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Steel consumption and economic growth: Evidence from India

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Abstract

This paper examines cointegration and Granger causality between steel consumption and economic growth in India for the time span of 1951–1952 to 2003–2004 in a bivariate vector autoregression format. Augmented Dickey–Fuller tests reveal that both series, after logarithmic transformation, are non-stationary and individually integrated of order one. This study finds the absence of cointegration but the existence of unidirectional Granger causality running from economic growth to steel consumption. Thus, a growth in income is found to be responsible for a higher level of steel consumption. The impulse response function divulges that GDP growth does not seem to be responsive due to a shock in steel consumption growth. Finally, this study forecasts steel demand in India till 2011–2012 and highlights the preparedness of the Indian steel industry along with required policy prescriptions to meet this demand.

JEL classification: C32; C53

Keywords: India; Steel consumption; Economic growth; Cointegration; Granger causality

Introduction

Being a core sector, the Indian steel industry tracks the overall economic growth of the country. The sector was de-licensed and de-regulated in 1991 and 1992, respectively. The steel industry has been removed from the list of industries reserved for the public sector. Price and distribution controls have been removed with a view to make the steel industry efficient and competitive. The role of the public sector, which accounted for more than 50% output few years back, has been reduced and today, private-sector production accounts for about two-third of the steel production in the country. Although India is the eighth largest producer of steel in the world, which accounts for 1.3% of India's GDP and has a cumulative capital investment of over Rs. 1 trillion, per capita consumption of steel is only 30 kg as against 180 kg in China and an average of over 400 kg in the developed countries. This wide gap in relative steel consumption indicates that the potential ahead for India to raise its steel consumption is high. Experts opine that demand for steel in India is strong and likely to remain so, as the economy sustains higher growth path.

The objective of this study was to examine cointegration and Granger causality between steel consumption and economic growth in India in bivariate vector autoregression (VAR) framework. The answer to these queries is expected to play a crucial role in policy formulation.

In many cases, economic theory tells us that two or more variables should be cointegrated and a test for cointegration is the test of the theory. The presence of cointegration among the variables rules out the possibility of "spurious" correlation. Again, if, for example, there is unidirectional Granger causality running from steel consumption to economic growth, reducing domestic steel consumption could lead to a fall in national income. On the other hand, no causality in either direction (neutrality hypothesis) would indicate that steel consumption would not affect India's economic growth and vice versa.

Economic methodology and data description

Engle and Granger (1987) showed that if the series X and Y (say) are individually $I(1)$ (i.e. integrated of order one)

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and cointegrated, then there would be a causal relationship at least in one direction. However, the direction of causality can be detected through the vector error correction model of long-run cointegrating vectors. Furthermore, Granger's representation theorem demonstrates how to model a cointegrated $I(1)$ series in a VAR format. VAR can be constructed either in terms of the level of the data or in terms of their first differences, i.e. $I(0)$ variables, with the addition of an error correction term to capture the short-run dynamics.

If the series are $I(1)$ but not cointegrated, the causality test may give misleading results unless the data are transformed to induce stationarity.

A three-stage procedure has been employed to test the existence of causality. The first step tests for the order of integration of the natural logarithm of the variables by using augmented Dickey and Fuller (ADF) (1981) statistics. Conditional on the outcome of the tests, the second stage involves investigating the cointegration relationship among the variables using the VAR approach of Johansen (1988, 1991) and Johansen and Juselius (1990).

The third stage (or second if bivariate cointegration is rejected) involves constructing standard Granger-type causality tests, augmented where appropriate with a lagged error correction term.

ADF test for stationarity

ADF test is conducted with the following model:

$$\Delta X_t = \alpha_0 + (1-k)\beta t - (1-k)X_{t-1} + \Sigma\gamma_j \Delta X_{t-j} + \varepsilon_t, \quad (j: 1, 2, \ldots, p), \tag{1}$$

where X_t is the underlying variable at time t, ε_t is the error term and α_0, β, k and γ_j are the parameters to be estimated.

The lag terms are introduced in order to justify that errors are uncorrelated with lag terms. For the above-specified model the hypothesis, which would be of our interest, is

$$\mathrm{H}_0: \quad (1-k) = 0.$$

Granger causality test

If the series, X and Y are individually $I(1)$ and cointegrated then Granger causality tests may use $I(1)$ data because of the superconsistency properties of estimation:

$$X_t = \alpha + \sum_{i=1}^{m} \beta_i X_{t-i} + \sum_{j=1}^{n} \gamma_j Y_{t-j} + u_t, \tag{2}$$

$$Y_t = a + \sum_{i=1}^{q} b_i Y_{t-i} + \sum_{j=1}^{r} c_j X_{t-j} + v_t, \tag{3}$$

where u_t and v_t are zero-mean, serially uncorrelated, random disturbances.

Secondly, Granger causality tests with cointegrated variables may utilize the $I(0)$ data with an error correction term i.e.,

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \delta \mathrm{ECM}_{t-1} + u_t, \tag{4}$$

$$\Delta Y_t = a + \sum_{i=1}^{q} b_i \Delta Y_{t-i} + \sum_{j=1}^{r} c_j \Delta X_{t-j} + d\,\mathrm{ECM}_{t-1} + v_t. \tag{5}$$

Thirdly, if the data are $I(1)$ but not cointegrated, valid Granger-type tests require transformation to make them $I(0)$. So, in this case the equations become

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + u_t, \tag{6}$$

$$\Delta Y_t = a + \sum_{i=1}^{q} b_i \Delta Y_{t-i} + \sum_{j=1}^{r} c_j \Delta X_{t-j} + v_t. \tag{7}$$

The optimum lag lengths m, n, q and r are determined on the basis of Akaike's (AIC) and/or Schwarz Bayesian (SBC) and/or log-likelihood ratio (LR) test criterion.

Now, for Eqs. (2) and (3), Y Granger causes (GC) X if

$\mathrm{H}_0: \quad \gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ is rejected,

Against $\mathrm{H}_\mathrm{A}: \quad =$ at least one $\gamma_j \neq 0$, $j = 1, \ldots, n$

and X GC Y if

$\mathrm{H}_0: \quad c_1 = c_2 = \ldots = c_n = 0$ is rejected,

Against $\mathrm{H}_\mathrm{A}: \quad =$ at least one $c_j \neq 0$, $j = 1 \ldots r$

For Eqs. (4) and (5), ΔY, GC ΔX if

$\mathrm{H}_0: \quad \gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ is rejected,

Against $\mathrm{H}_\mathrm{A}: \quad =$ at least one $c_j \neq 0$, $j = 1, \ldots, n$ or $\delta \neq 0$

and ΔX GC ΔY if

$\mathrm{H}_0: \quad c_1 = c_2 = \ldots = c_n = 0$ is rejected,

Against $\mathrm{H}_\mathrm{A}: \quad =$ at least one $\gamma_j \neq 0$, $j = 1, \ldots, r$ or $d \neq 0$.

For Eqs. (6) and (7), ΔY, GC ΔX if

$\mathrm{H}_0: \quad \gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ is rejected,

Against $\mathrm{H}_\mathrm{A}: \quad =$ at least one $\gamma_j \neq 0$, $j = 1, \ldots, n$

and ΔX GC ΔY if

$\mathrm{H}_0: \quad c_1 = c_2 = \ldots = c_n = 0$ is rejected,

Against $\mathrm{H}_\mathrm{A}: \quad =$ at least one $c_j \neq 0$, $j = 1, \ldots, r$.

The tests are conducted on annual data for India covering the period of 1951–1952 to 2003–2004. Data on gross domestic product (GDP) at 1993–1994 prices, as a proxy to economic growth, have been collected from