In what way does the construction sector contribute to economic growth? Empirical evidence from India

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Abstract: In its attempt to investigate the change in the demand of the construction industry mix and its impact on the economic growth as India develops, the study tries to analyse the long-run equilibrium relationship between construction subsectors and economic growth using ARDL bounds test to cointegration for the period 1970–2011. The empirical findings indicate that the impact of new construction subsector on the economic growth is greater than that of repairs and maintenance construction subsector in the long run. The findings ratify an assumption that in the upward growth trend in developing countries, the structure of the construction industry tends to conform that of the general economy. Findings have important policy implications for policy makers. To boost employment and enhance the productivity of the industry, the government should efficiently make use of local resources in the development and maintenance of structures in the country.

Keywords: construction sector; new construction works; repair and maintenance works; economic growth; cointegration test; autoregressive distributed lag model; ARDL model; Granger causality test.


Biographical notes: Vandana Bhavsar is an Associate Professor and holds a PhD in Economics. Her research interests are construction management, housing sector and infrastructure management and econometrics.

Abhijeet Sangapurkar holds a Master’s in Civil Engineering and is an Assistant Professor. He is also a research scholar and his research interests are construction management, safety and health, and TQM.
1 Introduction

This study pioneers to examine the change in the demand of the construction industry mix in India to resolve a query – how much and/or in which form does the construction sector contribute to economic growth as the country develops over a period of time? The case of India as a developing economy is interesting and suitable because of her transition from least developed economy to new emerging economy. In investigating the varying role of the construction sector at various stages of development of a country, various scholars like Bon (1992), Pietroforte and Gregori (2006), Tan (2002), Wells (1986) and others concluded that in the initial stages of development the share of construction increases, but ultimately it decreases. Hitherto, except for studies of advanced economies like Bon and Pietroforte (1993) and Wong et al. (2008), to best of knowledge, none, of the studies for developing countries have been carried to examine the transformation in the mix of construction demand as a country develops. The present study, thus, seeks to fill this gap in extant literature by providing empirical evidence of causal links between new construction, repairs and maintenance (hereafter RM) and economic growth in India.

The rationale to undertake this analysis is, first, both construction subsectors contribute to economic growth. However, of the two subsectors of construction, new construction delivers to final demand, whereas RM produces for intermediate use in the economy (Pietroforte and Gregori, 2003). This is because RM may concern inputs from all sectors of the economy. In its final form, it either adds to total output or is further used for production process, whereas, it indirectly adds to total output and income in its intermediate form by increasing employment. However, in most countries RM activities are not reported at all or under-reported in national accounts, thus making it difficult to know the real economic growth rate of a country.

Second, as Bon (1992) claims, countries which are yet to expand, their construction demand is low, as they expand the construction growth increases and when a country attains maturity the growth in construction slows down. This is also in line with Rostow’s five stages of growth theory (Rostow, 1956). While this may be true for the construction sector as a whole, it may not be for sub-sectors within the construction sector. Interestingly, Bon’s output data excludes housing as well as RM.

Third, in the initial stages of economic development of the country, the proportion of new construction works in the total construction output is more as compared to the share of RM works, but consequently the share of RM work rises in the total construction output as the country develops from a less developed country to newly industrialised country and to advanced industrialised country eventually with time. Besides, as cited by Horner et al. (1997), the reduction in resources applied to building maintenance will have a direct effect on a nation’s economy.

Lastly, because of the policy of attracting 100% FDI in the construction sector in the recent past and huge investments in building physical infrastructure by the Government of India (12th Five-Year Plan). Therefore, it is quite reasonable to speculate that there would be a transformation in the mix of construction demand as India progresses from an agrarian economy to a service economy.
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Given the above setting, the intent of this work is threefold. The first aim is to examine the trends in the ratio of new construction works to GDP and a ratio of repairs and maintenance works to GDP as India progresses. Second is to empirically investigate the long-run equilibrium relationship of new and RM construction activities in context of economic growth and employment in the country. In other words, to know whether new construction works (final form) contribute to economic growth or whether RM works (intermediate form) contribute to economic growth in India. Third is to explore and examine the pattern of causality among the variables in India.

In recognition of the need for this study, the autoregressive distributed lag (ARDL) bounds approach to cointegration, fully modified ordinary least square (FMOLS) and Granger causality tests are used to empirically test the relationship between two subsectors of construction and aggregate economic growth in India. ARDL and FMOLS both are renowned for producing parsimonious results in small sample data as in this study. It also estimates short-run and long-run elasticities and confirms the nature and pattern of causality between new construction, repair and maintenance and economic growth in India.

The rest of the paper is structured as: Section 2 provides an overview of the construction sector and in particular glance of new and RM activities in India; Section 3 outlines various strands of extant literature and finds mixed evidences; Section 4 summaries the methodology on ARDL approach to cointegration; Section 5 discusses econometric results and Section 6 focuses on conclusion and policy implications of the findings.

2 Construction sector and Indian economy

In India the estimates of construction value added to GDP is estimated from corresponding estimates of the value of output, that is, value of construction by type. The estimates of the value of output from construction are prepared separately for accounted (pucca) construction and labour intensive unaccounted (kutcha) construction. The estimates of former are prepared by commodity flow approach and for later are prepared by expenditure approach using sample surveys, budget documents of central/state governments, local bodies and annual reports of public and private enterprises. The output from accounted and unaccounted construction, thus obtained includes new construction and repairs and maintenance of dwellings, other buildings and structures. So the entire output of construction of the whole economy is compiled by a composite methodology, including commodity flow approach and expenditure approach and taken as total production costs of accounted and unaccounted construction.

A closer look at India’s growth story indicates that the performance of the Indian economy was almost stagnant till the late 1970s mainly because of ceaseless growth of the manufacturing sector and deceleration in agricultural growth. Nevertheless, this trend reversed and there was a great impulse to the growth during 1980s and further, since the
1990s due to comprehensive reforms encompassing various sectors of the economy. Furthermore, there has been distinctive strengthening of growth momentum since 2003–2004 due to restructuring measures, improved corporate profitability, and so forth.

In India, construction is the second largest economic activity after agriculture due to its forward and backward linkages with the other sectors. About 250 ancillary industries such as cement, steel, brick, timber and building materials are dependent on the construction industry. The construction sector in India has an imperative role in the development of a country’s infrastructure, which is a key engine of economic growth. While the Indian economy grew by 7.23% during 2000–2010 as compared to 5.78% during 1990–2000, the construction industry grew by 9.25% during 2000–2010 against 5.57% during 1990–2000.

Table 1  Growth by construction subsector at constant prices: base year 2004–2005

<table>
<thead>
<tr>
<th>Year</th>
<th>New construction CARG (% p.a.)</th>
<th>Repair and maintenance CARG (% p.a.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950–1960</td>
<td>3.88</td>
<td>3.38</td>
</tr>
<tr>
<td>1960–1970</td>
<td>5.8</td>
<td>10.67</td>
</tr>
<tr>
<td>1970–1980</td>
<td>3.53</td>
<td>2.54</td>
</tr>
<tr>
<td>1980–1990</td>
<td>4.15</td>
<td>0.42</td>
</tr>
<tr>
<td>1990–2000</td>
<td>6.41</td>
<td>7.1</td>
</tr>
<tr>
<td>2000–2010</td>
<td>9.1</td>
<td>10.52</td>
</tr>
</tbody>
</table>

Source: http://economicoutlook.cmie.com

As is evident from Table 1 the compound annual rate of growth of new construction works in India has been a consistently increasing over a period of time, except for the period 1970–1980s. Conversely, the growth of RM works has been highly erratic in the country. This specifies that in India RM works occupy smaller share in the total construction output, whereas new construction works are of greater standing. However, after late 1980s due to policy reforms in India, the share of new construction works marginally increased while that of RM declined. Moreover, due to a crisis in 2007–2008, the share of new construction activities declined while the share of RM increased. Interestingly, the share of RM ranges around 20% of the total output over a period of time.

By looking at Figure 1 it is quite clear that over the period of time as economic growth expands new construction as well as RM also increases. This historical trend lays a strong foundation for further examination of the change in the mix of construction demand.

The industry enjoys focus from the top officials of the Government for initiating policies that would ensure time-bound creation of world class infrastructure in the country. Acknowledging the fact that strong infrastructure facilities, form the mainstay of a nation’s growth, the 12th Five Year Plan (2012–2017) saw an ambitious investment target of nearly USD 1 trillion in building physical infrastructure such as roads, ports, railroads, airports, dams, canals, power, irrigation, housing, urban utility, watershed development works, building special economic zones and so on. Equally, during 2002–2007 for the first time, the construction industry was accorded industrial concern status under the Industrial Development Bank of India (Amendment) Act (11th Five-Year Plan, p.240).
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Figure 1  Trends in volume of new construction, repairs and maintenance and GDP in India

3 Literature review

Construction is an important part of capital investment and it is a significant argument catalysing government’s economic policies. Construction activities are an important component of a country’s macroeconomic development. Wells (1985), by and large defined the term ‘construction’ to encompass the creation of physical infrastructure (roads, railways, harbours), other civil-engineering work (dams, irrigation projects, power plants), all building work (including housing), as well as the maintenance and repair of existing structures. Similarly, the UN handbook in its ‘Classes of Construction’ (p.27, para-73) draws clear distinction between new construction and repair and maintenance. Accordingly, new construction includes site preparation for, and construction of entirely new structures and/or significant extensions to existing structure, whether or not the site was previously occupied, whereas repair and maintenance includes all construction work not included under new construction that is restoration and conversions intended to extend the normal economic life or to increase the productivity of existing structures.

Scholars like Bon (1990), Lean (2001) et al. suggest that construction has a strong linkage with many upstream economic activities, such as cement, bitumen, steel, quarries (road and building aggregates), industrial products, services (engineering, technology transfer) and downstream activities such as creation of social infrastructure, agriculture, defence, transportation and whatever happens to the industry will directly and indirectly influence other industries and ultimately, the wealth of a country.
In the extant literature, there are three strands on the role of construction sector in an economy. First comprises of studying the relationship between construction and economic development. Since 1970s various scholars and international bodies (e.g., Drewer, 1980; Strassmann, 1970; Turin, 1973; Wells, 1986; World Bank, 1984) assessed cross-sectional data across countries and established a positive correlation between several measures of construction output and the level of income per capita.

The second consists of assessing whether investing in construction leads GDP growth or vice versa. Ever since 1990s, researchers like Anaman and Osei-Amponsah (2007), Green (1997), Lean (2001), Lopes et al. (2011), Tse and Ganesan (1997) and so on, used econometric methodologies like Granger causality test to analyse the linkages between construction sector and economic growth and found that either bidirectional or unidirectional relationship exists between GDP and construction sector in various developed and developing economies. Wong et al. (2008) using Granger causality test on the gross value of construction works in Hong Kong found that of the sub-sectors (buildings, civil engineering, and maintenance and repairs) of the construction sector, only civil engineering sector Granger causes GDP. In yet another study, using Granger causality and cointegration, Yoo (2006) examined causality between seaport infrastructure and economic growth in Korea and found unidirectional influence on seaport infrastructure on economic growth. In India, there exist two studies on the relationship between construction sector growth and economic development. Mallick and Mahalik (2010) examined the role of construction in economic growth in the presence of capital stock in India using Engle-Granger cointegration and ARDL approach to cointegration. The primary finding is that the construction sector is not a significant determinant of economic growth in the presence of capital stock. Another study in Indian context was carried by Tiwari (2011) to examine the static and dynamic causal relationship between construction flows and economic growth. The outcomes indicate bidirectional relationship between the variables and cointegration tests show strong evidence of long-run relationship between economic growth and construction flows.

A third strand of literature includes examination of role of construction in a national economy through input-output tables. Bon and Pietroforte (1993) by employing seven input-output tables of US construction sector found significant differences in terms of backward linkages and output multipliers of new construction and maintenance and repair. Pietroforte and Bon (1995) too incorporated input-output tables for Italian construction sector and found weakening of construction sector’s effect on the economy over 30 years. Pietroforte and Gregori (2003) and Gregori and Pietroforte (2015) used input-output tables for eight highly developed and six emerging economies respectively to analyse the performance of the construction sector and established that the construction industry follows the economic destiny for developed economies. For new emerging economies, they developed a new index to assess structural change and differences in input expenditures between the countries.

The present work is concerned with second strand of literature. Nevertheless, the study differs from existing literature since for the first time two subsectors of building activities (new construction and RM) and economic growth of India in the context of long-run cointegrating relationship and short-run cause (error correction term) is investigated. Also to note, the study takes into account total labour employment in construction to gauge the contribution of the construction sector in the economic growth in India.
4 Data and methodology

4.1 Data and empirical model

This study employs annual time series data of volume of new construction (NCon), volume of repair and maintenance (RM), total employment of labour in construction sector (TL) as indicators of construction sector and GDP per capita (Y) as an indicator of economic growth, measured at constant 2004–2005 prices. The study period ranges from 1970–2011. The data are mainly sourced and assessed from the official website of Centre of Monitoring Indian Economy’s (CMIE) Economic Outlook.

In estimating the empirical relationship between construction subsectors and aggregate economic growth in India, simple linear model is applied. Total labour employment in construction is included in this study since it is one of the factor inputs. Also, GDP per capita is used as an indicator of economic growth for the reason that it brings together population with total product of a nation which appears to be a better indicator of the country’s welfare than GDP. The investigation is done under a partial framework since the main aim is to see the relationship between construction activities and an overall growth rate without considering several other critical factors influencing economic growth. The functional form of the model is specified as:

\[ Y_t = \beta' Con_t + TL_t + \epsilon_t \] (1)

where \( Y_t \) is economic growth in year \( t \), \( Con_t \) is value of output of construction (further decomposed into new construction and RM) in year \( t \), \( TL_t \) is total labour employment in construction in year \( t \) and \( \epsilon_t \) is a disturbance term. All the variables in the equation (1) are transformed by their logarithm to form an equation (2).

\[ \ln Y_t = \alpha_0 + \alpha_1 \ln Con_t + \alpha_2 \ln TL_t + \epsilon_t \] (2)

Further, in order to seek the answer to the question whether new construction and/or RM activities of construction contributes to the economic growth, the components of construction activities are used to model equations (3) and (4) below to capture their respective relationships with economic growth.

\[ \ln Y_t = \beta_0 + \beta_1 \ln NCon_t + \beta_2 \ln TL_t + \epsilon_t \] (3)

\[ \ln Y_t = \gamma_0 + \gamma_1 \ln RM_t + \gamma_2 \ln TL_t + \mu_t \] (4)

where \( \mu_t, \epsilon_t \) are error terms, NCon is new construction works and RM is repair and maintenance works.

4.2 Unit root and cointegration test

To empirically evaluate level relationships and to capture long-run dynamic interactions among the variables of interest, bounds test for cointegration framework within ARDL model developed by Pesaran et al. (2001). This model was chosen over other methods of testing cointegration such as Johansen and Juselius’s (1990) cointegration and conventional Johansen’s (1988) cointegration tests for following reasons:
a. it can be applied to variables irrespective of their order of integration, that is, purely I(0), purely I(1) or mixed

b. it is efficient for limited sample data between 30 to 80 observations and large sample (Pesaran and Shin, 1995)

c. both short-run and long-run coefficients could be obtained simultaneously.

However, presence of I(2) makes this method unsuitable and so it is necessary to test for stationarity of variables. The unit root tests employed are augmented Dickey-Fuller (ADF) (1979) and Phillips-Perron (1989).

The foremost step in applying bounds test procedure by modelling equations (3) and (4) as unrestricted error correction model to capture both short-run and long-run dynamics for cointegration relationships is given as follows:

\[
\Delta \ln Y_t = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta \ln Y_{t-i} + \sum_{i=1}^{k} \theta_i \Delta \ln NCon_{t-i} + \sum_{i=1}^{k} \eta_i \Delta \ln TL_{t-i} + \pi_1 \ln Y_{t-1} \\
+ \pi_2 \ln NCon_{t-1} + \pi_2 \ln TL_{t-1} + \epsilon_t 
\]  

\[
\Delta \ln Y_t = \alpha_1 + \sum_{i=1}^{k} \delta_i \Delta \ln Y_{t-i} + \sum_{i=1}^{k} \gamma_i \Delta \ln RM_{t-i} + \sum_{i=1}^{k} \theta_i \Delta \ln TL_{t-i} + \pi_1 \ln Y_{t-1} \\
+ \pi_2 \ln RM_{t-1} + \pi_2 \ln TL_{t-1} + \epsilon_t 
\]

To examine the long-run relationship among the variables two hypotheses are developed. The null hypothesis of no cointegration (H_0: \( \pi_1 = \pi_2 = \pi_3 = 0 \)) is tested against the alternative hypothesis of the existence of cointegration relationship (H_0: \( \pi_1 \neq \pi_2 \neq \pi_3 \neq 0 \)).

This is based on F-test by ordinary least square (OLS) estimation. Then the computed F-statistics value is compared with simulated critical bound values from Narayan (2005) generated specifically for small sample data. F-statistics have non-standard distribution that depends on whether the variables included in the model are purely I(0), I(1) or mixed. If the F-statistics is more than the upper critical value, the null hypothesis of no long-run cointegration can be rejected, that is, there exist cointegration relationships. On the other hand, if the test statistics is less than the lower upper critical value the null hypothesis is not rejected that is there is no cointegration. However, if the test statistics fall between lower and upper critical values, the result is inconclusive.

In the succeeding step, once cointegration is established, then following long-run model will be estimated to obtain long-run coefficients of the relationship between the variables:

\[
\Delta \ln Y_t = \alpha_2 + \sum_{i=1}^{k} \beta_2 \Delta \ln Y_{t-i} + \sum_{i=0}^{k} \theta_2 \Delta \ln NCon_{t-i} + \sum_{i=0}^{k} \eta_2 \Delta \ln TL_{t-i} 
\]

\[
\Delta \ln Y_t = \beta_2 + \sum_{i=1}^{k} \delta_2 \Delta \ln Y_{t-i} + \sum_{i=0}^{k} \gamma_2 \Delta \ln RM_{t-i} + \sum_{i=0}^{k} \theta_2 \Delta \ln TL_{t-i} 
\]

In the next step, to obtain the short-run coefficient, the error correction model of ARDL specification is specified as:
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\[ \Delta \ln Y_t = \alpha_3 + \sum_{i=1}^{k} \beta_{3i} \Delta \ln Y_{t-i} + \sum_{i=0}^{k} \theta_{3i} \Delta \ln NCon_{t-i} + \sum_{i=0}^{k} \eta_{3i} \Delta \ln TL_{t-i} + \delta_i ECM_{t-i} + \varepsilon_{3i} \]

\[ \Delta \ln Y_t = \beta_3 + \sum_{i=1}^{k} \beta_{2i} \Delta \ln Y_{t-i} + \sum_{i=0}^{k} \theta_{2i} \Delta \ln RM_{t-i} + \sum_{i=0}^{k} \theta_{3i} \Delta \ln TL_{t-i} + \delta_i ECM_{t-i} + \varepsilon_{2i} \]

where \( \delta_i \) is the coefficient of the error correction term, which measures the speed of adjustment at which the disequilibrium will be corrected in the long run from short run.

For robustness to ARDL estimate, fully modified ordinary least square (FMOLS) of Phillips and Hansen (1990) is used. Also FMOLS deals with serial correlation problems as well the sample size bias. Lastly, serial correlation test, heteroscedasticity test and normality test are carried out to check the stability and efficiency of the estimates.

4.3 Granger causality

To further examine the pattern of causality among the variables, Granger’s (1969) concept of causality is employed. This is based upon a prediction error: “X ‘causes’ Y if and only if Y is better predicted by using the past history of X than by not doing so with the past Y being used in either case”. This is carried out by means of the following formulation:

\[ X_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} X_{t-i} + \sum_{i=0}^{n} \alpha_{2i} X_{t-i} + \mu_t \]

where \( \mu_t \) are zero-mean, serially uncorrelated, random disturbances. The optimum lag lengths \( m \) and \( n \) are determined on the basis of Schwarz-Bayesian criterion (SBC).

5 Results and discussion

5.1 Results

India’s advancement from a least developed economy to a developing country provides an opportunity to examine variation in the construction activities viz. new construction and repair and maintenance works as India develops and to analyse how construction contributes to the growth of the country. In this context, data of total construction output as a share of GDP, new construction as a share of GDP and RM as a share of GDP and GDP per capita are plotted in Figure 2.

An upward trend is depicted both in total construction output as well as new construction as a share of GDP, however, for RM the trend is more or less invariant. The growth in new construction works in India is mainly attributed to growth in infrastructure, in the building sector, and in housing. Since 10th five-year plan, the Government of India planned massive investments on creating physical infrastructure viz.
roads (the ambitious Golden Quadrilateral Project 2004), housing, transportation, irrigation, urban development, civil aviation and so on which augmented construction demand in the economy. Correspondingly, as per the five-year planning documents (10th, 11th and 12th plans) there has been increasing significance of construction activities in the growth of the economy since the component of construction comprises nearly 60%-80% of the project cost of certain infrastructure projects. As a result, a more careful empirical investigation is needed to know about the long-run and short-run relationships among the variables in Indian setting.

Figure 2 Total, new construction and repairs and maintenance as a share of GDP and GDP per capita

For this empirical analysis, firstly stationarity of all variables is examined to determine their order of integration. This is required to ensure that none of the variables are of order I(2), since variables of order I(2) violates the properties of ARDL bounds test. In order to test for stationarity unit root tests carried by ADF test and also PP tests are displayed in table 2.

Table 2 ADF and PP unit root tests

<table>
<thead>
<tr>
<th></th>
<th>At levels</th>
<th></th>
<th>First difference</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADF</td>
<td>PP</td>
<td>ADF</td>
<td>PP</td>
</tr>
<tr>
<td>lnY</td>
<td>-0.88694</td>
<td>-0.88694</td>
<td>-7.93954*</td>
<td>-9.29068*</td>
</tr>
<tr>
<td>lnNCon</td>
<td>-0.81688</td>
<td>-1.0864</td>
<td>-9.62461*</td>
<td>-9.88747*</td>
</tr>
<tr>
<td>lnRM</td>
<td>-0.63748</td>
<td>-0.42159</td>
<td>-6.13569*</td>
<td>-6.65106*</td>
</tr>
<tr>
<td>lnTL</td>
<td>-1.94198</td>
<td>-1.95698</td>
<td>-5.86522*</td>
<td>-5.85933*</td>
</tr>
</tbody>
</table>

Notes: Eviews 9 used for estimations.
The critical values for ADF and PP tests at 1%, 5% and 10% are -4.19, -3.52, -3.19 respectively for with trend and intercept.
*Denotes the rejection of the null at 1% significance level.
Source: Authors’ calculations using economic outlook data
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ADF and PP tests are incorporated because of its extensive usage in the literature. The test regression included both a constant and trend for the log-levels and for the first differences of the variables. It is apparent from the outcomes that all series are non-stationary for ADF and PP at levels but they become stationary after first difference. Hence, these variables are integrated of order I(1).

The next step is to determine the optimal lag length. Table 3 exhibits the results of lag length as selected by four different criteria: final prediction error (FPE), Akaike information criteria (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion. As is clearly evident, optimal lag length of (1) out of maximum 4 lags lengths has been selected by all the four criterions.

<table>
<thead>
<tr>
<th>Lag</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.53E-08</td>
<td>-6.14131</td>
<td>-5.96893</td>
<td>-6.07998</td>
</tr>
<tr>
<td>1</td>
<td>7.17E-12*</td>
<td>-14.31580*</td>
<td>-13.45392*</td>
<td>-14.00915*</td>
</tr>
<tr>
<td>2</td>
<td>8.60E-12</td>
<td>-14.1642</td>
<td>-12.6128</td>
<td>-13.6122</td>
</tr>
</tbody>
</table>

Note: *Indicates lag order selected by the criterion.

Source: Same as Table 2

Now to test for existence of cointegration between the variables equations (5) and (6) is estimated to produce the value of F-statistics and reported in Table 4. As mentioned earlier, to reject the null hypothesis of no long-run cointegration among the variables, the F value should be greater than upper bound critical values.

<table>
<thead>
<tr>
<th>Model</th>
<th>F-statistic</th>
<th>Lag</th>
<th>Level of significance</th>
<th>Critical value bounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F(\ln Y_t, \ln N_{Con}, \ln TL_t)$</td>
<td>7.274132*</td>
<td>1</td>
<td>5%</td>
<td>4.133</td>
</tr>
<tr>
<td>$F(\ln Y_t, \ln RM_t, \ln TL_t)$</td>
<td>5.691298*</td>
<td>1</td>
<td>5%</td>
<td>4.133</td>
</tr>
</tbody>
</table>

Notes: SIC was used for lag length selection. The number of regressors is 2.

*Indicates statistical significant at 5% level.

Source: Same as Table 2

The results in Table 4 display the computed F-statistics to be greater than the upper bound critical value obtained from Table Case III in Narayan (2005). This shows that rejection of null hypothesis, implying that there is long-run cointegrating relationship between GDP per capita, new construction, repair and maintenance and total labour employment. In other words, the variables form stable long-run relationships with one another. While there may be temporary deviations in the short run, but in the long run there is equilibrium among the variable.

After establishing long-run cointegrating relationship among the variables, equations (7) and (8) are estimated using ARDL specification. FMOLS is also used to check the robustness of long-run estimates obtained from ARDL. The results obtained from ARDL and FMOLS estimations of the equations (7) and (8) are displayed in Table 5.
Table 5  Long-run estimates

<table>
<thead>
<tr>
<th>Variable</th>
<th>Autoregressive distributed lag (ARDL)</th>
<th>Fully modified ordinary least square (FMOLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>lnNCon</td>
<td>0.660751*</td>
<td>-</td>
</tr>
<tr>
<td>lnRM</td>
<td>-</td>
<td>0.362834</td>
</tr>
<tr>
<td>lnTL</td>
<td>-0.04686</td>
<td>0.911836</td>
</tr>
<tr>
<td>C</td>
<td>0.520407</td>
<td>-1.88826</td>
</tr>
</tbody>
</table>

Notes: Selected model: ARDL (1, 0, 0) for equations (7) and (8) based on Schwarz criterion (SIC).

*Significant at 1% level.

Source: Same as Table 2

Evidently from the long-run estimates in ARDL estimates, only new construction works is found to have a significant positive relationship with economic growth at 1% and not RM works. The long-run coefficient of new construction implies that a percentage increase in new construction would lead to 0.66% growth in real economy. Further, the total labour employment in construction is inversely related to economic growth in India that is the coefficient is negative and insignificant. The FMOLS estimation of new construction is in line with ARDL estimates with the positive and significant long-run relationship between new construction and economic growth and negative relationship between total labour employment and economic growth.

Interestingly, however, the FMOLS estimates of RM are not consistent with ARDL estimates. RM as well as total labour employment both is positively and significantly related with economic growth. After obtaining long-run coefficients, short-run error correction model using equations (9) and (10) is estimated and this is expected to complement long-run ARDL cointegration results.

Table 6 presents results of the short-run ARDL model. Consistent with the long-run estimates, new construction exhibit positive significant relationship with economic growth in India in the short run at 1%. Even short-run coefficient of total labour employment is in accordance with long-run estimates. However, for RM short-run estimates are not according to the long-run estimates. Further, the coefficient of ECT_{t-1} for model 1 is negative and significant at 1%, whereas, for model 2 it is positive. The disequilibrium in the short run is corrected in the long run at a rate of 25.99% for new construction works in the following period. Further, the coefficient of determination (R^2) between the variables is just 0.37.

The estimated short-run coefficients were subjected to diagnostics test for reliability under Lagrange multiplier (LM) tests. At 5% level of significance the tests give no evidence of serial correlation, Heteroscedasticity, functional form misspecification. Additionally, the coefficients are normally distributed as indicated from normality test.
In what way does the construction sector contribute to economic growth?

Table 6  Short-run error correction model

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔlnNCon</td>
<td>0.171719*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(3.186227)</td>
<td>(-0.02776)</td>
</tr>
<tr>
<td>ΔlnRM</td>
<td>-</td>
<td>-0.02776</td>
</tr>
<tr>
<td></td>
<td>(-0.4877)</td>
<td>(-0.53713)</td>
</tr>
<tr>
<td>ΔlnTL</td>
<td>-0.01218</td>
<td>-0.06976</td>
</tr>
<tr>
<td></td>
<td>(-0.22493)</td>
<td>(-0.53713)</td>
</tr>
<tr>
<td>ECT(−1)</td>
<td>-0.25989*</td>
<td>0.0765</td>
</tr>
<tr>
<td></td>
<td>(-2.72336)</td>
<td>(1.036026)</td>
</tr>
</tbody>
</table>

Model diagnostics

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistics</td>
<td>7.274132*</td>
<td>5.691298*</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.370988</td>
<td>0.315751</td>
</tr>
<tr>
<td>Adj. R-squared</td>
<td>0.319987</td>
<td>0.260272</td>
</tr>
<tr>
<td>DW statistics</td>
<td>2.420111</td>
<td>2.409305</td>
</tr>
<tr>
<td>Autocorrelation test</td>
<td>0.547</td>
<td>0.557</td>
</tr>
<tr>
<td>Heteroscedasticity test</td>
<td>0.8779</td>
<td>0.8718</td>
</tr>
<tr>
<td>Normality test</td>
<td>41.48*</td>
<td>18.07*</td>
</tr>
</tbody>
</table>

Notes: t statistics given in parenthesis.
*Significant at 1%.

Source: Same as Table 2

Table 7 displays the results of pattern of causality among the variables. The null hypothesis of new construction does not Granger-cause economic growth can be rejected by 10%, while that of economic growth does not Granger-cause new construction is rejected by 1%. This indicates bidirectional short-run causality between new construction works and economic growth in India. Conversely, for RM the causality is unidirectional, that is, economic growth Granger-cause RM at 1%. Further, the total labour employment in construction also has unidirectional causality from economic growth. In other words, economic growth causes employment in construction in India.

Table 7  Granger causality results

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>F-statistic</th>
<th>Decision on H₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnNCon does not Granger cause lnGDPpc</td>
<td>3.58077***</td>
<td>Do not reject</td>
</tr>
<tr>
<td>lnGDPpc does not Granger cause lnNCon</td>
<td>9.69318*</td>
<td>Do not reject</td>
</tr>
<tr>
<td>lnRM does not Granger cause lnGDPpc</td>
<td>0.07758</td>
<td>Reject</td>
</tr>
<tr>
<td>lnGDPpc does not Granger cause lnRM</td>
<td>8.00917*</td>
<td>Do not reject</td>
</tr>
<tr>
<td>lnTL does not Granger cause lnGDPpc</td>
<td>0.21136</td>
<td>Do not reject</td>
</tr>
<tr>
<td>lnGDPpc does not Granger cause lnTL</td>
<td>7.57397*</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Notes: *Significant at 1%.
***Significant at 10%.

Source: Same as Table 2
5.2 Discussions

The predominant share of new construction works as compared to RM in the total output of construction over a period of time is due to the fact that in India most of the government funded projects gave greater attention to new construction which is seen as evidence of development rather than maintaining assets. Additionally, in India, better political gain is seen in initiating a new construction project. Besides, the reasons why RM activity is less in India may be that repair and maintenance is mostly paid out income and so proper budget is not allocated for the same. Also, it is often considered economical to demolish a building (which is in poor shape due to lack of maintenance) and build a new building rather than defending it. There is also a lack of implementing regulations and building norms by the government. So the Indian construction sector produces very little for intermediate use since RM share is less.

The overall results of long-run and short-run coefficients suggest that in India construction sector contributes to economic growth through new construction (final form). The results corroborate from previous works of Bon (1992), Pietroforte and Gregori (2006), Tan (2002), Tiwari (2011) and Wells (1985, 1986), who suggested that for low income countries, construction output is low, but as they proceed for industrialisation, construction as a percentage of GDP increases due to more demand for factories, offices, houses and infrastructure while RM works are less. Further, the bidirectional causality between new construction and economic growth is in agreement with Tse and Ganesan (1997) who recommended that it is possible that expansion of construction activity is preceded by an increase in economic output, with the initial effect felt largely within the construction sector and only subsequently on the aggregate economy. Thus of the two subsectors new construction works translates into economic growth.

However, as indicated by error correction estimates it transpires that new construction works achieves slower convergence to long-run equilibrium and as indicated by $R^2$, new construction works is not strongly associated with economic growth. It is hence deduced that in India, the construction industry mix so far do not characterise the one like advanced economies.

Talking about total labour employment in construction sector in India, for new construction model, the negative and insignificant coefficient of total labour indicates that in India for the past few years the construction companies are focusing on mechanisation and so technology is replacing labour. Further, negative relationship between total employment in the construction sector and economic growth could be for following reasons – firstly, Indian construction industry is characterised as highly fragmented and large numbers of unorganised players work on subcontracting basis in this industry. These players further hire labourers who are casual workers. Thus reliable data related to the number of labourers working in this sector is not easily available. Secondly, the construction sector is characterised as low productive sector in India. Thirdly, in India, government schemes like Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), give employment to labour who migrate from agriculture to construction but they are counted under subsidiary activity status. Hence, they too are not counted in total labour employment force.
6 Conclusions

This study examined the causal relationship between new construction, RM and economic growth in India on an annual time series data from 1970–2011. ARDL bounds approach to cointegration was applied to investigate the long-run equilibrium relationship between construction subsectors and economic growth in India. ARDL was chosen over other conventional methods because of its advantages for small sample size. The FMOLS was also employed to test for the robustness of the long-run relationship. Both the test results are consistent and new construction was found to have a positive long-run relationship with economic growth. However, FMOLS estimates of RM were found to have a positive long-run relationship with economic growth. Disequilibrium in short-run model with a new construction model was corrected by the error correction term at a rate of 25.99%. Bidirectional causality was found between economic growth and new construction, conversely unidirectional causality was found to run from economic growth and RM. Thus new construction activities are found to be important in pushing economic activity than that of the RM activities. These results support the assumptions that in the upward growth trend in developing countries, the pattern of the construction industry tends to follow that of the general economy. Also, if economic growth is negatively related to the level of employment it indicates jobless growth as is the case with new construction model in the study.

Since there are significant differences in terms of backward linkages and output multipliers of new construction and RM (Bon and Pietroforte, 1993), the findings provided in this analysis would help researchers further to discern the multiplier and dimensional implications on the growth and development process of India. This is because direct backward linkage is considered as a rough measure of industrialisation in the construction industry. This would further help government to frame policy reforms to position the construction industry to drive the economic growth.

The Indian construction industry is conduit for a substantial part of its development investment and is poised for growth on account of industrialisation, urbanisation, economic development and people’s rising expectations for improved quality of living. However, this has put strain upon existing infrastructure and to add to it is a deficiency of repair and maintenance as a consequence of which under capacity and deterioration subsists.

For a much desired inclusive-growth and sustainable development as a priority, an important policy implication is that government should focus on well-maintained buildings since they contribute to sustainable development through comfortable working environment, extending the longevity of building and reducing carbon emissions. This could be done by supplementing adequate and easy flow of institutional finance for RM works in the country which further augments lot of job opportunities for local contractors too. As well, to advance employment and enhance productivity of the industry, the government should efficiently make use of local resources in the development and maintenance of structures in the country.
Due to lack of availability of data on residential, non-residential and other structures the study looks only at new construction and RM as subsectors of construction. Further also due to paucity of data on total labour employment from 1970–2011, the data period was influenced by starting period from 1970.

References


In what way does the construction sector contribute to economic growth?


