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## A CAUSAL ANALYSIS BETWEEN CONSTRUCTION FLOWS AND ECONOMIC GROWTH: EVIDENCE FROM INDIA

### ABSTRACT

The study examined the causal relationship between construction flows and economic growth under a static and dynamic framework by employing the Engel-Granger and IRFs approach with incorporation of endogenously determined structural breaks. The static causality test result provided the evidence of bidirectional Granger-causality between construction flows and economic growth in India. The dynamic causality analysis indicated that for the first ten years, a standard deviation innovation in construction had positive impact on the GDP, while the long-run impact was negative. However, a standard deviation shock/innovation in GDP had a negative impact on the construction flows of the economy for the first 10 years of the period under shock analysis, while for the long-run, the impact was in the positive direction.

*Key Words: construction flows, economic growth, Granger-causality, IRFs*

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## INTRODUCTION

Construction sector activity assumes critical importance for the Indian economy, as it employs a sizeable proportion of unskilled laborers and skilled laborers. There has been an increasing contribution of the construction in the services sector, especially in the post-liberalization era for the Indian economy. Construction contributed annual average of around 5.5 % to 7 % of total output in the economy during 2000-2008, and employed around 4.5 % to 3.5 % of total labor force of the economy during the same period (Mallick, 2011). Studies show that the growth of this sector affects the overall growth of the economy through backward and forward linkages with other sectors of the economy (Leamer, 2007). It also provides growth impetus to other downstream manufacturing sectors like cement, bitumen, iron and steel, chemicals, bricks, paints, tiles etc and for upstream manufacturing sectors such as shopping malls and other final output manufacturing industries including mining in the primary sector. Construction is an important part of capital investment. According to the World Bank (1993), there were three basic functions of capital investment: First was capital accumulation; second was efficient allocation of resources, and the third dealt with rapid technological catch-up with other countries. The expansion of construction activity is headed by an increase in economic expansion<sup>1</sup> with the initial effect felt fundamentally within the construction sector and only subsequently on the aggregate economy. We discuss the demand and supply side factors that influence construction below.

The construction sector includes laying down of infrastructure projects (roads, bridges etc) and construction of buildings and houses. Further, construction of housing is both for residential as well non-residential purposes.<sup>2</sup> However, with the economic slowdown beginning 2007-2008, the orders to construction companies began to dry up by FY09. Profitability margins of the construction industry came under pressure as the prices of key raw materials like cement and steel were hovering at peak levels.<sup>3</sup> To get economic growth back on track, the government announced various stimulus packages that emphasized on easing liquidity and liberalizing the lending policies, in order to provide funding to the long-term infrastructure projects. Post Union Government elections in

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<sup>1</sup> Economic expansion is usually measured by gross domestic product (per capita) or gross domestic product growth per capita.

<sup>2</sup> Construction for on-residential purposes includes construction for commercial activity.

<sup>3</sup> The data for the discussion in the introduction section of this paper was compiled from the various Five Year Planning documents of the Planning Commission of India. Special mention must be made of the Ninth, Tenth and Eleventh Five year plans.

early FY10, the Government of India (GoI) began to award projects under different infrastructure segments. This, coupled with the recovery in the macro-economic conditions and the industrial sector, has once again lead to increase in the inflows to the construction companies since FY10. The GoI had set an ambitious target of increasing the proportion of the infrastructure investment to about 9% of Gross Domestic Product (GDP) by the terminal year of the Eleventh Five Year Plan. For a sustained growth in the GDP at a 9% level, the contribution of the construction sector is targeted to increase further to 10.3% by the end of the Twelfth Five Year Plan. This will bring about a massive investment to more than Rs. 40,000 billion in the infrastructure sector. Note that the power and road sector are estimated to account for the major chunk of the investment planned in the infrastructure. In order to achieve the mammoth investment target, the GoI is seeking the support of the private sector through Public Private Partnerships (PPP). It is estimated that almost 60% of the power generation capacity addition in the Twelfth Five Year Plan will be contributed by the private sector. To encourage the participation of private companies in the road sector, the Ministry of Road had taken various initiatives like relaxing the land acquisition norms, providing cost overruns and increasing the concession period. The emphasis on roads began under the BJP Government at the centre, who launched the ambitious Golden Quadrilateral project<sup>4</sup> in 2004. Under the road sector, more than 36,000 kilometers of roadways are yet to be developed. This is likely to generate potential orders of worth about Rs. 1,800 billion. Furthermore, the outstanding investment in the industrial sector could potentially translate into an effective construction investment of about Rs. 2,900 bn during the next 4-5 years period.<sup>5</sup> The recent economic growth, coupled with the structural changes and population growth have put substantial pressure on India's physical infrastructure. Before the recession, India's total investment in infrastructure was estimated at approximately 5% of GDP in 2006-2007.<sup>6</sup> However, after the recession, there were several delays in the achieving the desired targets despite of adequate supply of liquidity. Constraints have been due to reasons apart from liquidity or recession. The construction sector is facing not only problems of supply of cement and steel and other ancillaries but also of manpower. The construction sector is facing a labor

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<sup>4</sup> The Golden Quadrilateral is a highway network connecting India's four largest metropolises: Delhi, Mumbai, Chennai and Kolkata, thus forming a quadrilateral.

<sup>5</sup> <http://www.bharatbook.com/detail.asp?id=158942&rt=Report-on-Indian-Construction-Industry-For-Indian-Customers.html>

<sup>6</sup> <http://taxguru.in/finance/indian-construction-and-growth.html>

shortage of around 10 million persons during any given day, and the situation will worsen in next decade when requirement for workers is likely to go up three-fold.

To achieve a target GDP growth rate of 9% set by the Planning Commission for Eleventh Five Year Plan, gross capital formation (GCF) in infrastructure should rise to 9% of GDP by the end of 2012. This equates to an increase of GCF from 2,598 billion rupees in 2007-08 to 5,740 billion rupees in 2011-12. If achieved, the 11th Five-Year Plan period (2007-2012) will result in an aggregate GCF of 20,115 billion rupees (USD 447 billion at an exchange rate of 45 rupees/U.S. dollar). Further, more than USD 475 bn worth of investment would flow into India's infrastructure by 2012. No other country in the world has the capacity to absorb such a large amount of funds for the infrastructure sector. With the above investments, India's infrastructure would be equal to the highest in the world by 2017. During the next five years, the planned infrastructure investment in India in some key sectors shall be (at current prices): modernization of highways USD 75 billion; development of civil aviation USD 12 billion; development of Irrigation system USD 18 billion; development of ports USD 26 billion; development of railways USD 71 billion; development of telecom USD 32 billion; development of power USD 232 billion.

In a market economy, there are possibilities of interdependence between different markets. Therefore, disturbances in one market are transmitted to other markets and these disturbances distract from the proper functioning of the economy. In this study, by having the same concern (i.e., whether the construction sector and the aggregate economy are segmented or interdependent, and/or whether construction activity contributes to economic growth and/or vice versa), we examined the explicit lead-lag relationships between construction flow and gross domestic product (GDP). For the empirical analysis, in the time series structure, we employed Engle-Granger-causality methodology in the Vector Error Correction Modelling (VECM) framework. In addition to that, we utilized a novel approach to test the stationary characteristics of the test variables and cointegrating relation, which allows for endogenous structural breaks in order to incorporate structural change in the industry and economy. Further, we also calculated the impulse response functions and variance decompositions in order to see the dynamics of these variables.

Rest of the paper is organized as follows. Section 2 and 3 respectively presents review of literature and data source, variables definition and methodology adopted for empirical analysis. Section 3 presents data analysis and findings. Section 4 concludes.

## LITERATURE REVIEW

There is a complex relationship between an economy's level of construction activity and the stages of economic development. Hence, empirical and theoretical relationship has been assessed by various scholars and international bodies since the 1970s (e.g., Turin, 1973; Drewer, 1980; Wells, 1985). However, existing paradigms on structural change in the construction industry, as a national economy develops over time, tend to be based on cross-sectional data across countries rather than longitudinal studies based on a country's time series statistics. Numerous studies have focused on the simple relationship between the gross value/value added of construction output and GDP/GDP per capita. For example, Crosthwaite (2000) by utilizing cross sectional analysis verified the inverted U-shaped relationship between construction spending share in GDP and GDP per capita as advocated by Bon (1992). On a similar line, Jin et al. (2003) found a non-linear relationship between the share of construction output in GDP with the GDP per capita across 34 countries and regions. In these studies, the phenomenal relationship was explained by indication to the change of growth rate in construction output at different stages of economic development. However, cross-sectional analysis has its limitations due to the heterogeneity of the built environment in different countries. For example, there are, besides the stages of economic development, many factors such as geographical size, topology of land and even culture vary enormously between countries which affects the prospects of the construction industry (Yiu et al., 2004). Without controlling these differences, any supposition as to the relationship between construction growth and economic growth becomes incredible. A more direct approach is to make use of longitudinal/time series analysis as it controls the characteristics of the built environment as constant, unless there is structural change in the industry. Further, if there are structural changes one can incorporate them and inference drawn will be more credible. The important studies using the longitudinal analysis to explore the longitudinal relationship between the growth rates of construction output and the economy are Crosthwaite (2000), Yiu et al. (2004) and Wong et al. (2008). Akintoye and Skitmore (1994) suggested that there is a derived demand for construction investment, which is dependent on the economic growth. However, results they found from the empirical analysis of the relationship between national output and construction demand are mixed.

## ESTIMATION METHODOLOGY

This study attempted to know the direction of causality between construction flows and economic growth in the context of India. For the analysis, we adopted data from the Hand Book of Statistics of Indian Economy and assessed from the official website of Reserve Bank of India. The period of the study is 1950-51 to 2008-09. Construction flow has been measured as a component of GDP (at constant prices of 1999-2000 in Rupees Crore) and economic growth is measured by GDP at factor cost (i.e., at constant prices of 1999-2000 in Rupees Crore). This study examined the direction of the causality between economic growth and construction flows both in static and dynamic framework by incorporating endogenously determined structural changes of the construction sector and the economy. However, to know the causality among these test variables in the Vector Error Correction Modeling (VECM) framework, certain pre-estimations (like testing the stationarity of the variables included in the VECM analysis and seeking the cointegration of the series) we should carry out without which, conclusions drawn from the estimation will not be valid. Therefore, in the first step, we tested the stationarity property of the data by carrying out unit root analysis following Saikkonen and Lütkepohl (2000a, b, c) and Lanne et al. (2002), which allows us to incorporate endogenously determined structural breaks in the data set, for the equation

$$y = \mu_0 + \mu_1 t + f_t(\theta)' \gamma + x_t \quad (1)$$

where  $f_t(\theta)' \gamma$  is a shift function and  $\theta$  and  $\gamma$  are unknown parameters or parameter vectors and  $x_t$  is generated by AR(p) process with possible unit root. We used a simple shift dummy variable with shift date  $T_B$ .  $f_t' = d_{1t} : \begin{cases} 0, < T_B \\ 1, \geq T_B \end{cases}$  the function does not involve any parameter  $\theta$  in the shift term  $f_t(\theta)' \gamma$ , the parameter  $\gamma$  is scalar. Dates of structural breaks have been determined by following Lanne et al. (2001). They recommended to chose a reasonably large AR order in a first step<sup>7</sup> and then pick the break date which minimizes the Generalized Least Square (GLS) objective function used to estimate the parameters of the deterministic part.

After confirming that variables under consideration have first order integration even in the presence of endogenously determined structural breaks, we moved to examine the cointegration relationship between the variables. As Perron (1989) observed, ignoring the issue of potential structural breaks can render invalid the statistical results not only of unit

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<sup>7</sup> Here, we have fixed largest lag length 4 as time duration is not large enough.

root tests but of cointegration tests as well. Therefore, we are considering the effects of potential structural breaks as well in cointegration analysis.

There are two different tests of cointegration proposed by Johansen et al. (2000) and Saikkonen and Lütkepohl (2000a, 2000b, 2000c), which considers the potential structural breaks. Saikkonen and Lütkepohl (2000a, 2000b, 2000c) proposed a test for cointegration analysis that allows for possible shifts in the mean of the Data-Generating Process (DGP). The Saikkonen and Lütkepohl (SL) test investigates the consequences of structural breaks in a system context based on the multiple equation frameworks of Johansen-Juselius, while earlier approaches like Gregory-Hansen (1996) considered structural break in a single equation framework as their approach was based on analyzing the unit root properties of residuals by including dummy variable for known date of structural breaks.

However, SL approach has limitation in the sense that if we use this approach, we can test for cointegration in the presence of only one structural break while, Johansen et al. (2000) have suggested a model of cointegration in which we can test for cointegration among the set of variables in the presence of two structural breaks. Therefore, in this study we have preferred Johansen et al.'s (2000) test and results of Johansen et al.'s (2000) test will be presented. Johansen et al.'s (2000) test can be described as follows:

Consider a Vector Autoregressive (VAR) model of the form Johansen and Juselius (1990):

$$Y_t = \omega + \sum_{i=0}^p \Pi Y_{t-i} + \varepsilon_t \quad (2)$$

where  $Y = [\text{GDP}_t, \text{Construction}_t]'$ ,  $\omega$  is a  $2 \times 1$  vector of deterministic variables,  $\Pi$  is a  $2 \times 2$  coefficient matrix and  $\varepsilon$  is a  $2 \times 1$  vector of disturbances with normal properties. If there exists a cointegrating relationship between real exports and real imports, then Equation 2 may be reparameterized into a Vector Error Correction Model (VECM):

$$\Delta Y_t = \omega + \sum_{i=0}^{p-1} \varphi_i \Delta Y_{t-i} + \Pi Y_t + \varepsilon_t \quad (3)$$

where  $\Delta$  is the first difference operator and  $\varphi$  is a  $2 \times 2$  coefficient matrix. The rank,  $r$ , of  $\Pi$  determines the number of cointegrating relationships. If the matrix  $\Pi$  is of full rank or zero, the VAR is estimated in levels or in first differences, respectively, since there is no cointegration amongst the variables. However, if the rank of  $\Pi$  is less than  $n$  then there

exist  $2 \times r$  matrices  $\beta$  (the cointegrating parameters) and  $\alpha$  (the adjustment matrix, which describes the weights with which each variable enters the equation) such that  $\Pi = \alpha\beta'$ , and Equation 3 provides the more appropriate framework. The  $\Pi$  matrix is estimated as an unrestricted VAR and tested to see whether the restriction implied by the reduced rank of  $\Pi$  can be rejected. The test statistics for determining the cointegrating rank of the  $\Pi$  matrix are the trace statistic given by  $Q_t = -T \sum_{i=T-r}^k \log(1 - \lambda_i)$  for  $r = 0, 1, \dots, k-1$  and  $\lambda_i$  = the  $i$ -th largest eigenvalue and the maximum eigenvalue statistic, which is given by  $Q_t = -T \log(1 - \lambda_{T-1}) = Q_t - Q_{t+1}$ . If the data and unit root analyses suggest structural breaks then we employ the test specification and procedure detailed in Johansen et al. (2000). The authors generalized the multivariate likelihood procedure of Johansen (1988) by allowing up to two structural breaks, either in levels only or in levels and trend jointly, to be added to the specification. Assume there are two breaks, in which case the sample can be split into three periods ( $q=3$ ) and Equation 3 is specified as:

$$\Delta Y_t = \omega E_t + \sum_{i=1}^p \sum_{j=1}^q K_{j,i} D_{j,t-1} + \sum_{i=1}^{p-1} \Phi_i \Delta Y_{t-i} + \alpha \begin{pmatrix} \beta \\ \mu \end{pmatrix}' \begin{pmatrix} Y_{t-1} \\ tE_t \end{pmatrix} + \varepsilon_t \quad (4)$$

where  $E_t$  is a vector of  $q$  dummy variables  $E_t = (E_{1,t}, \dots, E_{q,t})$  with  $E_{j,t} = 1$  ( $j = 1, 2, \dots, q$ ) if observation  $t$  belongs to the  $j$ -th period and zero otherwise, with the first  $p$  observations set to zero; and  $D_{j,t} = 1$  ( $j = 2, \dots, q$  and  $i = 1, \dots, p$ ) is a dummy that equals unity if observation  $t$  is the  $i$ -th observation of the  $j$ -th period. The hypothesis for determining the cointegration rank is formulated as before except that the asymptotic distribution now depends on the number of nonstationary relationships, the location of the break points and the trend specification. In this regard, the critical values as well as the p-values of all Johansen trace tests are obtained by computing the respective response surface according to Johansen et al. (2000). Further, since there is no lag structure for the dummy series, therefore dummy variable is included in the system, but not in the cointegration space. For this reason, the dummy result is not present in the cointegration results. In this case also optimum number of lags has been based on SIC.

Once the cointegrating vectors have been estimated among a set of variables one can proceed to carry out VECM analysis. If variables in the system are nonstationary and cointegrated, the Granger-causality test in VECM framework will be based on the following equations:



$$\Delta X_t = \alpha_x + \sum_{i=0}^k \beta_{x,i} \Delta X_{t-i} + \sum_{i=0}^k \gamma_{x,i} \Delta Y_{t-i} + \varphi_x ECT_{x,t-i} + \varepsilon_{x,t} \quad (5)$$

$$\Delta Y_t = \alpha_y + \sum_{i=0}^k \beta_{y,i} \Delta Y_{t-i} + \sum_{i=0}^k \gamma_{y,i} \Delta X_{t-i} + \varphi_y ECT_{y,t-i} + \varepsilon_{y,t} \quad (6)$$

where,  $\varphi_x$  and  $\varphi_y$  are the parameters of the ECT term, measuring the error correction mechanism that drives the  $X_t$  and  $Y_t$  back to their long run equilibrium relationship.

The null hypothesis ( $H_0$ ) for the equation (5) is  $H_0: \sum_{i=0}^k \gamma_{x,i} = 0$  suggesting that the lagged terms  $\Delta Y$  do not belong to the regression i.e., it do not Granger cause  $\Delta X$ . Conversely, the null hypothesis ( $H_0$ ) for the equation (6) is  $H_0: \sum_{i=0}^k \gamma_{y,i} = 0$ , suggesting that the lagged terms  $\Delta X$  do not belong to regression i.e., it do not Granger cause  $\Delta Y$ . The joint test of these null hypotheses can be tested by either F-test or Wald Chi-square ( $\chi^2$ ) test.

If the coefficients of  $\gamma_{x,i}$  are statistically significant, but  $\gamma_{y,i}$  are not statistically significant, then  $X$  is said to have been caused by  $Y$  (unidirectional). The reverse causality holds if coefficients of  $\gamma_{y,i}$  are statistically significant while  $\gamma_{x,i}$  are not. However, if both  $\gamma_{y,i}$  and  $\gamma_{x,i}$  are statistically significant, then causality runs both ways (bidirectional). Independence is identified when the  $\gamma_{x,i}$  and  $\gamma_{y,i}$  coefficients are not statistically significant in both the regressions.

The statistical (non) significance of the F-tests applied to the joint significance of the sum of the lags of each explanatory variable and/or the t-test of the lagged error-correction term(s) will indicate the econometric (exogeneity) endogeneity of the dependent variable (or Granger causality). The F-tests of the ‘differenced’ explanatory variables give us an indication of the ‘short-term’ causal effects of the variables. On the other hand, the significance of the lagged error-correction term(s) will indicate the ‘long-term’ causal relationship<sup>8</sup>. The coefficient of the lagged error-correction term, however, is a short-term adjustment coefficient and represents the proportion by which the long-term disequilibrium (or imbalance) in the dependent variable is being corrected in each short period. The non-significance or elimination of any of the lagged error-correction terms

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<sup>8</sup> The lagged error-correction term contains the long-run information, since it is derived from the long-term cointegration relationship(s). Weak exogeneity of the variable refers to ECM-dependence, i.e., dependence upon stochastic trend.

affects the implied long-term relationship and may be a violation of theory. The non-significance of any of the ‘differenced’ variables which reflects only the short-term relationship, does not involve such a violation because, the theory typically has nothing to say about short-term relationships.

Finally, we carried out Impulse Response Functions (IRFs) and Variance Decomposition (VDs) analysis. Since, F-test and t-test in VECM may be interpreted as within sample causality tests as they only indicate the Granger-exogeneity or endogeneity of the dependent variable within period under consideration (see Masih and Masih, 1996). These tests do not provide information regarding the relative strength of the Granger causal chain amongst the variables beyond the period under study. In order to analyze the dynamic properties of the system, the Impulse Response Functions (IRFs) and Variance Decompositions (VDs) are computed.<sup>9</sup> IRFs and VDs trace the impact of a shock in a variable into the system, over a period of time (in present study 10 years). More specifically, IRFs and VDs trace the effect of a one standard deviation shock to one of the innovations (error terms) and its impact on current and future values of the endogenous variables.

## **DATA ANALYSIS AND RESULTS INTERPRETATION**

Results of unit root analysis based structural breaks in are presented in Table 1. It is evident from Table 1 that both variables are non-stationary in level form for all cases. To check for cointegration, the order of integration of variables in consideration is required. Therefore, we transformed the data series in the first difference form, in order to check the order of integration of the variables. However, it should be noted that after making all variables in first difference form, we adopted two procedures to check the order of integration of the variables. In the first case, we determined again structural breaks and then carried out the unit root analysis for those dates. In the second case, unit root analysis was carried out by taking those structural breaks dates, which was being determined in level form of the variables.<sup>10</sup> Nevertheless, in both cases, we found that both the variables in first difference form were stationary. This implies that both variables have AR(1); therefore, we proceeded for cointegration analysis. However, as cointegration

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<sup>9</sup> To compute IRFs generalized approach has been preferred over Cholesky orthogonalization approach or other orthogonalization approaches because it is invariant of ordering of the variables as results of IRFs are sensitive to the ordering of the variables.

<sup>10</sup> In the paper, results of second case have been presented. However, results of the first case can be obtained from the author by request.

analysis requires knowledge about lag length, for analysis, we took the SIC for lag length selection as it has performed better in Monte Carlo studies (Kennedy, 2003). The results of the cointegration analysis are presented in Table 2.

**Table 1: SL unit root analysis**

Unit Root Test with structural break: Time trend included			
Variables	Impulse dummy: Used break date 1957	Shift dummy: Used break date 1957	Saikkonen and Lütkepohl (k)
Ln(Construction)	Yes	----	-1.3508 (1)
Ln(Construction)	----	Yes	-0.9888 (0)
D[Ln(Construction)]	Yes	-----	-5.5487***(0)
D[Ln(Construction)]	-----	Yes	-4.4248***(0)
	Impulse dummy: Used break date 1979	Shift dummy: Used break date 1979	
Ln(GDP)	Yes	-----	-0.7094 (1)
Ln(GDP)	-----	Yes	-0.6784 (1)
D[Ln(GDP)]	Yes	-----	-9.2628***(0)
D[Ln(GDP)]	-----	Yes	-4.5509***(0)

Note: (1) “k” Denotes lag length; (2) “D” denotes first difference form of the variable; (3) \*\*\*, \*\*and \*denotes significant at 1%, 5%, and 10% level respectively.  
Source: Author’s calculation

**Table 2: Results of cointegration analysis**

Johansen Trace Test: Intercept included			
Unrestricted and restricted dummies: [1957] and [1979] (1)			
r	LR	P-value	
0	110.86	0.00000	
1	9.43	0.3416	

Note: (1) “r” and “LR” denotes number of cointegrating relations/vectors and log likelihood ratio respectively. (2) Values in ( ) denotes the number of lag length used in cointegration analysis.  
Source: Author’s calculation

It is evident from Table 2 that, in all cases, there is strong evidence for the presence of one cointegrating vector (i.e., stable long run relationship exist between the two variables). Long run cointegrating equation is presented in Table 3.

**Table 3: Results of cointegration equation analysis**

Cointegration equation: t-value in “[ ]”		
	Construction	Deterministic term included
<b>GDP at Factor Cost</b>	0.611*** [7.737]	Constant, Impulse dummy and Shift dummy
	9.43	0.3416

Note: (1) \*\*\*, \*\*and \*denotes significant at 1%, 5%, and 10% level respectively.  
Source: Author’s calculation

It is evident from the cointegrating equation that coefficient of construction is positively significant, which shows that 1% age increase in construction flow in the Indian economy will bring 61% increase in the economic growth rate.<sup>11</sup> In the next step, VECM analysis has been carried out by incorporating one lead-lag relation and one cointegration relation. Results of VECM analysis are presented in Table 4.

**Table 4: VECM Engle-Granger causality analysis**

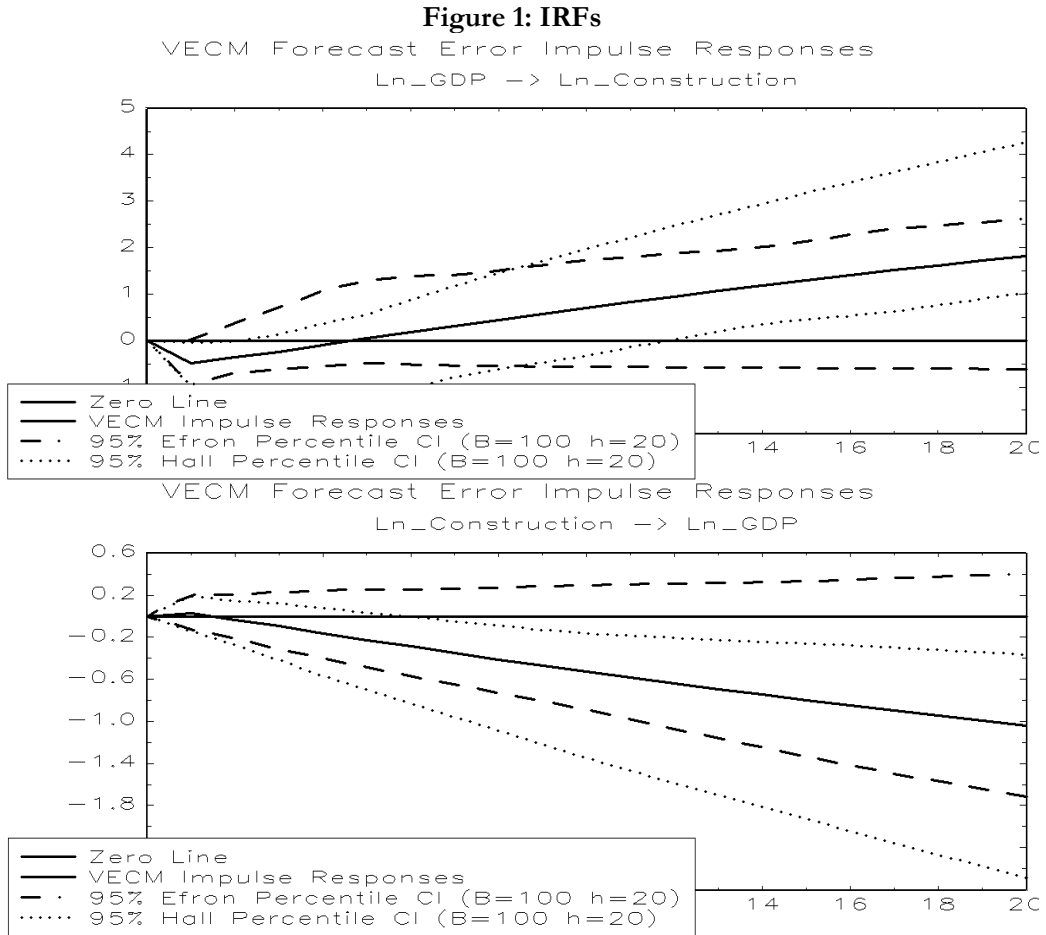
Vector Error Correction Estimates: Deterministic variables- Impulse, shift and Constant		
Independent variables (k)	Dependent variables	
	d(log of GDP at Factor Cost)	d(log of Construction)
CointEq (-1)	0.064***[8.853]	0.078***[5.173]
d(GDP at Factor Cost (-1))	-0.332**[-2.365]	-0.632** [-2.143]
d(log of Construction(-1))	0.107* [1.652]	0.296** [2.164]

Note: (1) \*\*\*, \*\*and \*denotes significant at 1%, 5%, and 10% level respectively; (2) 'd' denotes first difference; (3) (k) denotes lag length; (4) In "[ ]" t-values.  
Source: Author's calculation

It is evident from Table 4 that cointegration coefficient i.e., error correction term of both the variables is significant and positive. A negative and significant value of error correction term indicates that in the next period any disturbance in the corresponding dependent variable will get corrected by the amount of the coefficient value. Conversely, a positive and significant value of the error correction term indicates that any disturbance in the dependent variable will diverge from the equilibrium by the amount of the coefficient value. For example, when dependent variable is GDP corresponding to it value of error correction term is 0.064 which implies that any disturbance in the GDP will get diverge by 6.4% in the next year. Similarly, in the case of construction, any disturbance in the construction will get diverge by 7.8% in the next year. Further, we also found that past value of GDP had negatively significant impact on the GDP itself and construction while construction has positive and significant impact on the GDP and construction.

In the final step, we computed IRFs and VDs. IRFs have been presented in Figure 1 and in the association to IRFs; VDs are presented in Table 5.

<sup>11</sup> Here one might put question if 1% increase in construction sector increases GDP by 61%, it is worthless for Indian government to make investment in other sector and only focus on construction sector. This is true in case of India. Since independence, Indian government is focusing on construction sector and even today a big proportion of total annual expenditures go in this sector. On the other side, Indian government has not neglected technology and agriculture sector in her annual and five year plans because in these sectors, particularly, in agriculture sector, even today around 50% of the population is dependent. However, the above presented result is somewhat overestimated. This might be because of our model which analysis bivariate case and therefore, suffers form the problem of omitted variables bias.



It is evident from Figure 1 that any innovation in the GDP will have negative impact/response on the construction sector and thereafter, its impact turn towards positive direction and in the 8½ years it become positive. Conversely, any innovation/shock in the construction sector would have a positive impact on the GDP and thereafter, its impact moves in the negative direction. Similarly, from the results of VDs (as shown in table 4) we found that for the first ten years, any one standard deviation shock/innovation in GDP had negative impact on the construction sector of the economy, while for the long run i.e., after 10 years, its impact starts working in the positive direction. However, during the first 10 years of duration, any one standard deviation shock/innovation in the construction sector had positive impact on the GDP sector of

the economy while, for the long run i.e., after 10 years, its impact starts working in the negative direction.

**Table 5: Results of Variance Decompositions (VDs) analysis**

Proportions of forecast error in "Construction" accounted for by:		
Period	GDP at Factor Cost	Construction
1	0.13	0.87
2	0.07	0.93
3	0.06	0.94
4	0.05	0.95
5	0.05	0.95
10	0.07	0.93
15	0.11	0.89
20	0.17	0.83
Proportions of forecast error in "GDP at Factor Cost" accounted for by:		
Period	GDP at Factor Cost	Construction
1	1.00	0.00
2	0.99	0.01
3	0.99	0.01
4	0.99	0.01
5	0.99	0.01
10	0.93	0.07
15	0.82	0.18
20	0.70	0.30

Source: Author's calculation

## CONCLUSIONS

This study had examined the direction of causality between economic growth and construction flows both in static and dynamic framework by incorporating the endogenously determined structural changes of the construction sector and the economy for the period 1950-1951 to 2008-2009. For this, we employed a method which endogenously determined the most significant structural breaks. Subsequently, we incorporated those breaks dates in cointegration analysis. Cointegration analysis revealed that there was strong evidence of long-run relationship between economic growth and construction flows. Findings from the causality analysis indicated that there was a bi-directional causality between construction flows and economic growth. Since the error correction terms of both the equations are significant, it implied that both variables were econometric endogenous. However, positive and significant value of error correction term

implies that any disequilibrium in both the variables would not get corrected, but would diverge.

Results of dynamic Granger-causality analysis revealed that one standard deviation shock/innovation in GDP had negative impact on the construction sector of the economy for the first 10 years; while for the long run its impact starts working in the positive direction. However, for the first 10 years of duration, any one standard deviation shock/innovation in construction sector had positive impact on the GDP sector of the economy, while for the long run i.e., after 10 years, its impact starts working in the negative direction.

Our results have important policy implications. The results suggest that for the short-run, Indian government can focus on the development of construction sector as it increases GDP. However, in the long-run Indian government should gradually cut down her budget expenditure on construction sector. The work can be extended further by analyzing the issue under a multivariate framework.

## **ACKNOWLEDGEMENT**

I gratefully acknowledge feedback from two anonymous reviewers that helped a lot to improve the paper. The usual disclaimer applies.

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