SHORT-RUN AND LONG-RUN RELATIONSHIP BETWEEN CAPITAL FORMATION AND ECONOMIC GROWTH IN INDIA

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ABSTRACT

Capital Formation also termed as 'investment' is an important macroeconomic variable in any economy. In this paper, capital formation and economic growth variables are considered for analysis wherein the short-run and long-run relationship between these variables in India is empirically tested with the help of co integration technique and vector error correction technique. The study reveals a long-run relationship between capital formation and economic growth. From policy point of view it is suggested that more thrust may be given for boosting the capital formation in the economy in order to achieve high economic growth in Indian economy

Keywords: short-run, long-run, capital formation, economic growth, unit root, co integration,

INTRODUCTION

Capital Formation also termed as 'investment' is an important macroeconomic variable in any economy. Saving and investment variables are considered to play an important role in the economic growth process and as such the role played by the saving and investment variables has been at the centre of debate. In this paper, capital formation and economic growth variables are considered for analysis wherein the short-run and long-run relationship between these variables in India is empirically tested with the help of co integration technique and vector error correction technique. The study covers a long time-period from 1950-51 to 2009-10 in which annual time series data are used in the analysis.

OBJECTIVES OF THE PAPER

The present paper is a modest attempt to study the relationship between capital formation and economic growth. The main objectives of this study are –

- Review of existing literature on the study of relationship between capital formation and economic growth.

- To find out the short-run and long-run relationship between capital formation and economic growth.
- To bring forth conclusions and policy implications of the present paper.

REVIEW OF LITERATURE IN BRIEF

Many studies have been undertaken so far in this area of research. A brief mention of these studies and their results is being made in this section. This will add to make the present study a more meaningful and fruitful. Some of these studies are as stated below –

Mahambare and Balasubramanyam (2000) in their working paper carried out analysis about liberalisation and savings in developing countries with reference to India. They employed the long run vector autoregressive (VAR) model using the techniques of co integration and error correction mechanism (ECM) with the time series data for the years 1960-61 to 1996-97. Their results suggest that financial savings exhibit a long run positive association with the level of GDP per capita, the ratio of indirect taxes to total taxes and with the ratio of inward remittances to GDP. They concluded that in the long run, the level of income promotes savings rather than the other way round and Ricardian equivalence does not hold true in the Indian case.

The study by Athukorala and Sen (2002) is the comprehensive Indian case study of saving, investment and growth in India. The empirical analysis found strong empirical support for the view that the levels of investment as well as its efficiency are the proximate causes of growth. Verma and Wilson (2005) in their working paper considered per worker household, private corporate and public sector savings and investment, foreign capital inflows and economic growth for India in multivariate setting for the time period from 1950-51 to 2001-02. The estimates of long run co integrating vector elasticities (without trend and with unrestricted intercepts) in the first co integrating vector show that GDP per worker is determined by household savings per worker and private corporate savings per worker with respective long run elasticities of 0.65 and 0.15, which are significant at the one per cent level.

Desroches, B. et al. (2007) tried to find out the global forces that had led to the decline in the world real interest rate over recent decades and also to find out the key factors that shaped the behaviour of desired world savings and investment. For their analysis, they used the dataset on savings, investment and their determinants from 35 industrialized and emerging economies covering the time period from 1970 to 2004. Joshi (2007) presented in his paper an empirical examination of the savings and investment behaviour in the Indian economy over the period from 1950-51 to 2005-06. He made use of multivariate cointegration analysis methodology proposed by Johansen (1988). His results suggested that while a one per cent increase in the household financial savings rate increases the capital formation rate in the long term by just 0.25 per cent, On the basis of his analysis he concluded that of all the empirical estimates, among the various domestic savings components, the highest impact on long term capital formation is made by the private corporate savings.

Ray (2007) carried out the study on capital formation in the Indian Economy over a period of 34 years between 1970 and 2004. Three measures of capital formation viz. Gross Fixed Capital Formation, Gross Domestic Capital Formation and Net Domestic Capital Formation are studied. Results of the study revealed that there is no statistically significant impact of liberalization on any measure of capital formation.

Mazumdar (2008) tried to show that a specific investment-growth asymmetry had characterized the growth trajectory of the Indian economy since the 1991 exchange crisis induced shift in the economy policy paradigm. According to him, this asymmetry has created the conditions for cyclical fluctuations in both manufacturing investment as well as output, which in turn has affected aggregate growth.

SOURCES OF DATA AND METHODOLOGY ADOPTED

Time series data on capital formation and economic growth covering the time period from 1950-51 to 2009-10 have been used for analysis in this paper. The data for the present study have been taken from Economic Survey, Ministry of Finance, Government of India. In order to avoid the problem of heteroscedasticity, these data have been converted into logarithmic form and thereafter the econometric analysis has been carried out. The data on capital formation have been taken in terms of Gross Domestic Capital Formation (GDCF) at current prices and data on economic growth have been taken in terms of Gross Domestic Product (GDP) at current market prices. Thus, the present study has been undertaken only at current prices. Most of the macroeconomic time series are non-stationary which make the analysis spurious if the ordinary least squares (OLS) method is employed. In such a situation the pioneering work of Engle and Granger (1987) provides a very useful tool of analysis. Hence the techniques of co integration and error correction mechanism (ECM) have been employed in this paper.

THEORETICAL ASPECT OF THE STUDY

Regression of a non-stationary series on another non-stationary series may produce spurious regression. The concept of co integration developed by Engle and Granger (1987) addresses this problem of spurious regression..

Following steps are involved in the estimating the short-run and long-run relationship between the variables –

(1) Variables are to be converted into its log natural form to avoid the problem of heteroscedasticity.
(2) Unit root tests on time series data are to be carried out to ascertain the integration properties of the variables.
(3) If the variables are of same order, co integration test is to be carried out to find out the long-run relationship.

(4) If the variables are co integrated, then the vector error correction model (VECM) is to be estimated. In case of no co integration between the series, then the Vector Auto regression (VAR) is to be estimated.
(5) Results of the VECM or VAR are to be interpreted.

Unit Root Test – The order of integration of the series is ascertained by means of unit root test. Unit root test involves estimating Dicky-Fuller (DF) test in following three forms depending upon suitability according to the nature of the time series –

Yt is a random walk: $$\Delta Y_t = \delta Y_{t-1} + u_t \quad \textbf{(1.1)}$$

Yt is a random walk with drift: $$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t \quad \textbf{(1.2)}$$

Yt is a random walk with drift around a stochastic trend:
$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t \quad \textbf{(1.3)}$$

Here, t is the time or trend variable. $\delta = \rho - 1$ or alternatively, $\rho = \delta + 1$. It implies that for ρ to be less than unity, the value of δ should be negative. The null hypothesis is that δ is zero which means that $\rho = 1$ and it indicates the presence of unit root, implying that the series is non-stationary. The alternative hypothesis is that there is absence of unit root and the series is stationary. The null hypothesis is rejected if the calculated τ statistics is more negative than the critical τ value. Rejection of the null hypothesis indicates that the series is stationary. In case of the series being found to be non-stationary, the series is tested for stationarity in the first difference form. A series is said to be stationary, integrated of order zero, i.e., I (0) when it is found to be stationary at levels. If series becomes stationary after first differencing, then the series is said to be integrated of order 1, i.e., I (1). In other words, a series is said to be integrated of order d, i.e., I (d) if the series has to be differenced d times to yield a stationary series.

Co integration Test – Co integration test is done to see whether there exists a long run equilibrium relationship among the variables. If there is a vector (set of variables) X_t consisting of n variables, all of which are integrated of order 1, wherein stationarity is achieved by first differencing; this set of variables are said to be co integrated if these variables form a linear combination, $Z_t = a X_t$ such that Z_t is I (0), where a is called as co integrating vector.

Error Correction Mechanism – Error correction mechanism provides a means to reconcile the short-run (dynamic) and long-run (static) relationship between the

variables. Short-run relationship can be estimated through vector error correction model. The following equations have been estimated –

Equation for Capital Formation and Economic Growth:

$$D\,LNGDCF_t = a_1 + \sum_{i=1}^{k} b_{1i} D\,LNGDCF_{t-i} + \sum_{i=1}^{k} f_{1i} D\,LNGDP_{t-i} + l_1 Z_{t-1} + u_{1t} \qquad \textbf{(1.4)}$$

$$D\,LNGDP_t = a_2 + \sum_{i=1}^{k} b_2 D\,LNGDP_{t-i} + \sum_{i=1}^{k} f_2 D\,LNGDCF_{t-i} + l_2 Z_{t-1} + u_{2t} \qquad \textbf{(1.5)}$$

EMPIRICAL ANALYSIS OF THE STUDY

Unit Root Test Results – After converting the data series on Gross Domestic Capital Formation and Gross Domestic Product into their logarithmic form[1], the unit root test has been carried out and the results have been shown in table 1. Both the series LNGDP and LNGDS in levels are found to be integrated of order 1 because the Augmented Dicky-Fuller (ADF) test statistics are found to be lesser negative than the McKinnon critical values at all levels of significance (1 per cent, 5 per cent and 10 per cent). It means that the null hypothesis of unit root can not be rejected, indicating thereby that the series are non-stationary. On the other hand, both these series in their first difference are found to be stationary, i.e., I (0) because the ADF test statistics are found to be more negative than the McKinnon critical values at all levels of significance (1 per cent, 5 per cent and 10 per cent). It means that the null hypothesis can be rejected in favor of the alternative hypothesis that there is no unit root, indicating that these series are stationary. This means that both the series are integrated of same order and become stationary after first differencing. This permits carrying out co integration test between the two series.

Table 1: Unit Root Tests of Stationarity of Variables under Study

Variables	ADF Test Statistic (Intercept)	ADF Test Statistic (Trend and Intercept)	Level of Integration
LNGDCF	1.565010 (-3.5814)* (-2.9271)** (-2.6013)*** Durbin-Watson Stat: 1.974541	-1.879672 (-4.1383)* (-3.4952)** (-3.1762)*** Durbin-Watson Stat: 2.059511	I (1)

Variables	ADF Test Statistic (Intercept)	ADF Test Statistic (Trend and Intercept)	Level of Integration
LNGDP	1.742021 (-3.5572)* (-2.9167)** (-2.5958)*** Durbin-Watson Stat: 1.992903	-3.165765 (-4.1383)* (-3.4952)** (-3.1762)*** Durbin-Watson Stat: 1.896398	I (1)
DLNGDCF	-6.990195 (-3.5598)* (-2.9178)** (-2.5964)*** Durbin-Watson Stat: 2.065073	-5.823885 (-4.1458) (-3.4987) (-3.1782) Durbin-Watson Stat: 1.912987	I (0)
DLNGDP	-3.918298 (-3.5625)* (-2.9190)** (-2.5970)*** Durbin-Watson Stat: 2.108563	-4.032325 (-4.1458)* (-3.4987)** (-3.1782)*** Durbin-Watson Stat: 2.119734	I (0)

* McKinnon Critical value at 1 per cent level of significance

** McKinnon Critical value at 5 per cent level of significance

*** McKinnon critical value at 10 per cent level of significance

Notations:

LNGDCF - Natural Log of Gross Domestic Capital Formation

LNGDP - Natural Log of Gross Domestic Product

DLNGDCF - First Difference of LNGDCF

DLNGDP - First Difference of LNGDP

Co integration Test Results – Augmented Dicky-Fuller (ADF) test for unit root of the residual series of co integration between capital formation and economic growth indicate that the residual series is I (0) and hence it is stationary. Thus it indicates that both the series are co integrated which means that there is a long run relationship between capital formation and economic growth.

Co integration results have been shown in table 2. Both the dependent and independent variables in the co integrating regression models are in the natural logarithmic form which means that this kind of regression is of double-log or log-linear form. Accordingly, results of model 3 suggest that one per cent increase in LNGDP (Economic Growth) leads to an increase of 1.17 per cent in LNGDCF (capital formation). Coefficients results in model 4 suggest that one per cent increase in LNGDCF (capital formation) leads to an increase of 0.85 per cent in LNGDP (economic growth).Residuals are found to be stationary because the obtained τ statistics is -2.944126 which is more negative than the McKinnon critical values at all levels of significance (1 per cent, 5 per cent and 10 per cent). It means that there is a long run relationship between the two variables. Both the dependent and independent variables in the co integrating regression models are in the natural logarithmic form which means that this kind of regression is of double-log or log-linear form. Accordingly, results of model 1 suggest that one per cent increase in LNGDP (Economic Growth) leads to an increase of 1.17 per cent in LNGDCF (capital formation). Coefficients results in model 2 suggest that one per cent increase in LNGDCF (capital formation) leads to an increase of 0.85 per cent in LNGDP (economic growth).

Table 2: Co integration Test Results

Co integrating Regression Output					
Co integrating Regression Model 1: $LNGDCF_t = a_1 + a_2\ LNGDP_t + u_t$ **(1.8)**					
Variable	Coefficient	t-statistics	Probability	Adjusted R^2	D.W
C	-3.737 (0.116)	-32.291	0.000	.996	.680
LNGDP	1.170 (.010)	120.787	0.000		
Dependent Variable: LNGDCF Figures in parenthesis are the standard errors of the coefficients.					
Co integrating Regression Model 2: $LNGDP_t = a_1 + a_2\ LNGDCF_t + u_t$ **(1.9)**					
Variable	Coefficient	t-statistics	Probability	Adjusted	D.W

				R^2	
C	3.227 (0.073)	44.403	.000	.996	0.678
LNGDCF	0.852 (0.007)	120.787	.000		
Dependent Variable: LNGDP Figures in parenthesis are the standard errors of the coefficients.					
ADF Unit Root Tests of Residuals of Co integrated Estimates					
Variable	Obtained τ Statistics	McKinnon Critical Value	Durbin-Watson Statistics		Level of Integration
$\hat{u}_t$	-4.420939	-2.6064 * -1.9468 ** -1.6190 ***	2.222614		I (0)

* McKinnon Critical value at 1 per cent level of significance

** McKinnon Critical value at 5 per cent level of significance

*** McKinnon critical value at 10 per cent level of significance

Error Correction Model Results – Short-run relationship between capital formation and economic growth has been estimated in terms of error correction model. These estimates have been shown in table 3. It is observed from the results in table 3 that for the dependent variable Δ LNGDCF $_t$ all the coefficients are statistically insignificant even at 10 per cent level of significance except the constant term, $LNGDCF_{t-1}$ and Z_{t-1}. It means lagged values of economic growth do not seem to impact the capital formation. The coefficient of lagged Z_t is 0.323 with a t-statistics of 2.003 and a probability of 0.051. Interpretation of this coefficient is that if the capital formation is below its long-run relationship with the economic growth, it will increase to return to equilibrium.

The results for the other dependent variable Δ LNGDP $_t$ show that all the coefficients except the constant term (significant at 1 per cent) are statistically insignificant even at 10 per cent level of significance as the value of probability is more than 0.10. It means that all the independent variables in this error correction model equation do not impact the dependent variable Δ LNGDP $_t$.

Table 3: Estimated Error Correction Model Coefficients for Gross Domestic Product and Gross Domestic Capital Formation

Independent Variables	**Dependent Variable**	
	Δ LNGDCF $_t$	**Δ LNGDP $_t$**
Constant	0.138 (3.243) (0.002)	0.078 (3.930) (0.001)
Δ LNGDP $_{t-1}$	– 0.337 (-1.120) (0.268)	0.124 (0.887) (0.380)
Δ LNGDP $_{t-2}$	0.053 (0.183) (0.855)	0.089 (0.665) (0.509)
Δ LNGDCF $_{t-1}$	0.281 (1.867) (0.068)	0.013 (0.186) (0.853)
LNGDCF $_{t-2}$	-0.027 (-0.203) (0.840)	0.059 (0.944) (0.350)
Z $_{t-1}$	0.323 (2.003) (0.051)	– 0.124 (-1.651) (0.105)

Statistics for Δ LNGDCF $_t$ Variable			
R-squared	0.150218	Mean dependent var	0.138825
Adjusted R-squared	0.059816	S.D. dependent var	0.096091
S.E. of regression	0.093173	F-statistic	1.661660
Durbin-Watson stat	2.223151	Prob (F-statistic)	0.162497
Statistics for Δ LNGDP $_t$ Variable			
R-squared	0.233674	Mean dependent var	0.109987
Adjusted R-squared	0.152150	S.D. dependent var	0.046931
S.E. of regression	0.043213	F-statistic	2.866325
Durbin-Watson stat	1.989578	Prob(F-statistic)	0.024387

Figures in parenthesis corresponding to each coefficient are t statistics and the probability value.

Notations:

Δ LNGDCF	**-**	**First Difference of Natural Log of Gross Domestic Capital Formation**
Δ LNGDCF $_{t-1}$	**-**	**One year lagged value of First Difference of Natural Log of Gross Domestic Capital Formation**
Δ LNGDCF $_{t-2}$	**-**	**Two year lagged value of First Difference of Natural Log of Gross Domestic Capital Formation**
Δ LNGDP $_{t}$	**-**	**First Difference of Natural Log of Gross Domestic Product**
Δ LNGDP $_{t-1}$	**-**	**One year lagged value of First Difference of Natural Log of Gross Domestic Product**
Δ LNGDP $_{t-2}$	**-**	**Two year lagged value of First Difference of Natural Log of Gross Domestic Product**
Z $_{t-1}$	**-**	**One year lagged value of the residual of the cointegrating regression of LNGDP and LNGDS**

CONCLUSIONS AND POLICY IMPLICATIONS OF THE STUDY

Co integration test results suggest that there exists a long-run relationship between capital formation and economic growth wherein model 1 suggests that one per cent increase in LNGDP (Economic Growth) leads to an increase of 1.17 per cent in LNGDCF (capital formation) and the coefficient in model 2 suggests that one per cent increase in LNGDCF (capital formation) leads to an increase of 0.85 per cent in LNGDP (economic growth).

It is observed from the results in table 3 that for the dependent variable Δ LNGDCF $_{t}$ all the coefficients are statistically insignificant even at 10 per cent level of significance except the constant term, $LNGDCF_{t-1}$ and Z_{t-1}. It means lagged values of economic growth do not seem to impact the capital formation. The coefficient of lagged Z $_{t}$ is 0.323 with a t-statistics of 2.003 and a probability of 0.051. Interpretation of this coefficient is that if the capital formation is below its long-run relationship with the economic growth, it will increase to return to equilibrium. The results for the other dependent variable Δ LNGDP $_{t}$ show that all the coefficients except the constant term (significant at 1 per cent) are statistically insignificant even at 10 per cent level of significance as the value of probability is more than 0.10. It means that all the independent variables in this error correction model equation do not impact the dependent variable Δ LNGDP $_{t}$. From policy point of view it is suggested that more thrust may be given for boosting the capital formation in the economy in order to achieve high economic growth in Indian economy.

Notes : All data series have been converted into natural logarithmic form before using them in the econometric analysis. It is done this way so as to remove heteroscedasticity in the series

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