Manufacturing Sector in India: A Study of Kaldor's First Law Using ARDL Model

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Abstract
This study seeks to probe the applicability and pertinence of Kaldor's First Law within the Indian economy, particularly examining the long-run relationship between the manufacturing sector's output and overall economic growth. Kaldor's proposition, which identifies manufacturing as the primary engine of economic growth, is central to understanding the potential trajectory of developing economies. However, this law is not without its criticisms, such as inquiries into the direction of causality and its universal relevance amidst diverse economic structures and the rise of service-oriented growth patterns. Despite criticisms, the Indian context presumes specific significance considering the nation's strategic push to invigorate its manufacturing base as evidenced by policy initiatives like 'Make in India'. With a notable shift towards services and the emergence of a knowledge economy, evaluating the role of manufacturing in propelling economic growth is critical. Utilizing time-series data and employing an Autoregressive Distributed Lag modeling approach, this paper assesses the long-term co-integrating relationship between manufacturing output and GDP growth in India. Testing such a hypothesis is instrumental in informing policy directions to leverage manufacturing as a medium for sustained economic advancement and addressing the nuances of the contemporary Indian economic landscape. Findings from this study could elucidate the extent to which Kaldor's First Law holds within a rapidly transforming and globally significant economy, bearing implications for both economic theory and practical policy formulation.

Keywords: Manufacturing, ARDL, economic growth, India.

1. INTRODUCTION

The engine of growth hypothesis suggests that a thriving manufacturing sector can act as a catalyst for economic advancement (Szirmai & Verspagen, 2015). Studies by Szirmai (2013) and Kathuria & Raj (2013) in the Indian context have found empirical support for this hypothesis, demonstrating that manufacturing continues to be a key driver of growth. Additionally, while some recent studies have indicated a growing importance of services in terms of inter-sectoral linkages (Talreja & Dasgupta, 2022), the consensus remains that manufacturing remains a crucial engine of growth, particularly in developing countries with adequate human capital and capital investment (Ndiaya & Lv, 2018). The complementarity between manufacturing and other sectors has been explored in the literature, with manufacturing not only stimulating demand for services but also creating strong backward linkages that benefit the entire economy. The decline in manufacturing could have adverse effects on future growth by impacting the demand for services and other sectors. In conclusion, the engine of growth hypothesis holds relevance, especially in developing economies like India. The manufacturing sector's role in driving economic growth, creating employment opportunities, and fostering inter-sectoral linkages underscores its significance in shaping overall economic development strategies.

The ARDL model, as proposed by Pesaran et al., offers a robust framework for investigating the relationship between non-stationary variables, particularly in the context of manufacturing output and economic growth. By applying the ARDL bounds testing approach, researchers can explore the long-run dynamics between these variables without the need for data transformation, making it a valuable tool for assessing Kaldor's First Law. Studies such as those by and Verspagen (Szirmai & Verspagen, 2015), (Wells & Thirlwáll, 2003), (Attiah, 2019), and Keho (2018) have delved into the relationship between manufacturing output and economic growth in various contexts, providing empirical insights that contribute to the understanding and validation of Kaldor's hypothesis. These works highlight the significance of manufacturing as an engine of growth and its impact on overall economic development, shedding light on the intricate dynamics between these variables in different economic settings.

2. The First Law: The Engine of Growth Hypothesis:

The first law maintains that the growth of GDP is positively associated with the growth of the manufacturing sector of the economy and this is the reason why the First Law is usually called ‘The engine of growth hypotheses.

1) For Kaldor’s First law the following expression holds:

$$y_{gdp} = b0 + b_1 y_m \,, \qquad \beta > 1 \qquad (1)$$

Where, y is the growth of GDP and y_m is the growth of manufacturing output respectively, and the condition of a positive $\beta 1$ indicates the positive association between the two variables. There exists a strong relationship between the growth rate of manufacturing output and growth of GDP.

3. Criticisms of the Model specification of Kaldor (1966):

Endogeneity poses a critical challenge to the empirical analysis of economic relationships, such as those proposed by Kaldor's First Law. This law posits a directional causality wherein growth in manufacturing output leads to overall economic growth, which in turn fosters further productivity gains within the manufacturing sector. The issue of endogeneity arises when this assumed causality is not clear-cut. (Greenwood, J. and Jovanovic, B. ,1990). Variables may be endogenously determined; for example, economic growth can itself spur manufacturing development through increased demand, investment, and technological diffusion, thus reverse causality may be at play. Further compounding the problem could be simultaneously occurring economic processes or omitted variable bias, where other growth-induced factors affecting both manufacturing and economic growth are not accounted for. This entanglement blurs the distinction between cause and effect, rendering the identification of the true nature of the relationship between manufacturing output growth and overall economic expansion more complex. Addressing endogeneity is paramount in the examination of Kaldor's First Law to ensure that any observed correlation is not spuriously driven by these internal dynamics of the economic system. Statistical techniques, such as Instrumental Variable methods, Granger causality tests, and Vector Auto Regression, alongside robust econometric modeling, can be utilized to mitigate the effects of endogeneity. Such methodological rigor is required to provide more credible estimations of the causal relationships that Kaldor theorized, and to better understand the modern economic mechanisms in a complex and interdependent global economy like India.

4. Methodology

Data: Annual time series data on Gross Domestic Product (GDP), Net state domestic product (NSDP), Manufacturing Value added (MVA)...etc. from 1991-2017 have been used in this study. The data has been obtained from different sources, including CSO, Annual Survey of Industries (ASI), Handbook of Information of the Indian Economy, published by RBI. The analysis is done at two levels ; first is will be done at an aggregate (national) level and then at state level taking 16 states of India.

Auto Regressive Distributed Lag Model Approach

The Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration will be used to investigate the long-run dynamic relationship between GDP and Manufacturing output. This time series analysis will be done at :

1. All India Level to check for co-integration between GDP and Manufacturing Output
2. At state level for 16 individual states to check for Co-integration between NSDP and Manufacturing output.

The ARDL approach has some certain advantages in comparison with other conventional co- integration methods such as Engle-Granger (1987) and Johansen-Juselius (1990) methods. The ARDL approach does not require prior knowledge on the order of integration of the variables. It can be easily used for the variables with different orders of integration. At this point, it should be noted that all variables must be I(0) or I(1), but not higher than I(1). Among others, the most important advantage of this technique is that it gives the possibility of short and long run parameters of the model simultaneously by using the unrestricted ARDL error correction model. (Ozturk & Acaravci, 2015; Bekhet & Matar, 2013)

The co-integration analysis takes into account the non-stationarity problem in the data, which is generally observed in various macroeconomic time series. It examines the presence of long- term stability in the relationship between two or more time series when they are integrated of order 1 or 0. The associated error correction mechanism explores the short-term dynamics along with the adjustment process.

Before computing the long-run relationship between the variables, both the data series are tested for stationarity. The present study uses the Augmented Dickey-Fuller (ADF) unit root test procedure to test the stationarity of the variables. It is highlighted in the classic works of Granger (1986) and Engle and Granger (1987) that as long as variables are co-integrated there has to be causality at least in one direction.

5. Empirical Findings

Test for Stationarity

To finalise the methodology to be used for estimating the regression model , Augmented Dickey fuller test and Phillips Perron test have been performed to test for presence of unit root .The findings reveal that the considered variables fail to reject the unit root hypothesis at levels, whereas the hypothesis is rejected at first-difference. Thus, it can be inferred that the series are stationary at first difference. The results also reveal that since the two series are stationary at first difference, the dataset can be further tested for co-integration. In the ARDL approach all variables should be integrated of the order I (0) or I (1), but not higher than I(1). According to the ADF and PP unit root test results, all variables are found to be stationary in their first differences. Thus, the ARDL approach can be easily employed to examine the possible long-run relationship between (a) Gross Domestic Product and Manufacturing, (b) Manufacturing and Non- Manufacturing output.

TABLE 1.1: RESULTS OF UNIT ROOT TEST (ALL INDIA LEVEL)

	Variable	Augmented Dickey-Fuller Test		Phillips-Perron test Statistic	
		Drift Only	Drift and Trend	Drift Only	Drift and Trend
At Level I(0)	LnGdp	0.0136 (2.12)	-0.1469 (-1.664)	0.012 (1.88)	-0.23 (-2.86)
	LnMfg	0.003 (0.28)	-0.298 (-2.42)	0.014 (0.89)	-0.29 (-2.59)
First Difference I(1)	LnMfg	-0.68*** (-4.49)	0.66*** (3.77)	-0.66 (-4.03)	-0.66 (-3.74)
	LnGdp	-0.68*** (-4.49)	-0.744*** (-4.35)	-0.69*** (-4.50)	-0.744 (-4.35)
Source : Author's calculation using EViews 10. *Figures in parentheses are t values.***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.					

The Autoregressive Distributed Lag (ARDL) bounds Test

As required by ARDL approach, firstly bounds test was applied to determine the presence of long-run relationship between the variables. As seen from the table when LnGdp is the dependent variable then, the values of the F-statistics, calculated as 5.00, is greater than the upper critical value bounds at 2.5% significance level. Thus, the null hypothesis of no long-run relationship between GDP and Manufacturing outputs can be rejected.

The ARDL Bound Co-integration test model which will be tested:

$$\Delta lngdpt = \alpha_0 + \beta_1\, lnGdp_{t-1} + \beta_2 lnMfg_{t-1} + \sum\delta_1 lnGdp_{t\text{-}k} + \sum\delta_2 lnMfg_{t-k} + \varepsilon_t \qquad (2)$$

The Null and alternate hypothesis for the bounds test will be :

Null hypothesis of no long-run relation: H_0: ($\beta_1 = \beta_2 = 0$)

Alternative hypothesis of long-run relation: H1 : ($\beta_1 \neq 0$, $\beta_2 \neq 0$)

The alternative hypothesis is accepted if the F-statistic value of the bound test is greater than the upper critical value given in by Pesaran et.al. (2001). In Eq.2, LnGdp is the log of GDP and LnMfg is the log of Manufacturing value Added, α_0 is the intercept, ε_t is the error term, $\beta_1$and β_2 represent the long-run elasticity, $\delta_1$and δ_2 are the short-run dynamic of independent variables.

ARDL-Regression Results

To estimate the ARDL model, the lag length was selected automatically using Akaike Information Criterion (AIC) for ARDL model with a lag length of 4 . The Hannan- Qiunn Criterion (HQ) was also used to remove any possible heterogeneity and the best model was chosen for the analysis. The probability value of F-statistic is highly significant indicating the overall performance of the selected model. Further the Durbin Watson value (2.7) is higher than the R-squared value (0.99), rejecting the chance of spurious results, serial correlation, and autocorrelation.

The ARDL Regression results show that the positive sign of the coefficient values of LnMfg confirms a complementary relationship between manufacturing output and Gross domestic product.in other words, Manufacturing sector can have a positive effect on the Indian GDP at aggregate level. The contribution of manufacturing to GDP is also statistically significant and this can be taken into consideration while formulating manufacturing related policies, focusing on manufacturing performance. The coefficients of GDP is also significant at 1% level with the expected sign.

TABLE 1.2: Regression Results of ARDL model (3,4)

Variables	Coefficient	t-Statistic	Probability value
LnGDP(-1)	0.59***	2.78	0.01
LnGDP(-2)	0.02	0.01	0.99
LnGDP(-3)	-0.28*	-1.76	0.10
LnMfg	0.32***	4.66	0.00
LnMfg(-1)	0.017	0.18	0.89
LnMfg(-2)	-0.23***	-2.18	0.04
LnMfg (-3)	0.39***	4.18	0.00
LnMfg (-4)	-0.15*	-2.05	0.06
Constant	5.13***	3.7	0.00
Source : Author's own calculation using EViews 10			

ARDL Bounds Test Results

The results of ARDL Bounds Tests revealed that cointegration among variables of interest exists and significant at 1% level. This can be explained by the fact that the F-statistics having a value (9.78) greater than the values of the lower bound (8.7) and the upper Bound (9.63) of the Narayan (2005) table. This confirms that cointegration exists between the variables. Because of the existence of long run relationship between the variables, the coefficients of their long run relationship are estimated, (Pesaran, et al. 2001). The results show the existence of a long-run relationship and long-run coefficient of the selected variables are estimated by applying the ARDL long form and bound test. The long-run relationship between the dependent variable and the independent variable is indicated by a long-run coefficient.

TABLE 1.3: ARDL Bounds Test Results, Selected Model: (3,4)

Bound Test Value		**Bound test Critical Value**	
Test Statistic	**Value**	**I(0)**	**I(1)**
F-Statistic value	9.78***	5.59 (10%) 6.56 (5%) 8.7 (1%)	6.26(10%) 7.3(5%) 9.63 (1%)
Source : Author's Calculations using EViews 10 .The asymptotic critical values reported in the table are based on the critical values suggested by Pesaran et.al. (2001)			

Error Correction Model

Error correction model introduced by Engle and Granger (1987) can be used to identify causal factors that can be influenced by the modelled variables. The error correction version of the ARDL model is given by Equation 3. The ECM represents the possible effects of departures from the long run equilibrium, (Baharumshah, et al., 2009).

The ECM equation which will be tested :

$$lnGdp = \beta_0 \sum_{i-1}^{t-n} LnGdp_{t-1} + \sum_{i-1}^{t-n} \beta_{\%} LnMfg_{t-1} + \lambda Ec_{t-1} + \mu_t \quad (3)$$

TABLE 1.4 Estimation of the Long run coefficient, Selected Model: ARDL (3,4)

Variable	Coefficients	t-statistics	Probability
LnMfg	0.57***	6.67	0.000

Source: Author's own calculation using EViews 10 Note: *** indicates significant at 1% level. Critical values are taken from Pesaran et al (2001), Table CI(iii) Case III, p. 300, and Narayan (2005),

The coefficient of the error term is negative (-0.68) and significant at 1% level indicating convergence towards equilibrium. This indicates the presence of short -run association and they adjust in the long term at the speed of 68 percent. long-run co-integration or a long run association between Manufacturing output and gross domestic Product. The value of the speed of adjustment parameter is 0.68 meaning that a 68 percent of adjustments can be completed within the first period. The value of R-Square value at 86 per cent is quite high and the Adjusted R-Squared value at 78 percent of ECM indicate goodness of fit of the model. Further, the Durbin-Watson stat result (2.02) confirms the lack of autocorrelation between the variables.

The results are further subjected to several diagnostic tests. The econometric tools employed included - Breusch-Godfrey serial correlation LM test, Breusch-Pagon-Godfrey heteroscedasticity test, Jarque-Bera test for normality and Ramsey RESET test for specification errors respectively (Greene,2008; Gujrati & Sangeetha,2007). These results indicate that the model is free from serial correlation, homoscedasticity, and heteroscedasticity. The error term is normally distributed and variance is constant in selected variables. The results also show that the model is free from functional form misspecification which means that it accounts for some important.

6. Conclusion

The ARDL model reveals the existence of a long-run relationship between manufacturing output and GDP growth in India, we can draw several important conclusions from this. Firstly, Kaldor's Law Validity, the evidence of a long-term relationship would lend empirical support to Kaldor's First Law within the Indian context, suggesting that the manufacturing sector indeed plays a significant role in driving the nation's economic growth. Secondly, the role of Manufacturing is as a catalyst for sustainable economic development. It could signify that manufacturing output growth leads to increased productivity, employment opportunities, and technological advancements in the Indian economy. This result could justify increased investment in manufacturing from both public and private entities. It highlights the economic value of industrial policy measures that support manufacturing through infrastructure development, skill enhancement, and innovation promotion.

Recognizing a long-term linkage would underscore the effectiveness of initiatives such as 'Make in India' and might encourage the government to continue or intensify efforts to expand and modernize the manufacturing sector as a strategic economic priority. It would imply that while the services sector remains significant, the balanced growth of both services and manufacturing might be essential for a diversified and resilient economy. Strengthening the manufacturing sector's output could also enhance India's global competitiveness, leading to a better trade balance and increased foreign investment.

In conclusion, the existence of a long-run relationship between manufacturing output and GDP growth in an ARDL model validates the importance of fostering the manufacturing sector for India's broader economic agenda. It would suggest that policy measures aimed at boosting manufacturing capacity could have enduring and substantial impacts on the nation's economic prosperity.

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