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A SIMULTANEOUS EQUATION MODEL OF ECONOMIC GROWTH IN INDIA

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Abstract: Empirical investigations aimed at determining what relationship, if any, exists between savings and real GDP has drawn ambiguous results. This is also the case for India, where all empirical studies have used the VAR methodology. In this study, we outline a dynamic simultaneous equations model. The model captures the interrelationships between, domestic savings, domestic capital formation and real GDP. Simultaneous equations are then developing to determine those variables.

Keywords: Structural break, Unit root, simultaneous equation system

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1. Introduction

India's success in improving its economic growth has generated several studies, which have endeavored to assess the role Gross Domestic Capital Formation (GDCF), Gross Domestic Saving (GDS) and Gross Domestic Product (GDP) have played in the country's economic development. In recent years, there has been extensive empirical work on relationship between GDP, GDCF and GDS. The role of savings and capital formation in promoting economic growth has received considerable attention in India. In many research studies causality relationship between these macroeconomic variables have been developed.

Our comprehensive annual data are for the period, 1960-2013. GDCF, GDS and GDP data are collected from the Economic Survey of the Government of India.

Dipendra Sinha (1996) studied the trend and unit root problem in saving and economic growth in india. Reetu Verma and Edgar J. Wilson (2004) developed the Causality relation among savings, investment, foreign inflows and economic growth of the Indian economy. J. L. Ford, Somnath Sen and Hongxu Wei (2010) constructed a simultaneous equation model of economic growth, FDI and government policy in China. David Fielding and Sebastian Torres (2005) formulated the Simultaneous Equation Model of Economic Development and Income Inequality for various developing countries by using dummy variable technique. Kishor Sharma (2000) investigated the determinants of export performance in India in a simultaneous equation framework.

I. Objective

The main objective of this paper is to develop a Simultaneous Equation Model for Gross Domestic Product, Gross Capital Formation and Gross Domestic Savings using the relevant data for the Indian economy.

II. Data source:

The data on the variables under the study have been obtained from Economic Survey of the Government of India and the reference period of the study is 1961 to 2013. . All variables are converted into log transformation for normality condition.

III. Econometric methodology

In this section, we discuss three types of econometric analysis. First, to check the significance of a known structural break point we use Chow test. Then the entire set of data has been divided into three sub periods (i) period 1960-1983 (ii) period 1984-2013 and (iii) period 1960-2013. Secondly, using Unit root test, we look into stationarity of the data set before developing the simultaneous model among the variables.. A variable is said to be stationary or integrated of order zero (ie., I(0)) if it does not have a unit root. In many cases, a variable may be non-stationary in its level form but stationary in its first-difference form. We used augmented Dickey-Fuller (ADF) test (See Dickey and Fuller (1979) and (1981)) stationary tests that are popular in the literature. To check the effect of exogenous variables on endogenous variable simultaneous equation model is determined.

IV. Econometric results and their implications

This section has been divided in two subsections: (a) First section analyzes the break point that significantly explains the growth in GDP, GDCF and GDS and (b) Second section develops the simulations equation model.

a. Structural change through known breakpoint:

We examine the question of the structural stability of the variables under study involving time series data and show how the Chow test can be used for this purpose. From the graph showing the growth of Gross domestic product, gross domestic saving and gross domestic capital formation in India for the period 1960–2013, we can observe that it changed around the year 1983. Therefore, we assume that the break point will be 1983 and check its significance of this break point by Chow test.

Figure -1

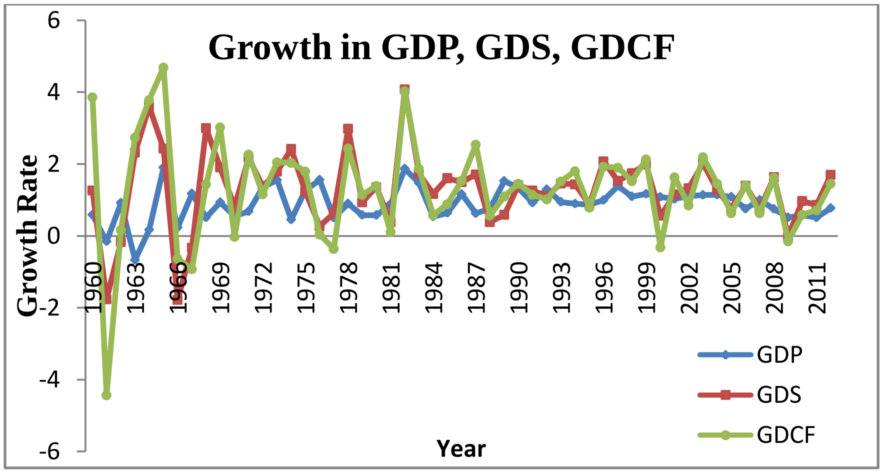


Table-1: Chow Test

Variables	Test Statistic	P-value
GDP	122.849	0.0000
GDS	46.91253	0.0000
GDCF	43.01087	0.0000

From Table-1, we can conclude that there is a significant structural change at break point 1983 over the entire period 1960-2013 for GDP, GDCF and GDS.

b. Simultaneous equation Modeling:

As far as the time series data are concerned, we have to check the problem of auto correlation as well as unit root. For testing, the problem of auto correlation, the Box-Ljung method and for unit root problem, ADF test is used. Then to construct the Simultaneous equation model, the model containing two endogenous variables GDP and GDCF and one exogenous variable GDS is used. The rationale behind this is the assumption in Economic theory that GDP in any economy primarily depends upon its GDCF and that GDCF itself depends on how much savings is made i.e. GDS.

General formulation:

GDP = f (GDCF) and GDCF=f (GDS)

As mentioned above, there is a problem of autocorrelation, unit root as well as while considering the structural break point at 1983; the simultaneous modeling is determined in three classified periods (i) for period 1960-1983 (ii) for period 1994-2013 and (iii) for period 1960-2013.

1. Simultaneous equation Modeling for period 1960-1983:

From the autocorrelation function and Box-Ljung Statistic, for GDP, GDS and GDCF we can detect the problem of autocorrelation. In addition, we check the unit root problem for GDP, GDS and GDCF.

Unit Root test:

H_0: The variable (GDP, GDCF and GDS) has unit root.

H_1: The variable (GDP, GDCF and GDS) has stationary.

Interpretation:

From Table-1.2 we can conclude that the Gross domestic product has stationary at lag =1 while gross domestic capital formation and gross domestic saving have stationary at lag = 1 and 2.

Therefore, the simultaneous equation Model is:

$$\ln GDP_t = \alpha_1 + \alpha_2 * \ln GDCF_t + \alpha_3 * \ln GDP_{t-1} + u_t \text{.............................(1)}$$

$$\ln GDCF_t = \beta_1 + \beta_2 * \Delta^2 \ln GDS + \beta_3 * \ln GDCF_{t-2} + v_t \text{......................(2)}$$

Testing the significance of structural coefficient:

H_0: The structural parameters are insignificant

H_1: The structural parameters are significant

Goodness of fit:

H_0: The simultaneous equation model is significant

H_1: The simultaneous equation model is insignificant

Test statistic = 7.55, P-value = 0.056 and R^2 = 0.998

Interpretation: From the coefficients given in Table-1.3, we can conclude that the structural parameters are statistically significant. The gross domestic capital formation increases when gross domestic saving and GDCF are significantly increased at lag = 2. The Gross Domestic Product increases when the estimated GDCF and GDP at lag=1are significantly increase. For

GDP we consider lag = 1 while for GDCF and GDS we consider lag = 2 because the at lag = 2 the assumption of homoscedastisity for residuals is satisfied.

2. Simultaneous equation Modeling for period 1984-2013:

From the autocorrelation function and Box-Ljung Statistic, for GDP, GDS and GDCF we can detect the problem of autocorrelation. In addition, we check the unit root problem for GDP, GDS and GDCF.

Unit Root test:

H_0: The variable (GDP, GDCF and GDS) has unit root.

H_1: The variable (GDP, GDCF and GDS) has stationary.

Interpretation:

From Table-2.2 we can conclude that the Gross domestic product, gross domestic capital formation and gross domestic saving have stationary at lag =1.

Therefore, the simultaneous equation Model is:

$$\ln GDP_t = \alpha_1 + \alpha_2 * \ln GDCF_t + \alpha_3 * \ln GDP_{t-1} + u_t \text{..............................(1)}$$

$$\ln GDCF_t = \beta_1 + \beta_2 * \Delta \ln GDS + \beta_3 * \ln GDCF_{t-1} + v_t \text{.......................(2)}$$

Testing the significance of structural coefficient:

H_0: The structural parameters are insignificant

H_1: The structural parameters are significant

Goodness of fit:

H_0: The simultaneous equation model is significant

H_1: The simultaneous equation model is insignificant

Test statistic = 1.16, P-value = 0.762 and R^2 = 0.990

Interpretation: From the coefficient Table-2.3, we can conclude that the structural parameters are statistically significant. The Gross domestic capital formation increases when gross domestic saving and GDCF are significantly increase at lag = 1. The Gross Domestic Product increases when the estimated GDCF and GDP at lag=1are significantly increased. The assumption of homoscedastisity for residuals is satisfied for lag=1.

3. Simultaneous equation modeling for period 1960-2013:

From the autocorrelation function and Box-Ljung Statistic, for GDP, GDS and GDCF we can detect the problem of autocorrelation. In addition, we check the unit root problem for GDP, GDS and GDCF.

Unit Root test:

H_0: The variable (GDP, GDCF and GDS) has unit root.

H_1: The variable (GDP, GDCF and GDS) has stationary.

Interpretation:

From Table-3.2 we can conclude that the Gross domestic product, gross domestic capital formation and gross domestic saving have stationary at lag =1.

$$\Delta \ln GDP_t = \alpha_1 + \alpha_2 * \Delta \ln GDS_t + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$\Delta \ln GDS_t = \beta_1 + \beta_2 * \Delta \ln GDCF + v_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Testing the significance of structural coefficient:

H_0: The structural parameters are insignificant

H_1: The structural parameters are significant

Goodness of fit:

H_0: The simultaneous equation model is significant

H_1: The simultaneous equation model is insignificant

Test statistic = 0.05, P-value = 0.8292 and R^2 = 0.729

Interpretation: From the coefficients given in Table-3.3, we can conclude that the structural parameters are statistically significant. The Gross domestic capital formation increases when gross domestic saving is significantly increased at lag = 1. The Gross Domestic Product increases when the estimated GDCF is significantly increased at lag = 1. The assumption of homoscedasticity for residuals is satisfied for integrated difference at lag=1.

V. Summary and Conclusion:

From the structural break theory, we found that economic growth influenced by time and some other reasons such changed government policy. In addition, we found that the current year economic growth depends on previous years and they are not stationary. Our findings suggest that savings are beneficial to economic development, while changes in gross domestic product and capital formation and saving are the most effective instruments in accelerating the rate of growth of output in the long run.

VI. Tables and Figures

Table- 1.2: Unit Root test

Variables	Test Statistic	P-value	lag
GDP	3.9	0.001	1
GDS	2.95	0.008	1
	2.56	0.020	2
GDCF	5.76	0.000	1
	4.40	0.002	2

Figure-2

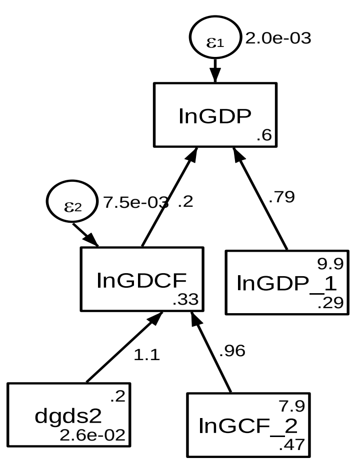


Table-1.3

Model	Coef.	Std. Err.	Statistic	P-value
lnGDCF<-				
Δ^2lnGDS	1.114811	0.1171	9.52	0.000
$lnGDCF_{t-2}$	0.955122	0.027523	34.7	0.000
Constant	0.32745	0.213676	1.53	0.125
lnGDP <-				
lnGDCF	0.195988	0.052328	3.75	0.000
$lnGDP_{t-1}$	0.788918	0.070555	11.18	0.000
Constant	0.596823	0.311299	1.92	0.055

Table- 2.2: Unit Root test

variables	Test Statistic	P-value	lag
GDP	2.86	0.009	1
GDS	5.49	0.000	1
GDCF	2.47	0.020	1

Figure-3

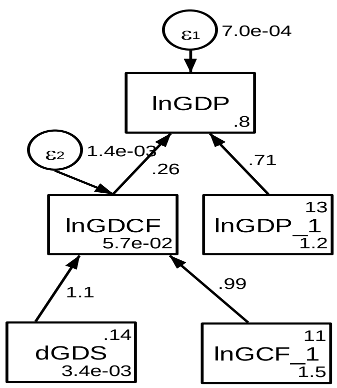


Table-2.3

Model	Coef.	Std. Err.	Statistic	P-value
lnGDCF<-				
ΔlnGDS	1.11649	0.120926	9.23	0.000
$lnGDCF_{t-1}$	0.993194	0.005742	172.98	0.000
Constant	0.05733	0.066975	0.86	0.392
lnGDP <-				
lnGDCF	0.259989	0.062743	4.14	0.000
$lnGDP_{t-1}$	0.713773	0.069457	10.28	0.000
Constant	0.801396	0.176495	4.54	0.000

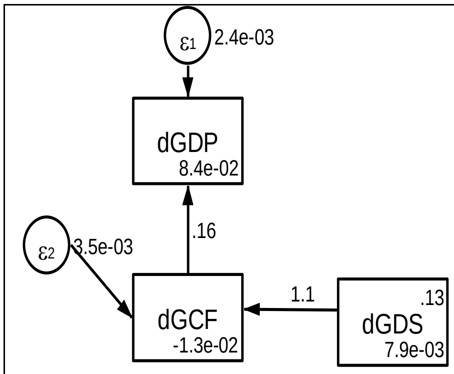
Table- 3.2: Unit Root test

variables	Test Statistic	P-value	lag
GDP	3.17	0.003	1
GDS	3.26	0.002	1
GDCF	3.07	0.004	1

Figure-4

Table-3.3

Model	Coef.	Std. Err.	Statistic	P-value
ΔGDCF <-				
ΔGDS	1.094	0.0916	11.94	0.000
Constant	-0.013	0.0142	-0.92	0.360



ΔGDP <-				
ΔGDCF	0.1634	0.0586	2.79	0.005
Constant	0.0844	0.0099	8.48	0.000

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