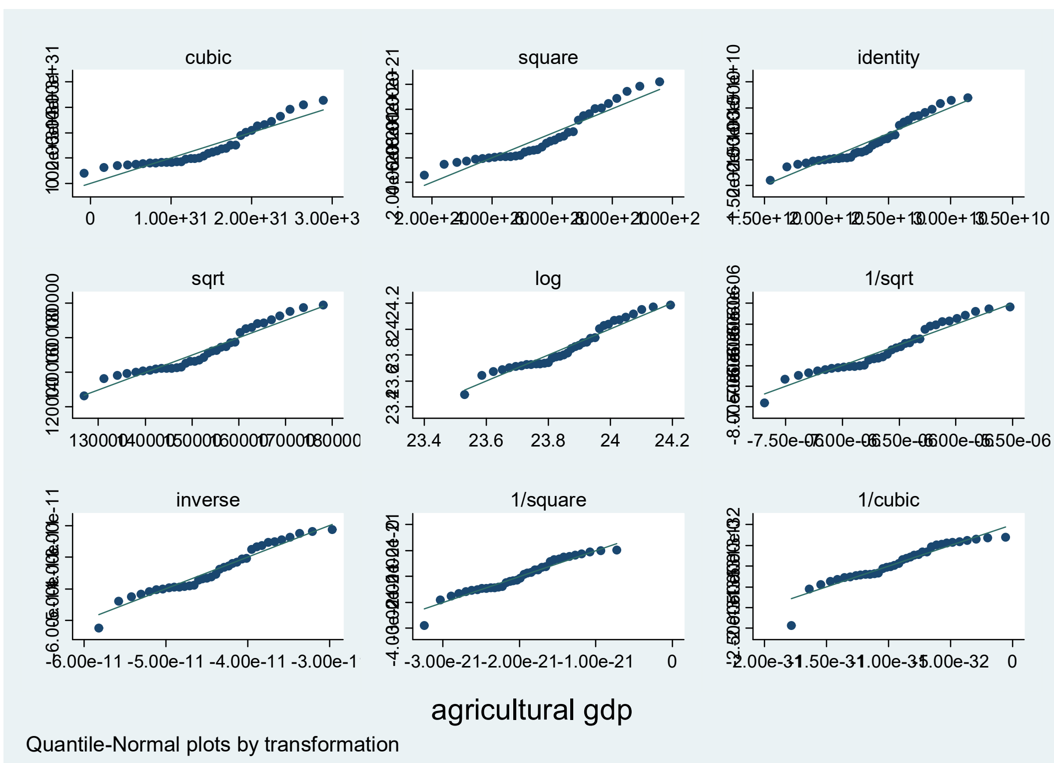

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
government tax revenue
Quantile-Normal plots by transformation

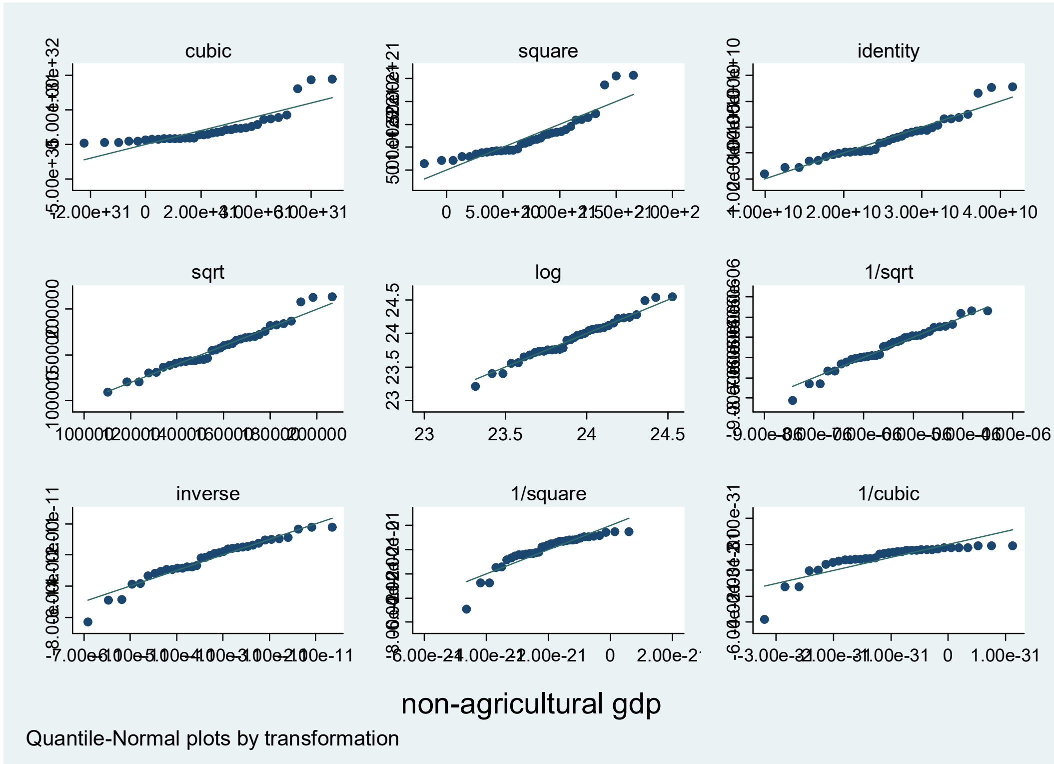

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
government expenditure
Quantile-Normal plots by transformation

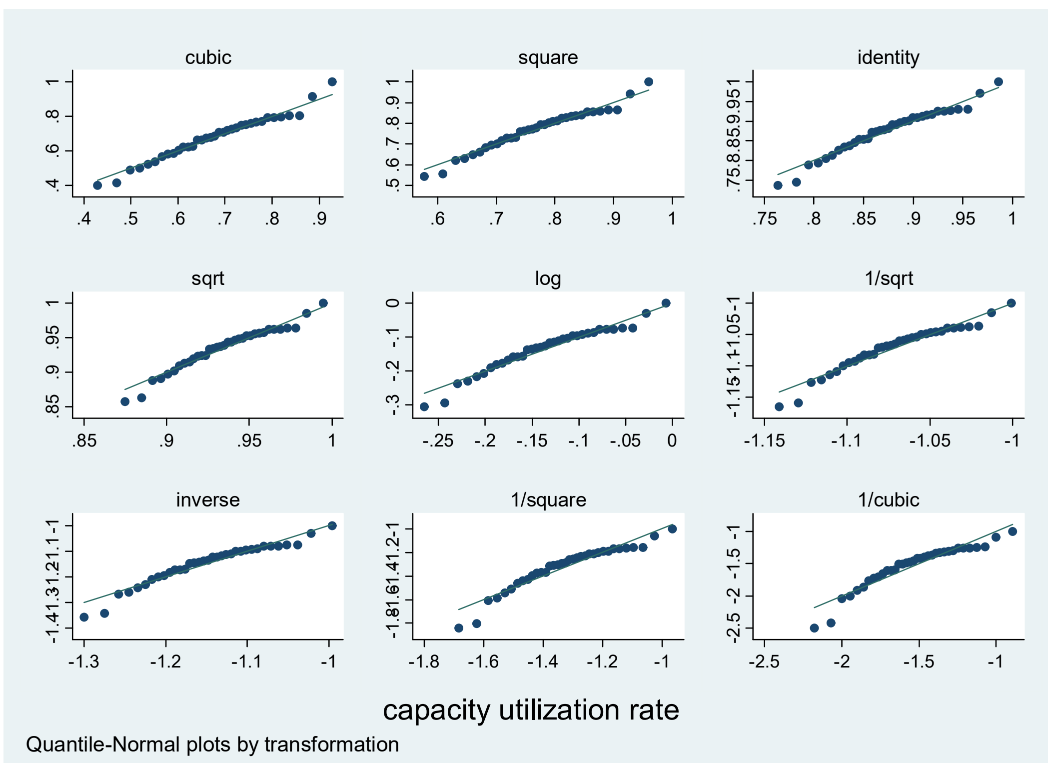

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
export
Quantile-Normal plots by transformation

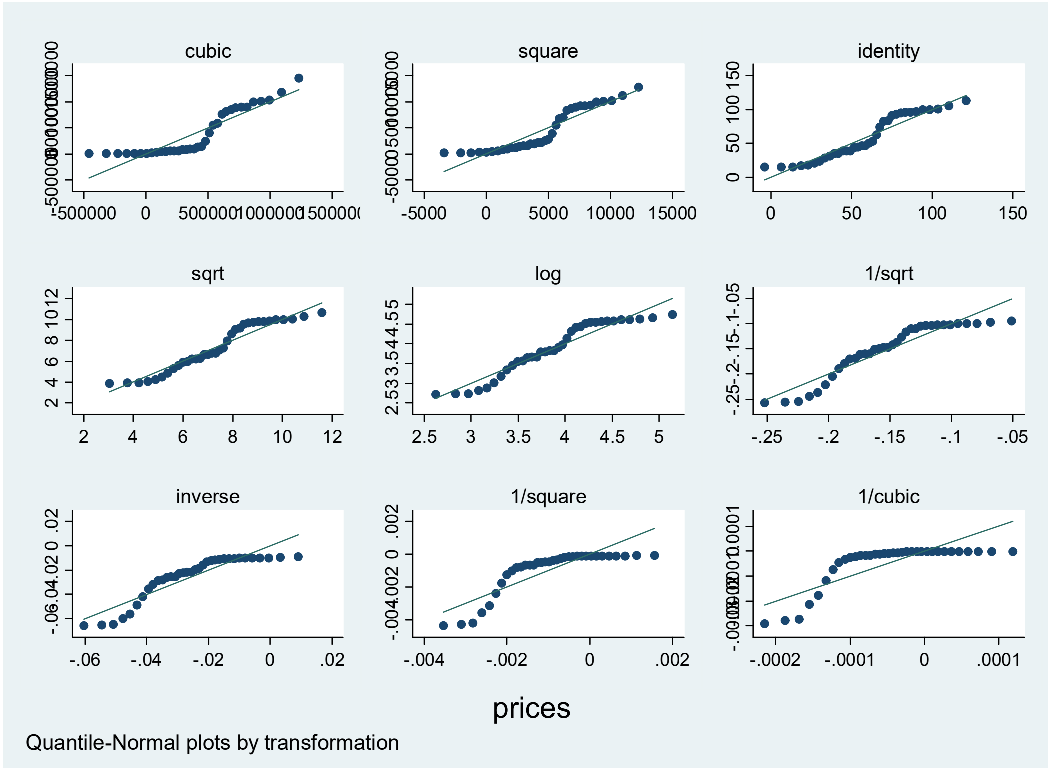

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
consumers' good import
Quantile-Normal plots by transformation

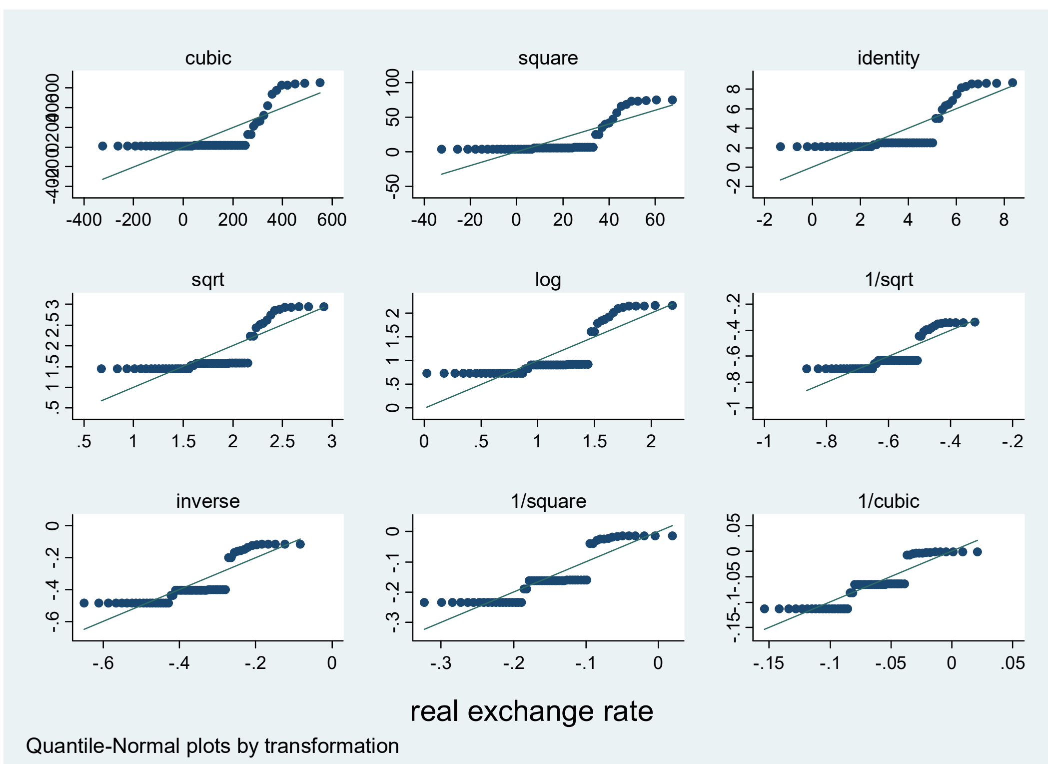

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
intermediate import
Quantile-Normal plots by transformation


cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
agricultural gdp
Quantile-Normal plots by transformation


cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
non-agricultural gdp
Quantile-Normal plots by transformation

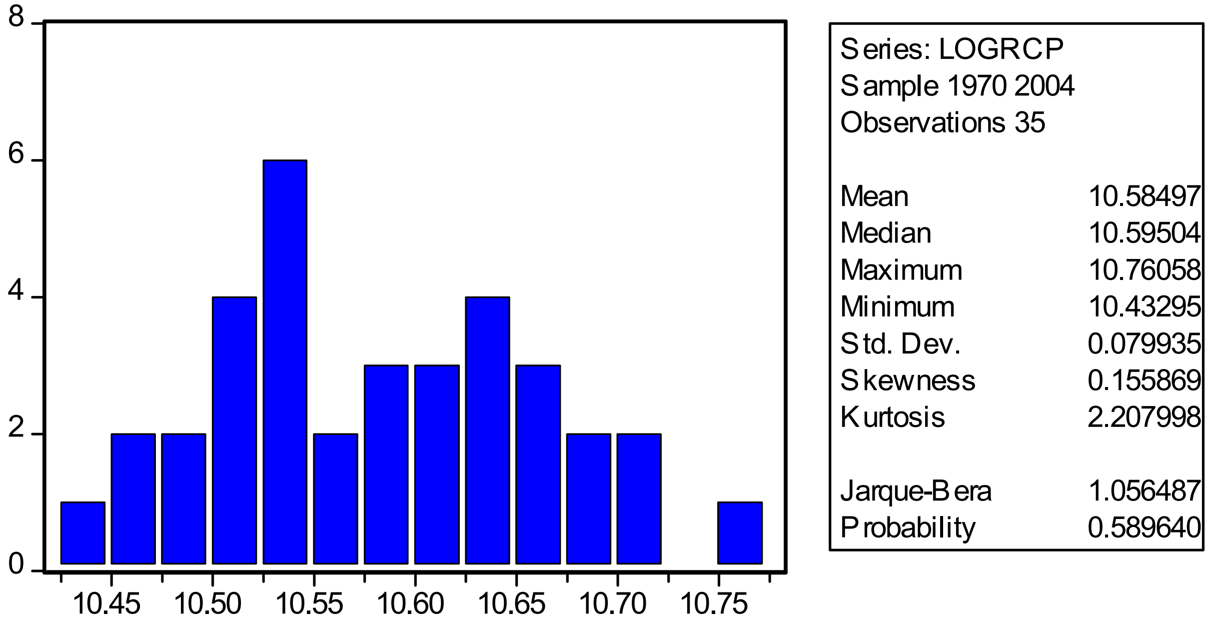

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
capacity utilization rate
Quantile-Normal plots by transformation


cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
prices
Quantile-Normal plots by transformation

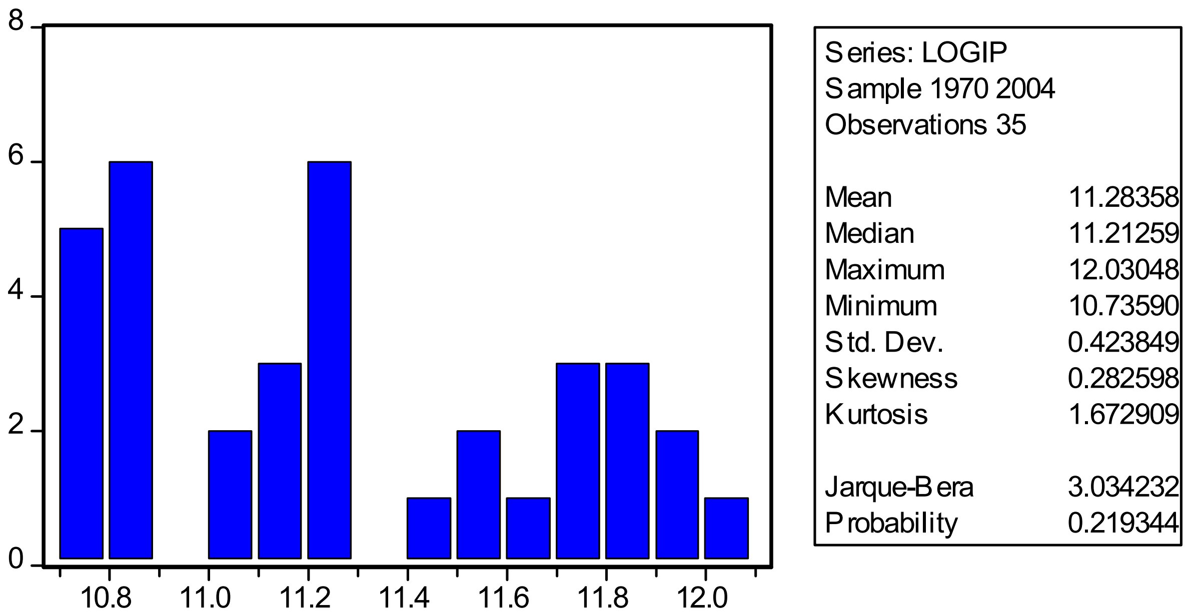

cubic
square
identity
sqrt
log
1/sqrt
inverse
1/square
1/cubic
real exchange rate
Quantile-Normal plots by transformation

Appendix E: Normality test

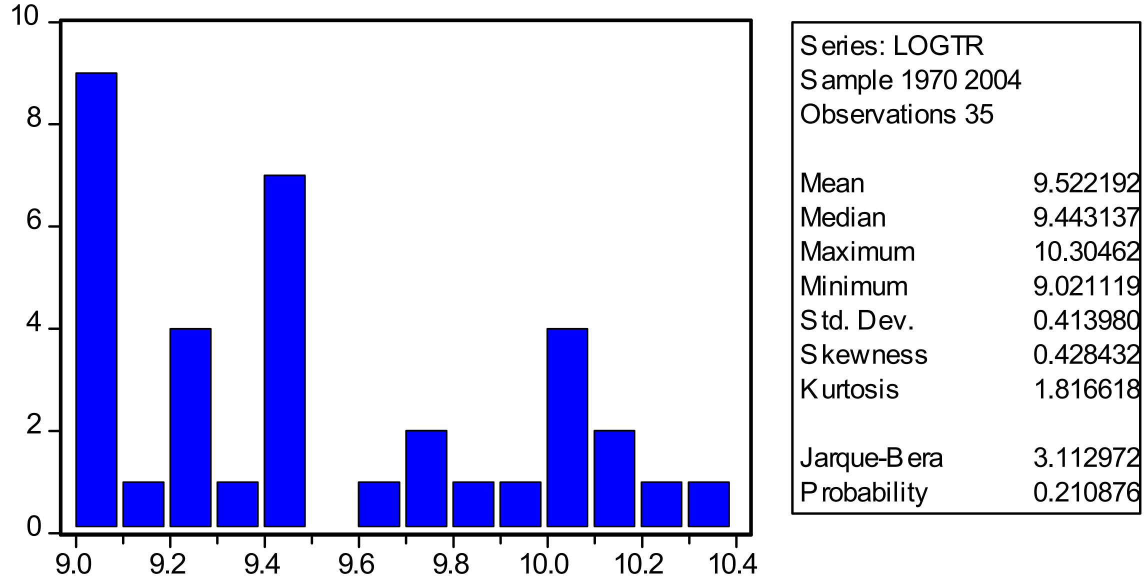
1. Private Consumption



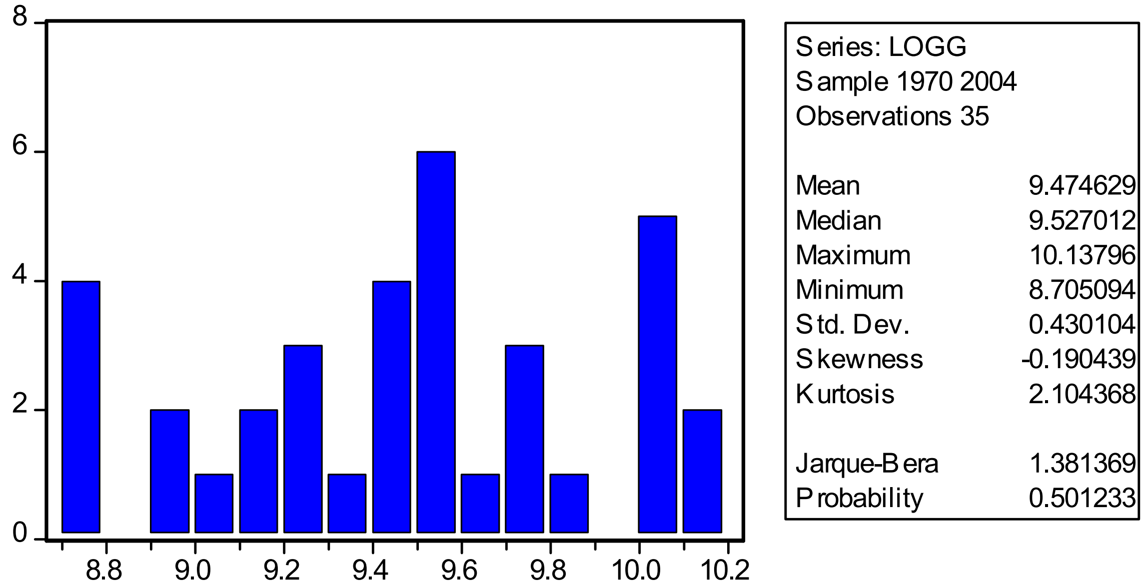
2.Private Investment



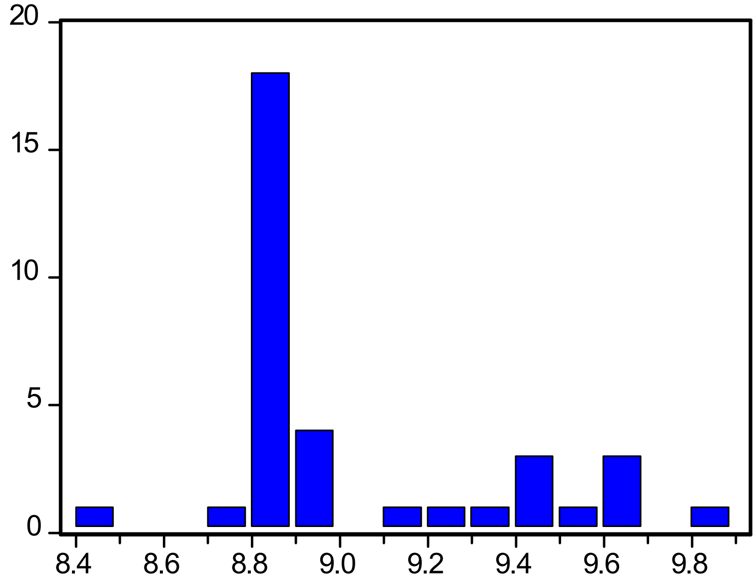
3. Tax Revenue



4. Government Expenditure

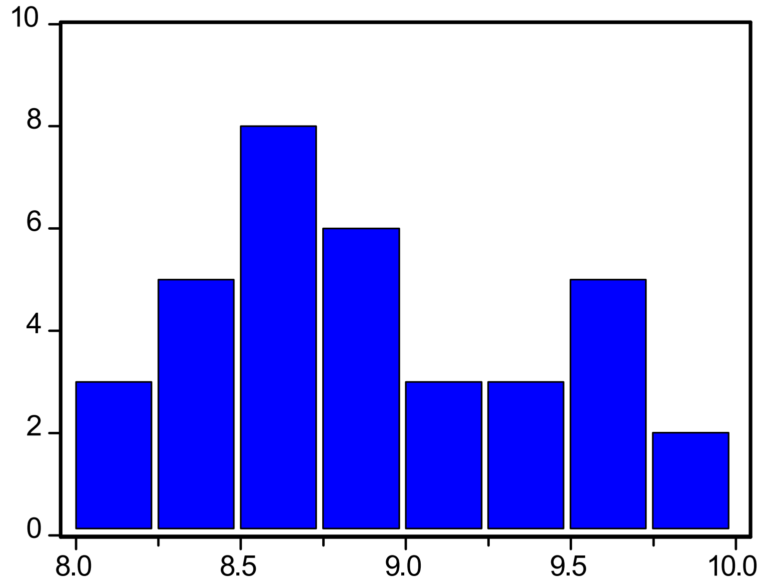


5. Export



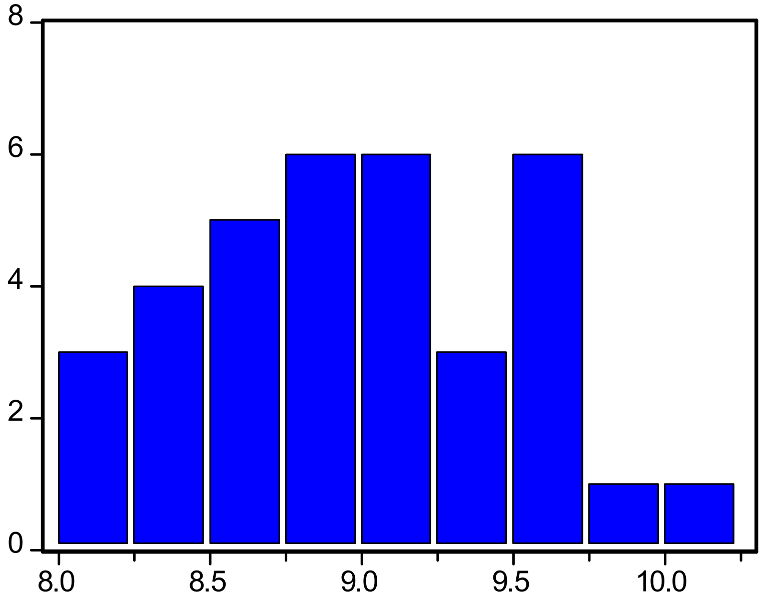
Series: LOGX	
Sample 1970 2004	
Observations 35	
Mean	9.052478
Median	8.872116
Maximum	9.805563
Minimum	8.425339
Std. Dev.	0.337042
Skewness	0.839208
Kurtosis	2.592461
Jarque-Bera	4.350455
Probability	0.113582

6. Consumers' Import



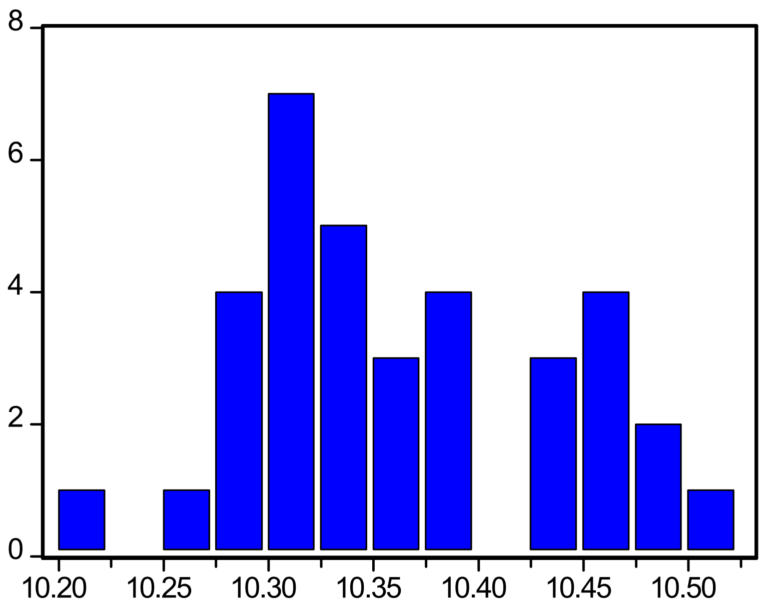
Series: LOGZCONS	
Sample 1970 2004	
Observations 35	
Mean	8.910529
Median	8.807893
Maximum	9.931046
Minimum	8.138618
Std. Dev.	0.515369
Skewness	0.431700
Kurtosis	2.085396
Jarque-Bera	2.307027
Probability	0.315526

7. Intermediate Import



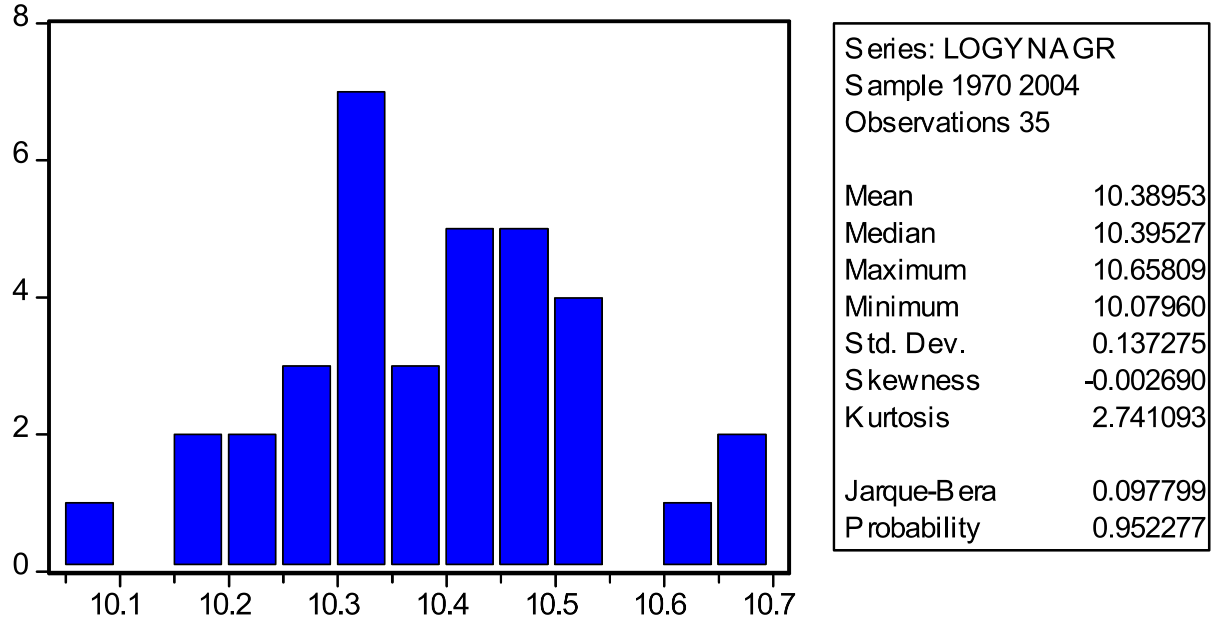
Series: LOGZRAC	
Sample 1970 2004	
Observations 35	
Mean	8.981902
Median	8.943099
Maximum	10.03349
Minimum	8.089552
Std. Dev.	0.529311
Skewness	0.104165
Kurtosis	2.104515
Jarque-Bera	1.232721
Probability	0.539906

8. Agricultural Production

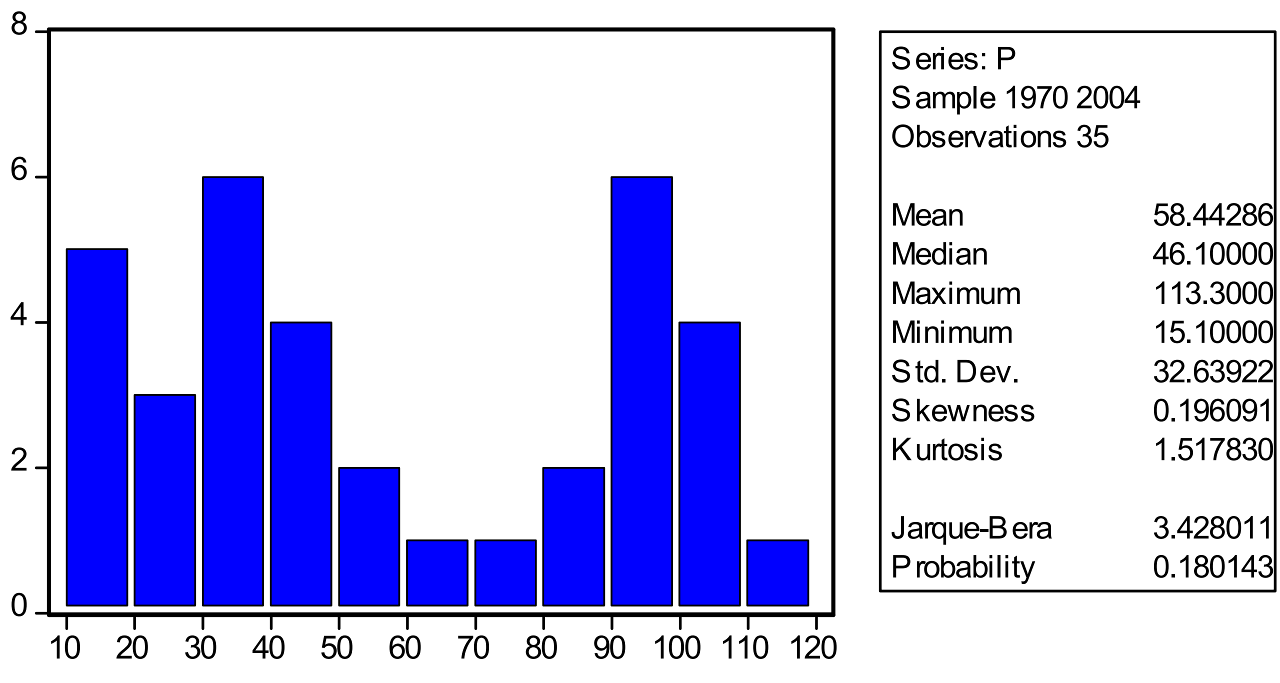


Series: LOGYAGR	
Sample 1970 2004	
Observations 35	
Mean	10.36331
Median	10.34386
Maximum	10.50486
Minimum	10.20461
Std. Dev.	0.075222
Skewness	0.294725
Kurtosis	2.210536
Jarque-Bera	1.415612
Probability	0.492724

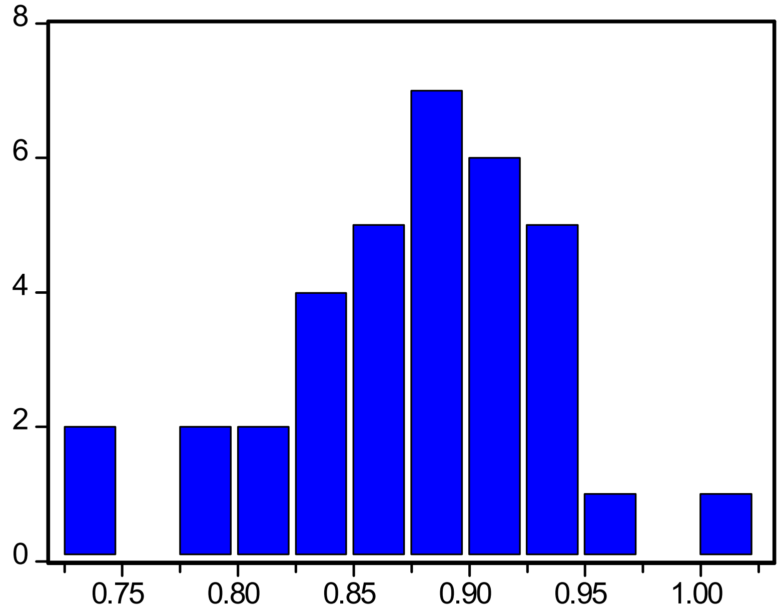
9. Non-Agricultural Production



10. Price

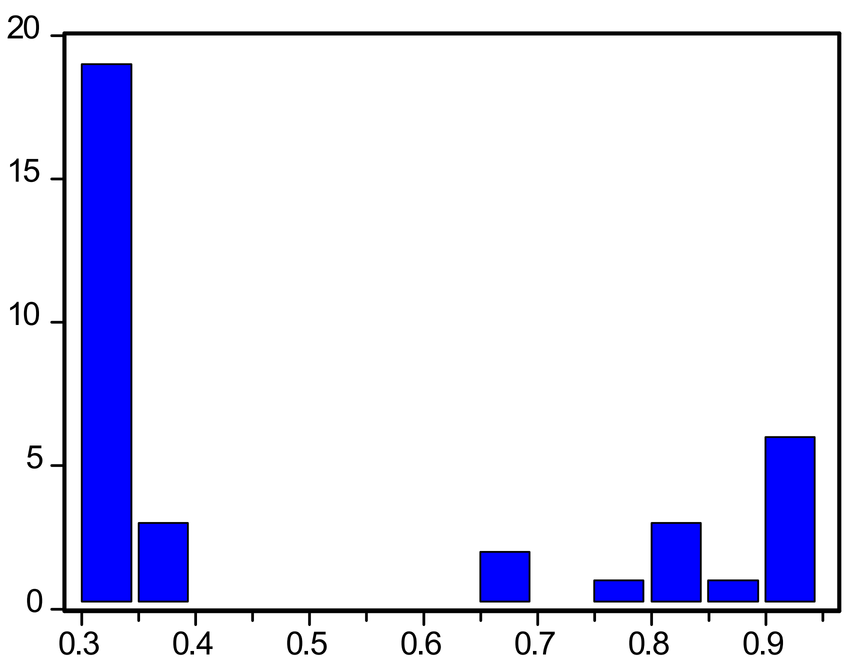


11. Capacity Utilization Rate



Series: LogCUR	
Sample 1970 2004	
Observations 35	
Mean	0.874801
Median	0.881320
Maximum	1.000010
Minimum	0.736530
Std. Dev.	0.057964
Skewness	-0.449136
Kurtosis	3.154933
Jarque-Bera	1.211726
Probability	0.545603

12. Real Exchange Rate



Series: LOGRER	
Sample 1970 2004	
Observations 35	
Mean	0.519594
Median	0.315970
Maximum	0.937016
Minimum	0.315970
Std. Dev.	0.264145
Skewness	0.632268
Kurtosis	1.537265
Jarque-Bera	5.452188
Probability	0.065475

Appendix F: Variance Inflation Factor Results

1. Private consumption

Variable	VIF	1/VIF
logRCp(-1)	2.37	0.422511
logRY(-1)	1.97	0.506816
P	1.59	0.627207
logRY	1.54	0.650469
Mean VIF	1.87	

2. Private investment

Variable	VIF	1/VIF
Log Ig	28.54	0.035044
LogZrac	18.91	0.052891
Logpb	8.4	0.119020
Δlogry	1.06	0.945241
Mean VIF	14.23	

3. Tax revenue

Variable	VIF	1/VIF
Log(x+z)	7.88	0.126897
logF	5.13	0.194763
logRY	2.39	0.418947
Mean VIF	5.13	

4. Government expenditure

Variable	VIF	1/VIF
LogTR	6.48	0.154380
LogF	5.66	0.176577
LogPm	4.40	0.227072
LogG(-1)	1.19	0.840772
Mean VIF	4.43	

5. Export

Variable	VIF	1/VIF
LogRY	2.71	0.369638
LogRER	2.38	0.420366
LogCUR	1.24	0.807186
Mean VIF	2.11	

6. Consumers import

Variable	VIF	1/VIF
LogRER	2.35	0.426424
LogRY	2.33	0.429497
LogR(-1)	1.12	0.892360
LogZcons(-1)	1.12	0.892607
Mean VIF	1.73	

7. Intermediate Import

Variable	VIF	1/VIF
LogRER	2.30	0.434673
LogRY	2.30	0.434965
LogR(-1)	1.03	0.974639
LogZrac(-1)	1.03	0.974639
Mean VIF	1.66	

8. Agricultural production

Variable	VIF	1/VIF
LogRF(-1)	1.05	0.956772
LogYagr(-1)	1.03	0.970955
LogLagr	1.02	0.976665
Mean VIF	1.03	

9. Non- Agricultural production

Variable	VIF	1/VIF
Lloglnagr	1.18	0.844410
Logcur	1.12	0.889521
LogΔk	1.11	0.898862
logzrac(-1)	1.02	0.978808
Mean VIF	1.11	

10. Price

Variable	VIF	1/VIF
LogRED	1.63	0.612700
LogPm	1.52	0.658400
LogCUR	1.12	0.895039
Mean VIF	1.42	

11. Capacity utilization Rate

Variable	VIF	1/VIF
LogRF(-1)	1.02	0.978806
LogZrac	1.02	0.978806
Mean VIF	1.02	

12. Real Exchange Rate

Variable	VIF	1/VIF
LogF	1.26	0.792046
LogOPEN	1.26	0.792046
Mean VIF	1.26	

13. Private Investment, after dropping one of multicollinear variable

Variables	VIF	1/VIF
ΔLogRY	5.61	0.178216
LogZrac	5.58	0.179148
LogPB	1.03	0.974802
Mean VIF	4.07	

Appendix G: Instrumental Variables used for 2SLS in each Equation in addition to those in the basic set

Dependent Variables	**Estimator**	**Instrumental Variables**
LogRCp	2SLS 2SLSAUT01 2SLSAUT02	LOGIg, LOGRF(-1), LOGΔK, LOGRED, LOGF, $LOGP^m$, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogIp	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGRF(-1), LOGΔK, LOGRED, LOGRY, LOGF, $LOGP^m$, LOGR(-1), r, LOGLagr, LOGLnagr, LOGRY(-1), LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogTR	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRED, $LOGP^m$, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogG	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRED, LOGRY, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogX	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRED, LOGF, $LOGP^m$, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogZcons	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRED, LOGF, $LOGP^m$, r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogZrac	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRED, LOGF, $LOGP^m$, r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1),LOGPB,LOGG(-1),LOGZCONS(-1),LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, RIg, RAD, ΔR, DCp, $G^S{}_P$.
LogYagr	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGΔK, LOGRED, LOGRY, LOGF, $LOGP^m$, LOGR(-1), r, ΔLOGRY, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGOPEN, FD, NTR, π, TB, RIg, RAD, ΔR, DCp, $G^S{}_P$.

LogYnagr	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGRED, LOGRY, LOGF, LOGP^m, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogCUR	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGΔK, LOGRED, LOGRY, LOGF, LOGP^m, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
P	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRY, LOGF, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), LOGOPEN, FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.
LogRER	2SLS 2SLSAUT01 2SLSAUT02	LOGRCp(-1), LOGIg, LOGRF(-1), LOGΔK, LOGRED, LOGRY, LOGP^m, LOGR(-1), r, ΔLOGRY, LOGLagr, LOGLnagr, LOGRY(-1), LOGPB, LOGG(-1), LOGZCONS(-1), LOGZrac(-1), LOGYagr(-1), FD, NTR, π, TB, Rig, RAD, ΔR, DCp, $G^S{}_P$.

Appendix H: Correlogram of Residuals

1. Private consumption

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>1</td><td>-0.097</td><td>-0.097</td><td>0.3463</td><td>0.556</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>2</td><td>-0.108</td><td>-0.119</td><td>0.7964</td><td>0.672</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>3</td><td>0.194</td><td>0.175</td><td>2.2779</td><td>0.517</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>4</td><td>-0.170</td><td>-0.155</td><td>3.4593</td><td>0.484</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>5</td><td>-0.115</td><td>-0.109</td><td>4.0208</td><td>0.546</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>6</td><td>-0.007</td><td>-0.098</td><td>4.0227</td><td>0.674</td></tr>
<tr><td>.**| . |</td><td>.**| . |</td><td>7</td><td>-0.289</td><td>-0.292</td><td>7.8167</td><td>0.349</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>8</td><td>-0.073</td><td>-0.155</td><td>8.0664</td><td>0.427</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>9</td><td>0.173</td><td>0.067</td><td>9.5279</td><td>0.390</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>10</td><td>-0.154</td><td>-0.127</td><td>10.735</td><td>0.379</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>11</td><td>-0.042</td><td>-0.152</td><td>10.830</td><td>0.458</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>12</td><td>0.112</td><td>-0.111</td><td>11.522</td><td>0.485</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>13</td><td>-0.011</td><td>-0.060</td><td>11.530</td><td>0.567</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>14</td><td>0.014</td><td>-0.118</td><td>11.541</td><td>0.643</td></tr>
<tr><td>. |**. |</td><td>. |**. |</td><td>15</td><td>0.294</td><td>0.216</td><td>17.121</td><td>0.312</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>16</td><td>-0.197</td><td>-0.179</td><td>19.753</td><td>0.232</td></tr>
</table>

2. Private investment

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>1</td><td>-0.181</td><td>-0.181</td><td>1.1858</td><td></td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>2</td><td>0.062</td><td>0.030</td><td>1.3275</td><td>0.249</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>3</td><td>-0.081</td><td>-0.067</td><td>1.5812</td><td>0.454</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>4</td><td>-0.073</td><td>-0.105</td><td>1.7942</td><td>0.616</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>5</td><td>-0.063</td><td>-0.093</td><td>1.9597</td><td>0.743</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>6</td><td>-0.104</td><td>-0.139</td><td>2.4234</td><td>0.788</td></tr>
<tr><td>. |**. |</td><td>. |**. |</td><td>7</td><td>0.324</td><td>0.290</td><td>7.0993</td><td>0.312</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>8</td><td>0.020</td><td>0.134</td><td>7.1179</td><td>0.417</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>9</td><td>-0.053</td><td>-0.098</td><td>7.2528</td><td>0.510</td></tr>
<tr><td>.**| . |</td><td>.**| . |</td><td>10</td><td>-0.212</td><td>-0.278</td><td>9.5098</td><td>0.392</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>11</td><td>0.115</td><td>0.106</td><td>10.209</td><td>0.422</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>12</td><td>-0.218</td><td>-0.108</td><td>12.824</td><td>0.305</td></tr>
<tr><td>. *| . |</td><td>.**| . |</td><td>13</td><td>-0.115</td><td>-0.203</td><td>13.591</td><td>0.328</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>14</td><td>0.091</td><td>-0.099</td><td>14.090</td><td>0.368</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>15</td><td>-0.007</td><td>-0.091</td><td>14.093</td><td>0.443</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>0.005</td><td>-0.038</td><td>14.094</td><td>0.518</td></tr>
</table>

3 Tax Revenue

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. *| . |	. *| . |	1	-0.081	-0.081	0.2503	0.617
. |* . |	. |* . |	2	0.078	0.072	0.4915	0.782
. |* . |	. |* . |	3	0.101	0.114	0.9068	0.824
. | . |	. | . |	4	-0.005	0.007	0.9077	0.923
. *| . |	. *| . |	5	-0.092	-0.112	1.2762	0.937
. | . |	. | . |	6	-0.004	-0.034	1.2770	0.973
. |* . |	. |* . |	7	0.137	0.158	2.1444	0.951
.**| . |	.**| . |	8	-0.299	-0.265	6.4447	0.598
. |* . |	. |* . |	9	0.135	0.084	7.3517	0.601
. |* . |	. |* . |	10	0.092	0.134	7.7915	0.649
. *| . |	. *| . |	11	-0.129	-0.101	8.6842	0.651
. | . |	. *| . |	12	-0.054	-0.101	8.8482	0.716
.**| . |	.**| . |	13	-0.190	-0.278	10.971	0.613
.**| . |	.**| . |	14	-0.227	-0.266	14.150	0.439
. | . |	. |* . |	15	-0.013	0.146	14.161	0.513
. | . |	. | . |	16	0.060	0.049	14.406	0.569

4 Government expenditure

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.035	0.035	0.0466	0.829
. *| . |	. *| . |	2	-0.144	-0.145	0.8611	0.650
. | . |	. | . |	3	-0.006	0.005	0.8626	0.834
. *| . |	.**| . |	4	-0.180	-0.206	2.2170	0.696
. |**. |	. |**. |	5	0.199	0.229	3.9237	0.560
. *| . |	. *| . |	6	-0.068	-0.177	4.1326	0.659
. *| . |	. *| . |	7	-0.164	-0.070	5.3715	0.615
. *| . |	. *| . |	8	-0.078	-0.170	5.6611	0.685
. *| . |	. | . |	9	-0.119	-0.056	6.3720	0.702
. |* . |	. | . |	10	0.144	0.035	7.4424	0.683
. |* . |	. | . |	11	0.087	0.046	7.8498	0.727
. | . |	. | . |	12	0.008	0.035	7.8536	0.796
. *| . |	. *| . |	13	-0.120	-0.165	8.6951	0.796
. *| . |	. | . |	14	-0.110	-0.049	9.4363	0.802
. | . |	. *| . |	15	0.030	-0.095	9.4962	0.850
. *| . |	. *| . |	16	-0.099	-0.161	10.162	0.858

5 Export

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |**. |	. |**. |	1	0.235	0.235	2.0964	0.148
. |* . |	. |* . |	2	0.189	0.141	3.4935	0.174
. *| . |	. *| . |	3	-0.058	-0.140	3.6310	0.304
. |* . |	. |* . |	4	0.073	0.096	3.8542	0.426
. *| . |	. *| . |	5	-0.146	-0.163	4.7797	0.443
.**| . |	.**| . |	6	-0.223	-0.218	6.9989	0.321
. *| . |	. |* . |	7	-0.083	0.097	7.3139	0.397
. *| . |	. *| . |	8	-0.129	-0.117	8.1125	0.423
. *| . |	. | . |	9	-0.073	-0.053	8.3816	0.496
. *| . |	. | . |	10	-0.087	0.014	8.7773	0.553
. | . |	. *| . |	11	-0.040	-0.113	8.8639	0.634
. *| . |	.**| . |	12	-0.184	-0.212	10.763	0.549
. *| . |	. | . |	13	-0.127	-0.055	11.718	0.551
. *| . |	. *| . |	14	-0.122	-0.117	12.642	0.555
. | . |	. *| . |	15	-0.051	-0.074	12.811	0.617
. | . |	. | . |	16	0.004	0.050	12.812	0.686

6 Import of consumers import

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. *| . |	. *| . |	1	-0.116	-0.116	0.4958	0.481
.**| . |	.**| . |	2	-0.206	-0.222	2.1156	0.347
. | . |	. *| . |	3	-0.022	-0.082	2.1354	0.545
. | . |	. | . |	4	0.035	-0.028	2.1850	0.702
. | . |	. | . |	5	0.010	-0.012	2.1892	0.822
. | . |	. | . |	6	0.012	0.013	2.1953	0.901
. *| . |	. *| . |	7	-0.085	-0.085	2.5252	0.925
. |* . |	. |* . |	8	0.127	0.117	3.2884	0.915
. *| . |	. *| . |	9	-0.081	-0.087	3.6065	0.935
.**| . |	. *| . |	10	-0.190	-0.185	5.4407	0.860
. |* . |	. | . |	11	0.112	0.040	6.1098	0.866
. *| . |	.**| . |	12	-0.162	-0.265	7.5649	0.818
. | . |	. | . |	13	0.017	-0.028	7.5816	0.870
. *| . |	.**| . |	14	-0.076	-0.208	7.9308	0.893
. | . |	. *| . |	15	-0.046	-0.125	8.0656	0.921
. | . |	. *| . |	16	0.007	-0.124	8.0692	0.947

7 Intermediate import

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.**| . |	.**| . |	1	-0.213	-0.213	1.6834	0.194
. |**. |	. |**. |	2	0.267	0.232	4.4075	0.110
. *| . |	. *| . |	3	-0.163	-0.077	5.4550	0.141
. | . |	. *| . |	4	0.026	-0.081	5.4820	0.241
. *| . |	. *| . |	5	-0.130	-0.091	6.2005	0.287
. | . |	. | . |	6	0.013	-0.021	6.2083	0.400
. | . |	. | . |	7	0.007	0.053	6.2106	0.515
. *| . |	. *| . |	8	-0.066	-0.087	6.4142	0.601
. | . |	. | . |	9	0.013	-0.040	6.4219	0.697
. *| . |	. *| . |	10	-0.143	-0.132	7.4648	0.681
. | . |	. | . |	11	0.064	0.014	7.6814	0.742
. *| . |	. *| . |	12	-0.124	-0.062	8.5409	0.742
. | . |	. *| . |	13	-0.039	-0.152	8.6286	0.800
.**| . |	.**| . |	14	-0.255	-0.305	12.620	0.557
. |* . |	. | . |	15	0.100	-0.001	13.270	0.581
.**| . |	. *| . |	16	-0.192	-0.121	15.778	0.469

8 Agricultural Production

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.050	0.050	0.0924	0.761
***| . |	***| . |	2	-0.366	-0.369	5.2069	0.074
. | . |	. |* . |	3	0.015	0.068	5.2163	0.157
. |* . |	. *| . |	4	0.079	-0.073	5.4678	0.243
. | . |	. | . |	5	-0.034	-0.005	5.5157	0.356
. *| . |	. *| . |	6	-0.136	-0.151	6.3258	0.388
. | . |	. | . |	7	-0.011	-0.006	6.3310	0.502
. | . |	. *| . |	8	-0.046	-0.172	6.4323	0.599
. |* . |	. |**. |	9	0.184	0.253	8.0904	0.525
. |* . |	. | . |	10	0.114	-0.023	8.7552	0.555
. *| . |	. | . |	11	-0.121	0.050	9.5289	0.573
. *| . |	.**| . |	12	-0.157	-0.203	10.901	0.537
. *| . |	. *| . |	13	-0.096	-0.112	11.435	0.574
. |* . |	. | . |	14	0.112	-0.007	12.205	0.590
. |* . |	. |* . |	15	0.116	0.152	13.070	0.597
. | . |	. | . |	16	-0.052	-0.038	13.253	0.654

9 Non-Agricultural Production

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>1</td><td>0.194</td><td>0.194</td><td>1.4355</td><td>0.231</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>2</td><td>-0.073</td><td>-0.115</td><td>1.6470</td><td>0.439</td></tr>
<tr><td>. |**. |</td><td>. |**. |</td><td>3</td><td>0.261</td><td>0.315</td><td>4.3967</td><td>0.222</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>4</td><td>-0.007</td><td>-0.173</td><td>4.3990</td><td>0.355</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>5</td><td>-0.043</td><td>0.091</td><td>4.4772</td><td>0.483</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>6</td><td>0.195</td><td>0.092</td><td>6.1715</td><td>0.404</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>7</td><td>0.039</td><td>0.005</td><td>6.2425</td><td>0.512</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>-0.032</td><td>0.004</td><td>6.2926</td><td>0.614</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>9</td><td>-0.070</td><td>-0.182</td><td>6.5339</td><td>0.686</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>10</td><td>0.019</td><td>0.132</td><td>6.5524</td><td>0.767</td></tr>
<tr><td>. *| . |</td><td>.**| . |</td><td>11</td><td>-0.148</td><td>-0.278</td><td>7.7267</td><td>0.738</td></tr>
<tr><td>. *| . |</td><td>. |* . |</td><td>12</td><td>-0.115</td><td>0.098</td><td>8.4698</td><td>0.747</td></tr>
<tr><td>. *| . |</td><td>***| . |</td><td>13</td><td>-0.172</td><td>-0.387</td><td>10.205</td><td>0.677</td></tr>
<tr><td>.**| . |</td><td>. | . |</td><td>14</td><td>-0.268</td><td>0.006</td><td>14.643</td><td>0.403</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.044</td><td>-0.005</td><td>14.766</td><td>0.468</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>16</td><td>-0.040</td><td>-0.075</td><td>14.874</td><td>0.534</td></tr>
</table>

10 Price

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>1</td><td>-0.148</td><td>-0.148</td><td>0.7865</td><td>0.375</td></tr>
<tr><td>.**| . |</td><td>***| . |</td><td>2</td><td>-0.307</td><td>-0.336</td><td>4.3029</td><td>0.116</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>3</td><td>0.140</td><td>0.034</td><td>5.0526</td><td>0.168</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>4</td><td>-0.039</td><td>-0.126</td><td>5.1117</td><td>0.276</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>5</td><td>-0.142</td><td>-0.132</td><td>5.9458</td><td>0.312</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>6</td><td>0.078</td><td>-0.030</td><td>6.2033</td><td>0.401</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>7</td><td>-0.051</td><td>-0.137</td><td>6.3183</td><td>0.503</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>8</td><td>0.083</td><td>0.093</td><td>6.6375</td><td>0.576</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>9</td><td>-0.009</td><td>-0.070</td><td>6.6414</td><td>0.674</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>10</td><td>-0.108</td><td>-0.075</td><td>7.2313</td><td>0.703</td></tr>
<tr><td>. *| . |</td><td>.**| . |</td><td>11</td><td>-0.161</td><td>-0.282</td><td>8.5841</td><td>0.660</td></tr>
<tr><td>. |* . |</td><td>. *| . |</td><td>12</td><td>0.072</td><td>-0.101</td><td>8.8661</td><td>0.714</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>13</td><td>0.046</td><td>-0.098</td><td>8.9909</td><td>0.774</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>0.054</td><td>0.023</td><td>9.1714</td><td>0.820</td></tr>
<tr><td>. |**. |</td><td>. |**. |</td><td>15</td><td>0.268</td><td>0.322</td><td>13.768</td><td>0.543</td></tr>
<tr><td>.**| . |</td><td>. *| . |</td><td>16</td><td>-0.195</td><td>-0.165</td><td>16.357</td><td>0.428</td></tr>
</table>

11 Capacity Utilization Rate

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.012	0.012	0.0051	0.943
.**| . |	.**| . |	2	-0.285	-0.285	3.0287	0.220
. | . |	. | . |	3	-0.038	-0.033	3.0843	0.379
. | . |	. | . |	4	0.056	-0.027	3.2090	0.523
.**| . |	***| . |	5	-0.296	-0.345	6.8182	0.235
. |**. |	. |**. |	6	0.229	0.293	9.0600	0.170
. |**. |	. |* . |	7	0.318	0.155	13.541	0.060
. | . |	. | . |	8	-0.029	0.057	13.580	0.093
. | . |	. |**. |	9	-0.045	0.209	13.678	0.134
. | . |	. | . |	10	0.049	-0.046	13.797	0.182
.**| . |	. *| . |	11	-0.243	-0.134	16.906	0.111
. *| . |	. | . |	12	-0.133	-0.039	17.880	0.119
. |* . |	. *| . |	13	0.161	-0.106	19.386	0.112
. | . |	. *| . |	14	0.039	-0.118	19.477	0.148
. | . |	. | . |	15	-0.019	0.010	19.501	0.192
. | . |	.**| . |	16	-0.008	-0.205	19.505	0.243

12 Real Exchange Rate

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.011	0.011	0.0050	0.943
. |* . |	. |* . |	2	0.180	0.180	1.2769	0.528
. | . |	. | . |	3	0.057	0.055	1.4093	0.703
. | . |	. *| . |	4	-0.052	-0.088	1.5218	0.823
. | . |	. | . |	5	0.026	0.007	1.5514	0.907
. | . |	. | . |	6	-0.010	0.014	1.5555	0.956
. | . |	. | . |	7	0.043	0.047	1.6411	0.977
. | . |	. *| . |	8	-0.055	-0.066	1.7868	0.987
. | . |	. | . |	9	-0.013	-0.029	1.7954	0.994
. | . |	. | . |	10	-0.052	-0.035	1.9340	0.997
. *| . |	. *| . |	11	-0.091	-0.074	2.3828	0.997
. | . |	. | . |	12	-0.038	-0.030	2.4654	0.998
. | . |	. | . |	13	0.016	0.054	2.4800	0.999
. | . |	. | . |	14	-0.040	-0.027	2.5781	1.000
. | . |	. | . |	15	0.028	0.013	2.6276	1.000
. | . |	. | . |	16	-0.041	-0.038	2.7416	1.000

Declaration

I, the undersigned, declare that this thesis is my original work, has not been presented for degrees in any other university and all sources of material used for the thesis have been duly acknowledged.

Declared By:

Name: Asrat Atsedeweyn

Signature: …………………

Place: Faculty of Science, Addis Ababa University

Date: June, 2008

This thesis has been submitted for examination with my approval as a University advisor.

Name: Olusanya E. Olubusoye (PhD)

Signature ……………………………..

Date: June, 2008