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Engineering Export of India – Bliss or Blasé

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Abstract: The validity of engineering export apportionment in India's economic growth is investigated in this paper. The export-led growth hypothesis is tested in this article to assess the relationship, impact, and contribution of engineering exports in the Indian economy. To test the hypothesis, economic growth measures such as GDP, total exports, total imports, and foreign exchange reserves are used. The study assumed that engineering exports have a direct or indirect effect on growth, but does this hold true for the entire economy? We added engineering export as gear for economic growth in our study to test the ELG hypothesis, which was Contrary to all previous studies. India's fastest-growing economy and rapid expansion of engineering exports in the country's foreign trade make it an ideal match for achieving good results. The nineteen years data from 1999-2000 till 2018-2019 is used for analysis. The OLS is used to establish a relationship between engineering exports and economic growth, the ADF is used to assess stationarity, and the ARDL and ECM are used to calculate the short- and long-term impact of engineering exports on economic growth. In addition, linear forecasting is used to anticipate the future growth of economic indicators. The results reveal that engineering exports had a favorable impact on most economic growth indicators in both the short and long run.

JEL: F1; F2; F4; F6
Keywords: Engineering Exports. Economic Growth. ELG. International Trade. Macroeconomics.

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1. Introduction

India ranked top amongst the nations producing around 1.5 million engineers in each subsequent year which somehow helps to flourish the engineering industry of the nation (Trines, 2018). The Industrial dominance of the nation is determined by share in the global market. Exports have always been a boon for the Indian economy as it contributes a significant share in GDP and other economic indicators. This presumption is analysed in this study through the export-led growth hypothesis. The export-led hypothesis is entailed by the neo-classical economists who suggest that exports play a major role in the country's economic growth (Kavoussi, 1984; Krueger, 1978; Ram, 1987). We tried to understand the very nature of engineering exports by analyzing their impact on total exports which helped further to associate engineering exports with other economic growth indicators. In most countries, the engineering industry adds value to GDP, money supply, and total exports which eventually leads to the economic growth of the nation (Sağlam and Egeli, 2018). This engineering industry so far seizes the largest segment in the Indian Industry by providing employment opportunities to approximately four million skilled and semi-skilled laborers (IBEF, 2019). The engineering export, in 1991-1992 counted for 2.23 percent in total exports (Khan, 2010), which enormously expanded to 24.50 percent in 2018-2019 (EEPC, 2019). Although the rise in manufacturing exports holds a significant role in sustainable economic development; this relation only works once it reaches the threshold level of development (Brandon J., 2012). The study targets the impacts of engineering exports on the economic growth of India by assessing the export-led growth theory. Indian engineering exports have observed massive growth due to significant investments and have always been an alluring industry to earn foreign exchange. Now due to liberalised policies in India, engineering goods can exploit the global market. In this article, the main focus of the study is to testify all the claims made against the engineering exports with the fair amount of share in the country's economy with the help of export led-growth hypothesis. Also, the time-series data is used to maintain the uniformity and accuracy level in research. The export performance determinants for engineering exports are indicated by world demand, total factor productivity, cumulative output, and exchange rates (Goldar, 1989). And, to exploit the global market achieving engineering excellence need to be entailed. The educational reforms, grooming research, and development culture in academics can bring innovation, creativity, and change and set the engineering industry in motion. The manufacturing and exports of robots, automation, and artificial intelligence can play a significant role to get a competitive edge with developed and emerging economies in the global market. The righteous way to measure the contribution and effectiveness of any sector, the economical instrumental linkage on the trade balance is a foundation. The article is in the following manner; Section 1 establishes a basic layout for the study where the origin and consequential terrain of the hypothesis are discussed. More emphasis is laid on engineering export and its growth in the Indian economy. Section 2 briefly discusses the export-led growth theory and earlier studies related to the hypothesis. It also contemplates the research outcomes derived from previous literature on ELG theory. Section 3 establishes the path forward for this study by reviewing engineering export-based literature which helped to define the research gap in the lateral study. Section 4 explains the nature of data and its applicability in our research. Also, it widely discusses the research methodology to find concrete evidence which can support or oppose the export-led growth statement. Section 5 depicts the empirical evidence derived from the analysis and discusses its relevance in the study. Sections 6 conclude and propose suggestions and policy implications following the fact-based evidence from the study.

2. Conceptual Framework

The export-led growth strategy; initially practiced by under-developed and developing countries after the great depression of World War II. The neoclassical economist (Kavoussi 1984; Krueger 1978; Ram 1987) supported the idea of an open economy despite import substitution strategy to build the county's economy.

The export-led growth strategy was adopted by many countries, especially developing economies where they opened up the domestic economy for foreign competitors in exchange for market access into their country. Love & Chandra (2005), Chandra Parida & Sahoo (2007), Dash (2009) found that an increase in exports has a positive effect on the economic growth of India as a whole including the gross domestic product, imports, exchange rates, industrial production, employment, etc (see Appendix Table 1). On the other hand, Dhawan & Biswal (1999), Shirazi & Manap (2005), Sharma & Panagiotidis (2005), Raghutla & Chittedi (2019) found export-led growth hypothesis invalid on various grounds and explained that numerous other growth indicators have more impact than exports in the growth of Indian economy. There are numerous studies conducted on the export-led growth hypothesis in the context of developed, under-developed, developing, and emerging countries worldwide (see Figure 1).

Figure 1: The economic growth indicators used to test ELG hypothesis in earlier studies

In recent studies, Kalaitzi & Cleeve (2017), Ee (2016), Tang et al. (2015), Bilas et al. (2015) Aktar et al. (2008) found evidence that exports influence the economic growth indicators (Figure 1) of a nation generalizes in various studies based on various countries (see appendix Table 1). And, Furuoka (2019), Ahmad et al. (2016), Bosupeng (2015) Palley (2011), Waithe et al. (2010), found evidence that the relationship doesn't exist betwixt exports and the economic growth of the nation (refer to Appendix Table 1). On the contrary, in all the earlier studies we included engineering export as gear for economic growth in India in this study to test the export-led growth hypothesis. In the initial, we tried to understand the very nature of engineering exports by analyzing their impact on total exports which helped further to associate engineering exports with other economic growth indicators. The basic idea to test the association between engineering exports and another exploratory variable was to testify the various claims made by government organizations on the share of engineering exports in total exports and the gross domestic product of India. Also, we included the foreign exchange reserve as economic growth indicators which were not included in the earlier studies (see Figure 2).

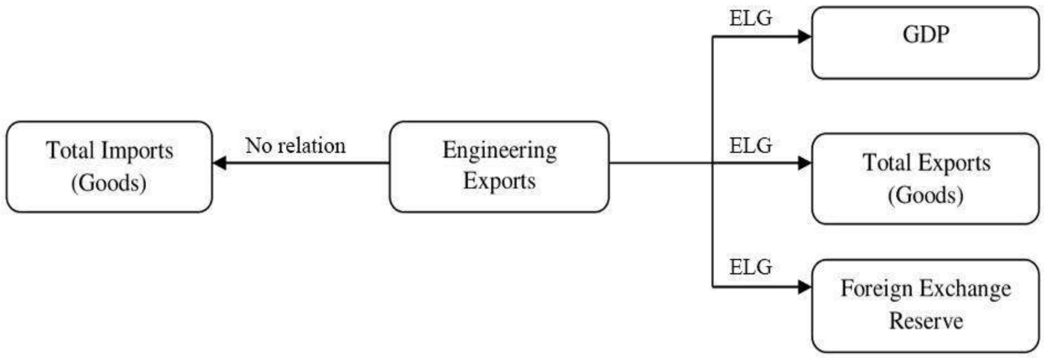

Figure 2: The export-led growth model in this study

The foreign exchange reserve plays a major role in establishing supremacy in the global market by equalizing the balance of payments and foreign debts. Total exports here in this study we used as economic growth indicator and engineering export as a regress or to investigate the export-led growth hypothesis (see Figure 2).

3. Literature & Research Gap

3.1. Engineering Export and Economic Growth Nexus

In India and various other nations, numerous studies accomplished to explore the relations betwixt export and economic growth. Wolter, F. (1975) in his study stated that the Least Developed Countries penetrated the world market in engineering exports from 1964-1965 and 1970-1971. Engineering goods exports grew twice as quickly as world exports because they restructured their export according to the high-income elasticity of demand commodities. Lall, S., & Kumar, R. (1981) observed that the engineering export performances are quite interesting and distressing as well. It's interesting because they invited innovative companies to lead the export activity but inward-looking and excess interventions of the government in terms of policies distort the forces to gain comparative advantage in the global market. The research conducted by Arora, D. S. (1990) states that favorable developments in technical expertise and infrastructure facilities can lead Indian engineering exports to the path of higher exports. Although the risk can be hedged by engineering exporters through integrated strategy, selectivity approach, technological up-gradation, market orientation, and teamwork, but problems such as enormous changes in technology, use of foreign technology in the manufacturing process, ever-changing substitutes for raw material still exists in the Indian engineering market. Norsworthy, J.R., Li, D., & Gorener, R. (2000) found evidence that insubstantial frequency of the macroeconomic time-series evidently influences the asset return which is GDP growth, Total Exports (TE), Total Imports (TI), and Foreign Exchange Reserve (FXR) in our study. Illiyan, A. (2006) stated that the engineering industry is a helping hand to the national development through value addition, export and employment. He suggested that to compete in the global market there should be an essential quality check, pricing, and proper monitoring over the rapid change in technology and innovation. Chakravarty, A., Kumar, S.N.V.S., & Faisal, M.N. (2011) studied local and engineering consulting service exports and evidently noticed that exporters mainly invest their time and resources in building relationships with overseas buyer. The huge number of professionals, a distinct network, Inclination of senior managers in international activity led this industry to exploit business opportunities available in the foreign market. Bandara, Y.M.W.Y. & Karunaratne (2013) suggested in their study the standalone public policies of open economies are deficient to attain sustainable growth in exports of the nation the forecast of political stability is also essential to ensure the interests of investors. Bopage, L., & Sharma K. (2014) in their research indicate that while the policy liberalization increased the export-import volume in the nation but productivity fell drastically. The excess capacity of production and high cost involved in production can be the main cause for massive fall in productivity in the automobile industry. Sahni, P. (2014) considers the vigorous performance of engineering exports are the substantial reason behind total export growth spurt. Also, the study suggests the government should promote high technology exports. Muthusamy, A., & Karpagalakshmi, S. (2015) reveals in their study that engineering export India can develop a remarkable presence in global engineering export provided access to global export markets. Also, the outbreak of outsourcing engineering services can help quantum growth. Anand, Rahul et al. (2015) in their working paper finds out that India is ready to benefit from the conventional changes in export baskets and the engineering industry has the potential to enter into new markets and diversifying into income enhancing exports. We noted that the engineering exports actually diversified and increased its market share in the global market. Krishna, G.D. & Kumar, R. (2015) stated that by share engineering goods exports are the largest segment of Indian exports. The study indicates that the global market penetration and volume growth are astounding for engineering goods and chemicals. Vidhya, R. et al. (2017) found out that the engineering sector is a significant contributor to total export growth in India. Also, it dominates the other sectors in foreign exchange earnings. Sultanuzzaman, Md Reza et al. (2019) identifies that export and technology do contribute to economic growth positively in India. The author supports the statement because the study shows that engineering export positively contributes to the indicators taken for the study.

3.2. Research Gap & Objective

The literature reviews suggest that earlier conducive researches have overseen the potentials and performance of the engineering export of India and its share in total exports. Even though the attempts were made, but it tried to link the total exports or engineering exports to technology-intensive and market-driven factors. So far few researchers have made an attempt to test the relationship between engineering exports and macroeconomic variables for India using econometric models. This empirical study will provide clear lineament and help academicians to understand the relationship between engineering export and the gross domestic product, foreign exchange reserve, total exports, and total imports of India. It will help the researcher to establish the long-run and short-run impact of engineering exports on taken economic growth indicators. Also, it will help the Government to push the engineering industry in the right direction through effective administrative policies and boosting the morale of engineering exporters.

4. Data & Methodology

4.1. Data

Time-series data from 1999-2000 till 2018-2019 is used to avoid analytical atrocities and uniformity in a dataset for further analysis. Also, ordinary least square and auto-regressive distributive lag models require uniform time-series data for acute results. The data for engineering export is collected from annual reports published by the Engineering Export Promotion Council (EEPC) of India. The missing data for engineering export from annual reports of EEPC was substantiated from Indiastat: Socio-Economic statistical database to avoid discrepancies in used methodology. The datasets of total exports (goods), total imports (goods), the gross domestic product (GDP), and foreign exchange reserve (FX) are collected from the World Bank database. To maintain uniformity in the data set, Indian Rupee (INR) is converted into United States Dollars (USD) and lacs converted into millions for the total engineering exports of India. The software used for analysis are Eviews, SPSS and Python in India and various other nations, numerous studies accomplished to explore the relations betwixt export and economic growth. Wolter, F. (1975) in his study stated that the Least Developed Countries penetrated

4.2. Methodology

In this study, OLS is used to evaluate the relationship between a dependent variable and the exploratory factor. The linear least square was the most appropriate method because the regression model evaluates the parameters by minimizing the sum of squared residuals. Studies conducted by Jawaid et. al. (2019); Sengupta & Puri (2018); Bandara & Karunaratne (2013); Greenaway, Morgan & Wright (1999) and Burney (1996) prove the authenticity and reliability of the *ordinary least square method* in exploration of the significance of taken variables. In this regression model dependent variable y_t articulate a linear combination of exploratory variable $x_1, x_2....., x_t$:

$$y_i = \beta_1 x_{1i} + \ldots + \beta_p x_{pi} + \varepsilon_i \qquad (1)$$

Where x_{ij} is the i^{th} observation on the j^{th} dependant variable $b_1, \ldots, b_p$ are the regression coefficient and $\mathcal{E}$ is the error term. We construct the following regression model for each variable:

$$TE = \beta_1 + \beta_2 EE + \mathcal{E}_i \qquad (2)$$
$$TI = \beta_1 + \beta_2 EE + \mathcal{E}_i \qquad (3)$$
$$GDP = \beta_1 + \beta_2 EE + \mathcal{E}_i \qquad (4)$$
$$FXR = \beta_1 + \beta_2 EE + \mathcal{E}_i \qquad (5)$$

In this model TE denotes total exports, TI denotes total imports, GDP denoted Gross domestic product and FXR denotes foreign exchange reserve and $\mathcal{E}i$ denotes the error term. The equation contains one dependent for instance, Total Exports (TE) and one Independent Engineering Exports (EE). Likewise, regression is calculated between Total Imports and Engineering Exports (EE), Gross Domestic Product (GDP) and Engineering Export (EE), Foreign Exchange Reserve (FXR), and Engineering Export (EE). This unit root test is conducted to analyse the volatility in the distribution shape with time. The stationarity criteria in time-series data set layouts of its applicability to measure the long-run relationship. To analyse the stationarity in variables we used the Augmented Dickey-Fuller Test (ADF) unit roots test (Dickey & Fuller, 1979). The number of studies like Burange, Ranadive, & Karnik (2019); Bong & Premaratne (2018); Alam, Ahmed, & Shahbaz (2017) and Kaur & Sidhu (2014) used ADF in their study to check the stationarity in their research articles. Before carrying out ARDL analysis, we investigate the stationarity of data using unit root test (ADF) with the following equation:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{pi} \beta_{IJ} \, \Delta y_{it-1} + x_{it}\,\delta + \mathcal{E}_{it} \qquad (6)$$

The concept of using ARDL and ECM in this study justifies because of two main reasons; the first autoregressive distributed lag model is based on the ordinary least square model and second, it can be applicable on non-stationary time series data as well just in case if our variable doesn't lies in stationarity criteria. Autoregressive Distributed Lag (ARDL) model developed (see Pesaran & Pesaran, 1997; Shin, & Smith, 2001) to carry out long term and short term relationship (using Error Correction Model) between engineering export and other exploratory variables. The purpose of using the ARDL approach is to measure the long term and short relationship which is concise and ensured its applicability and legitimacy in various earlier studies such as Ho & Iyke (2020); Adejumo & Adejumo (2019); Doojav (2018); Hye (2012) and Narayan & Smyth (2005). The following equation is constructed in initial, which consist of the main focus of the study:

$$lnEE_t = \beta_0 + \beta_1 InTE_{t-1} + \beta_2 InTI_t + \beta_3 InGDP_t + \beta_4 InFXR_t + \mathcal{E} \qquad (7)$$

A priori, β_2 expected to be negative and β_1, β_3, β_4 to be positive. The ARDL approach permits the dependent variable to lag as an independent variable which enables the estimate of past (denoted by lagged value) in current time.

The error correction relates to the fact that from long-run equilibrium in time-series data; the last interval's deviation, the error impacts its short-run dynamics. Most importantly the ARDL and Error Correction Model (ECM) bring Δ the first different operator, optimal lag length denoted by *q*, β_1..... β_4 point out the model's short-run dynamics, and a_5...... a_8 denotes long-run elasticity. The ECM denotes the error Correction term drawn from the long-term relationship. It also explains the adjustment patterns in short-run deviations for long-run values studied earlier in Adejumo & Adejumo (2019); Nilofer & Qayyum (2018); Sultanuzzaman et. al. (2018) and Dritsaki & Stiakakis (2014). The following models construct for ECM in this study;

$$lnEE_t = \beta_0 + \sum_{i=1}^{q1} \beta_{1i}\, \Delta InEE_{t-1} + \sum_{i=0}^{q2} \beta_{2i}\, \Delta InTE_{t-1} + \sum_{i=0}^{q3} \beta_{3i}\, \Delta InTI_{t-1} + \sum_{i=0}^{q4} \beta_{4i}\, \Delta InGDP_{t-1} + \sum_{i=0}^{q5} \beta_{5i}\, \Delta InFXR_{t-1} + \lambda ECM_{t-1} + \mathcal{E} \qquad (8)$$

Here, *q1, q2.......q5* represents the optimal lag length and, λ denotes the adjustment parameter's speed for error correction model analysis. Time-series data from 1999-2000 till 2018-2019 is used to avoid analytical atrocities and uniformity in a dataset for further analysis. Also, ordinary least square and auto-regressive distributive lag models require

5. Findings and Discussions

P In this section, the result drawn from the analysis explains briefly the relationship between engineering exports and taken indicators for the economic growth of India. The empirical evidence shows the average trade of engineering export from India which worth USD 43566.04 millions, foreign exchange reserve out of total reserve worth USD 213125 millions in average, and the average gross domestic product amount to be USD 1387487 millions (refer to Table 1). The standard deviation result shows the variation or

Table 1: Results from Descriptive Analysis

	Engineering Export (USDM)	*FX Reserve (USDM)*	*GDP (USDM)*	*Export (USDM)*	*Import (USDM)*
Mean	43566.04	213125.4	1387487	183796	274888.8
Median	39103.55	266084	1279311	183409.5	299573
Maximum	92021.34	351130	2718732	328387	503519
Minimum	4380	32667	458820.4	36877	50550
Std. Dev.	29998.70	112121	752190.8	108998.7	168555.7
Skewness	0.083210	-0.417748	0.255300	-0.072589	-0.109613
Kurtosis	1.491194	1.686524	1.793390	1.395850	1.434626
Jarque-Bera	1.920159	2.019392	1.430516	2.161977	2.082046
Probability	0.382862	0.364330	0.489066	0.339260	0.353093
Sum	871320.8	4262507	27749749	3675921	5497776
Sum Sq. Dev.	1.71E+10	2.39E+11	1.08E+13	2.26E+11	5.40E+11

Source: The Author's estimation using SPSS 26

dispersion and skewness depicts the asymmetry and distortion in the normality of a data set which helps to understand the concealed information in the data set. The standard deviation for engineering export is USD 29998.70 millions, foreign exchange reserve is USD 112121 millions; GDP is USD 752190.8 millions; export is USD 108998.7 millions, and standard deviation for import is USD 168555.7 millions. The skewness for engineering export is recorded to 0.083210, FX reserve is -0.417748 and GDP is 0.255300. The observed skewness in export and import is -0.072589 and -0.109613 (see Table 1). After fitting OLS model the researcher observed that total exports, the gross domestic product and foreign exchange reserves are significant at 5 per cent level of significance. We observe from the result that a total import is not a significant factor for engineering exports. It clearly shows that engineering export does not

have any significant impact on the country's import. The above result (see Table 2) evidently proves that there is a huge contribution of the engineering export towards the economic growth in terms of total exports, gross domestic product, and boosting the foreign exchange reserve.
There is a significant impact of the engineering export on the gross domestic product, total exports, and foreign exchange reserve (refer to Table 2).

Table 2: The result from Ordinary Least Square

Dependent Variable	***Independent Variable***	***Coefficient estimate***	***t-stat***	***Std. Error***	***p-value***
TE	EE	0.1663	3.0718	0.0541	0.00**
TI	EE	-0.0223	-0.7311	0.0306	0.47
GDP	EE	0.0254	9.9608	0.0025	0.00**
FXR	EE	-0.0285	-2.109	0.0135	0.05*

R-squared	0.996722	Mean dependent var	43566.04
Adjusted R-squared	0.995848	S.D. dependent var	29998.7
S.E. of regression	1932.935	Akaike info criterion	18.18378
Sum squared resid	56043542	Schwarz criterion	18.43272
Log likelihood	-176.8378	Hannan-Quinn criter.	18.23238
F-statistic	1140.35	Durbin-Watson stat	1.811415
Prob (F-statistic)	0		

Note: *Significant level at 5 per cent **Significant level at 1 per cent
Source: The Author's estimation using EViews11

The total import (goods) is not a significant factor for engineering exports. It is obvious from the magnitude of coefficient for total exports (0.16), the effect of the engineering export on economic growth is the most among all other selected economic growth indicators in India. The coefficient magnitude for the foreign exchange reserve (-0.02) is the least among all other selected economic growth indicators (excluding total imports). From Figure 3 we observed that engineering export increased to USD 92021.34 millions in 2018-2019 which was merely USD 4380 millions in the year 1999-2000.

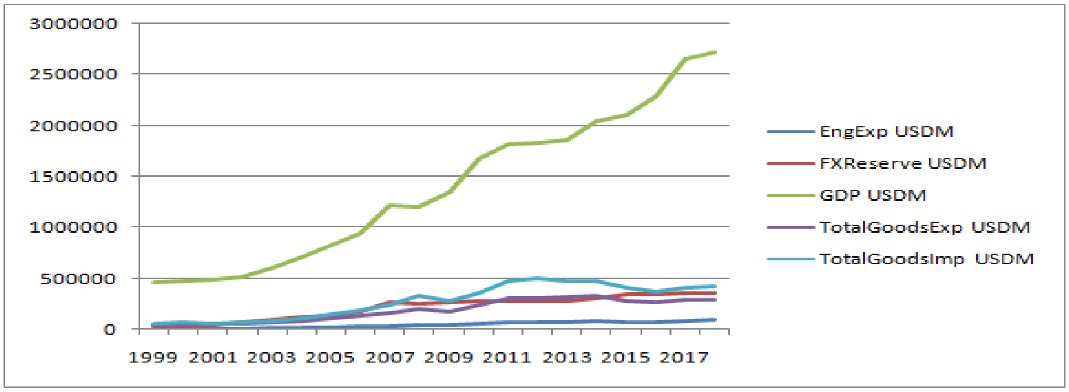

Figure 3: The graphical presentation of Engineering export, Foreign Exchange Reserve, Gross Domestic Product, Total Export (Goods), and Total Import (Goods)

Also, there is a massive GDP growth which touched a record high to USD 2718732.23 million in 2018-19 and it was noted USD 458820.41 million in 1990-2000. Total imports and total exports (goods) experienced volatility during the study period. Total exports have seen an upward trend from 1999-2000 (USD 36877 millions) till 2014-2015 with record-high exports (USD 328387 millions) afterward there is a fall in total exports (goods) with USD 294406.50 millions (see Figure 3). Total imports have also seen an upward trend from USD 50550 millions in 1999-2000 to USD 503519 millions in 2012-2013 afterward there is a fall till 2018-2019 to USD 427665. The foreign exchange reserve of India beholds the minimal volatility. The foreign exchange reserve was recorded USD 32667 millions and reached all-time high USD 351130 millions in 2018-2019 (refer to Figure 3). The massive increase and volatility in imports can have a retrospective effect on engineering exports as well as on other economic indicators taken for the study.

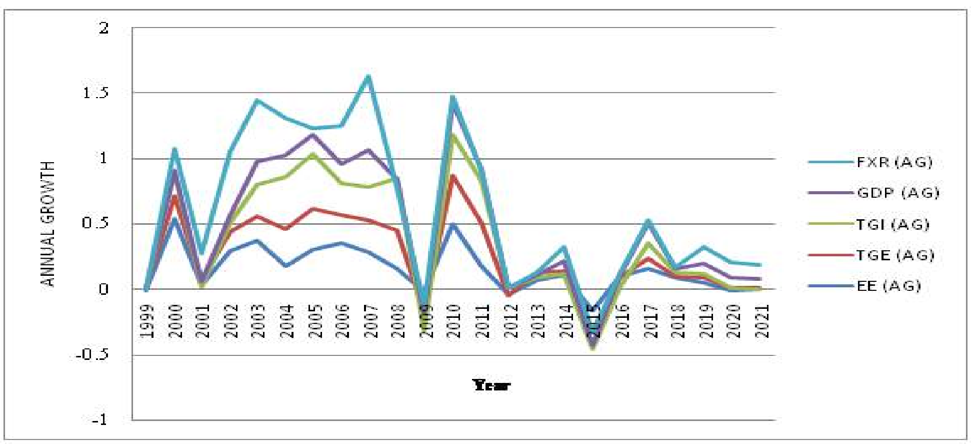

Figure 4: Trends & patterns in annual growth of Total Engineering export (EE), Foreign Exchange Reserve (FXR), Gross Domestic Product (GDP), Total Export and Total Import
Source: The Author's estimation based on EEPC, Indiastat & World Bank Data

In Figure 4 we observed the trend and pattern in the annual growth of taken indicators for economic growth and engineering export. The annual growth in engineering export lofted in 2000-2001 with 0.54 per cent. After that, the trend shows a gradual decrease in engineering export for the year 2021-2022 with 0.01 per cent. Similarly, the trend in total goods exported from India and total goods imported shows the decline in annual growth from 0.31 per cent and 0.41 percent in the year 2005-2006 to 0.01 for total exports in 2020-2021 and negative growth of -0.01 per cent in total imports (see Figure 4). Despite the decline and gradual decrease in total goods exports & imports, there is promising positive growth in GDP and foreign exchange reserve. In the last decade, the annual growth of GDP is lying between 0.29 per cent and 0.16 from 2007-2008 to 2017, which seems to decline in 2021-2022 to 0.08 per cent as per trend analysis results. The foreign exchange reserve's annual growth lies between -0.07 per cent in 2008-2009 to 0.01 in 2018-2019 which shows the consistent recovery in the annual growth of India's foreign exchange reserve (refer Figure 4). The linear forecasting predicted engineering exports will grow from USD 89362 millions to USD 101246 millions in the year 2020-2021 (see Figure 5). The reserve is expected to rise from USD 363681 millions in the year 2018-2019 to USD 384652 millions in 2020-2021. Similarly, total exports and total imports are expected to rise from USD 304098 millions and USD 436341 million (2018-2019) to USD 321515 millions and USD 467361 millions in the year 2020-2021. Also, the GDP expected to grow from USD 2771186 millions to USD 2956618 millions in the year 2020-2021 (refer to Figure 5).

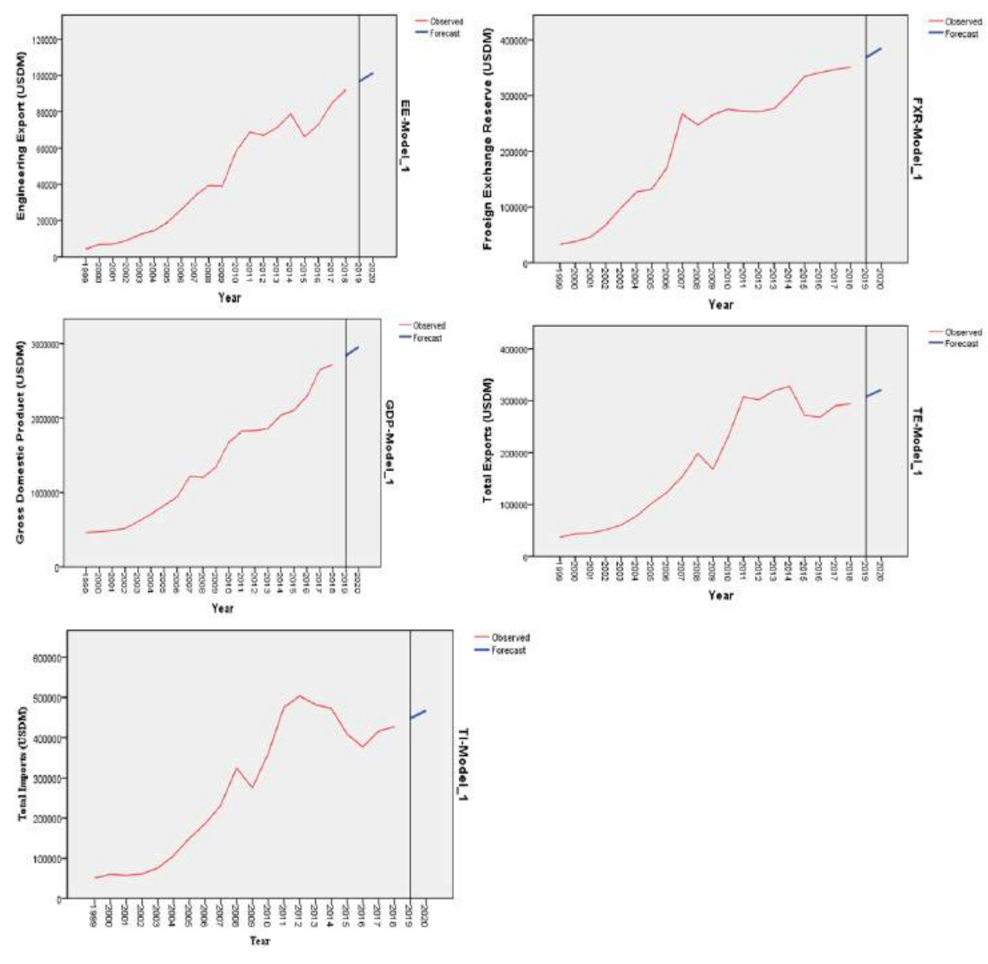

Figure 5: Linear Forecasting for Total Engineering export, Foreign Exchange Reserve, Gross Domestic Product, Total Exports and Total Imports
Source: The Author's estimation using SPSS 26

After using ADF it is observed at the level of significance 5 per cent GDP meets stationarity at the level itself. The engineering exports, total exports, total imports, and foreign exchange reserve meet stationarity after the first difference at 1 per cent significance level (see Table 3). Engineering exports and all other economic indicators meet the stationarity criteria at 1 per cent significance level only after the first difference of the unit root test.

Table 3: The result from Augmented Dickey Fuller test

Variable	ADF test stat	p-value	First difference	p-values
EE	0.07	0.95	-4.23	**Stationarity**
TE	1.16	0.26	-3.32	**Stationarity**
TI	0.99	0.90	-2.92	**Stationarity**
GDP	-6.16	0.00	4.70	**Stationarity**
FXR	1.96	0.98	-2.96	**Stationarity**

Note: **Significant level at 5 per cent *Significant level at 1 per cent
Source: The Author's estimation using EViews 11

Table 4: The Result from Estimated long-run coefficient: ARDL (1,0,0,0,0) model

Variable	Coefficient	Std. Error	t-Statistics	p-values
EE(-1)	-0.1227	0.0831	-1.4759	0.16
TE	0.1646	0.0304	3.0867	0.00**
TI	-0.0124	0.0533	-0.4092	0.68
GDP	0.0293	0.0034	8.509	0.00**
FXR	-0.0375	0.0144	-2.6013	0.02*
R-squared	0.997031		Mean dependent var	45628.46
Adjusted R-squared	0.995889		S.D. dependent var	29327.79
S.E. of regression	1880.496		Akaike info criterion	18.16855
Sum squared resid	45971454		Schwarz criterion	18.46679
Log likelihood	-166.6012		Hannan-Quinn criter.	18.21902
Durbin-Watson stat	1.899233			

Note: *Significant level at 5 per cent **Significant level at 1 per cent
Source: The Author's estimation using EViews11

In results, we observed that most of the taken economic growth indicators are significant for engineering exports and have a long-run relationship (refer to Table 4). The empirical analysis reveals the consistent effect of the engineering export on the economic growth of India (see Figure 3). The result of ARDL analysis shows that the p-Value total exports (goods), the gross domestic product, and foreign exchange reserve is less than 0.05 with a significant level of 5 per cent (refer to Table 4).Hence, a long-run relationship exists between engineering exports and total exports, engineering exports and gross domestic product, and engineering exports and foreign exchange reserve. After confirmation of long-run equilibrium, the Error Correction Model is used to estimate the short-run and long-run coefficients in ARDL results.

The results show the short-run elasticities which explain that engineering exports have insignificant effect on foreign exchange reserve in the short-run, the increase in engineering export will cause -0.03 shrink in foreign exchange reserve.

Table 5: The Results from Conditional Error Correction Regression - (ECM)

Variable	Coefficient	Std. Error	t-Statistic	P-values
FXR	-0.037564	0.01444	-2.601317	0.02*
GDP	0.029371	0.003452	8.509079	0.00**
TEXP	0.164637	0.053337	3.086763	0.00**
TI	-0.012451	0.030427	-0.409221	0.68
ECM (I)	-5.537915	0.703949	-7.866927	0.00**

Note: *Significant level at 5 per cent **Significant level at 1 per cent
Source: The Author's estimation using EViews11

The engineering export has a positive relationship with GDP in the short run as well because 1 per cent increase in engineering export will cause 0.02 per cent growth in the gross domestic product and 1 per cent increase in engineering export will cause 0.16 per cent growth in total exports (refer to Table 5). The engineering exports have insignificant effect on total imports in the short-run as well.

6. Conclusion

The study establishes the association between engineering export and economic growth which concludes that the export-led growth hypothesis is suitable for the Indian economy (Burange, Ranadive, & Karnik, 2019). Engineering exports play a significant role in the economic growth of India (excluding total imports). The total imports can have a retrospective effect on engineering exports. Firstly, it can cheer the upcoming technological know-how also it can disrupt the domestic engineering market by filling foreign engineering products in the country's territory. Also, the rise in total imports is a burden for external debt as well as foreign exchange reserves (Saji, 2019; Alam, Ahmed, & Shahbaz). Our study supports the export-led growth research outcomes of Love & Chandra (2005), Chandra Parida & Sahoo (2007), Dash (2009), and Sharma & Panagiotidis (2005) on Imports. The study also contradicts the results of Dash (2009) on Imports and Dhawan & Biswal (1999), Sharma & Panagiotidis (2005), Shirazi & Manap (2005), and Raghutla & Chittedi (2019) research outcomes on GDP. To achieve sustainable growth; engineering export firms need a methodical knowledge management mechanism to locate the favourable markets and criterion framework for the host country (Pillania, 2005). The study clearly shows that there is a long-run equilibrium between engineering exports and economic growth. Also, the short-run and long-run coefficients denote the significance of engineering exports to boost the GDP, total exports, total imports, and foreign exchange reserve. The outsourcing of services can play a key role in improving the performance of engineering exporters/firms to some extent (Sanchís-Pedregosa, Gonzalez-Zamora & Palacín-Sánchez, 2017; Mishra, 2012) because evidence shows the positive effect and linearity in financial aspect (Gilley & Rasheed, 2000; Görg & Hanley, 2004; Görzig & Stephan, 2002; Salimath, Cullen, & Umesh, 2008). The Government of India instead of providing a basket of incentives to engineering exporters; they should promote high technology exports (Sahni, 2014). Also, bilateral free trade agreements with countries like United States, United Arab Emirates, Germany, United Kingdom, Bangladesh, Mexico, and Singapore can create a substantial trade for Indian engineering goods because the bilateral integration strategy worked out really well for international trade of Pakistan (Abbas & Waheed, 2019). The engineering industry must opt the interrelationship and integration in infrastructure, procurement, technology, marketing, and production to ensure competency in the export market (Bhaskaran, 2019). The linear forecasting portrayed a clear and concise picture of the engineering industry and economic growth indicators for forthcoming years. It depicts the positive growth for all the variables. Also, the research and development linkages between industry and academics or academic-industry linkages can become a handout for the engineering exports and lead to the economic growth of the nation as we observed in this study.

Declarations of Conflict Interests

We, solemnly declare that content in this article wholly/Partially not published in any journal before. There is no conflict of interest concerning the research, authorship, and/or publication of this article.

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APPENDIX

Appendix Table 1: Earlier Studies on Export Led-Growth (ELG) Hypothesis

Study	Country/Region	Study Period	Methodology	Variables	Research Outcome
Marin, D. (1992)	Industrialized Countries (United States, Japan, United Kingdom, Germany)	1960-1987	Granger- Causality Technique, Unit Roots Tests	Productivity Exchange Rate World Output	ELG No relation No relation
Henriques, I., & Sadorsky, P. (1996)	Canada	1870-1991	Vector Autoregression (VAR), Granger Causality Test	Gross Domestic Product Terms of Trade	No relation No relation
Shan, J., & Sun, F. (1998)	China	1978-1996	Granger No-Causality Procedure in VAR System	Real Industrial Output	No relation
Glasure, Y. U., & Lee, A.R. (1999)	Korea	1973-1994	Vector Autoregressive Models, Vector Error Correction Models, Granger Causality Tests	Exchange Rate Money Government Expenditure	ELG ELG ELG
Asafu-Adjaye, J., & Chakraborty, D. (1999)	less developed countries (LDCs) - India, Nigeria, Fiji and Papua New Guinea	1960–94	Johansen's Multiple Cointegration Test, Unit Root Test, Granger Causality	Real Output and Export	No relation
Dhawan, U., & Biswal, B. (1999)	India	1961–93	Vector Autoregressive (VAR), Johansen's Model Selection and Maximum Likelihood Cointegration Procedure	Real Gross Domestic Product Terms of Trade	GDE GDE
Hatemi-J, A., & Irandoust, M. (2000)	Greece, Ireland, Mexico, Portugal and Turkey	1960–1997	Vector Autoregression (VAR), Granger Non Causality	Real Output	ELG (Ireland, Mexico and Portugal) No relationship (Greece and Turkey)

Note: ELG - export-led growth, GLE - growth-led export, GDE - growth driven export

Appendix Table 1 continues...

Study	Country/Region	Study Period	Methodology	Variables	Research Outcome
Smith, E.J.M. (2001)	Costa Rica	1950-1997	Unit Roots Test, Johansen Maximum Likelihood, Error Correction Model and Cointegration	Gross Domestic Product Population Gross Domestic Investment Gross Fixed Capital Formation	ELG ELG ELG ELG
Awokuse, T.O. (2003)	Canada	1961-2000	Granger Causality, Vector Error Correction Models (VECM), Augmented Vector Autoregressive (VAR)	Gross Domestic Product Capital Labor Foreign Output Shocks	ELG ELG ELG ELG
Shirazi, N. S., & Manap, T. A. A. (2005)	Bangladesh, India, Nepal, Pakistan and Sri Lanka	Pakistan (1960-2003) India (1960-2002) Bangladesh (1973-2002) Sri Lanka (1960-2002) Nepal (1975-2003)	Cointegration and Multivariate Granger Causality Tests	Gross Domestic Product Imports	ELG (except India & Sri Lanka) ELG (except India & Sri Lanka)
Love, J., & Chandra, R. (2005)	Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka	Bangladesh (1973-2000) Bhutan (1980-1997) India (1950-1998) Maldives (1977-2000) Nepal (1964-2000) Pakistan (1970-2000) Sri Lanka (1965-1997)	Cointegration, Error-Correction Modelling	Gross Domestic Product	ELG (India, Nepal and Maldives) Negative relationship (Bangladesh and Bhutan) No relation (Pakistan and Sri Lanka)

Note: ELG - export-led growth, GLE - growth-led export, GDE - growth driven export

Appendix Table 1 continues…

Study	Country/Region	Study Period	Methodology	Variables	Research Outcome
Sharma, A., & Panagiotidis, T. (2005).	India	1971-2001	Unit Root Tests, Johansen Cointegration Test, Breitung's Cointegration Test, Granger Causality, VAR—IRF Analysis	Gross Domestic Product	No relation
				GDP Net of Exports	No relation
				Real Imports	No relation
				Real Gross Domestic Capital Formation	No relation
				Employment	No relation
Awokuse, T. O. (2006)	Japan	1960-1991	Augmented VAR, Granger Non-Causality, Directed Acyclic Graphs, (VAR) Model	Productivity	ELG
				Terms of Trade	ELG
				Capital	ELG
				Foreign Output Shock	ELG
Chandra Parida, P., & Sahoo, P. (2007)	South Asia (India, Pakistan, Bangladesh and Sri Lanka)	1980–2002	Pedroni's Panel Cointegration	Gross Domestic Product	ELG
				Non-Export GDP	ELG
				Gross Fixed Capital Formation	ELG
				Public Expenditure on Health and Education	ELG
				Manufacturing Import	ELG
				Life Expectancy	ELG
				Labor Force	ELG
				GDP Deflator	ELG
				Consumer Price Index	ELG
				Exchange Rates	ELG
				Export Unit Value	ELG
				Import Unit Value	ELG

Note: ELG - export-led growth, GLE - growth-led export, GDE - growth driven export

Appendix Table 1 continues…

Study	Country/Region	Study Period	Methodology	Variables	Research Outcome
Narayan, P. K. et. al. (2007)	Fiji and Papua New Guinea	Fiji (1960-2001) Papua New Guinea (1961-1999)	Cointegration, Granger Causality	Gross Domestic Product Import	ELG ELG
Maneschiöld, P.O. (2008)	Argentina, Brazil, and Mexico	Argentina (1993-2006) Brazil (1991-2006) Mexico (1980-2006)	Unit Root Test, Johansen Cointegration Test	Gross Domestic Product	ELG
Aktar, S , Taban, S , Aktar, İ . (2008)	Turkey	1980-2007	Cointegration, Error Correction Procedures	Gross Domestic Product	ELG
Dash, R. K. (2009)	India	1992–2007	Cointegration, Error-Correction Models	Index of Industrial Production Imports Real Exchange Rate	ELG ELG ELG
Waithe, K., Lorde, T., & Francis, B. (2010)	Mexico	1960-2003	Cointegration and Error Correction Model	Gross Domestic Product	Negative Relationship
Dierk, H. (2010)	Forty five Countries (North Africa, sub-Saharan Africa, South America, Central America, Caribbean, East Asia, South Asia	1971-2005	Heterogeneous Panel Cointegration Techniques, Regression Analysis	Gross Domestic Product Secondary School Enrolment Absorptive Capacity Business Regulation Labor Regulation	ELG Negative Relationship Negative Relationship Negative Relationship Negative Relationship

Note: ELG - export-led growth, GLE - growth-led export, GDE - growth driven export

Appendix Table 1 continues…

Study	Country/Region	Study Period	Methodology	Variables	Research Outcome
Palley, T. I. (2011)	East Asia, NAFTA, OECD, South East Asia	1950-2008	Descriptive	GDP Growth	No Relation
				Labor Productivity Growth	No Relation
				Total Factor Productivity Growth	No Relation
Palley, T. I. (2011)	Emerging & Developed Economies	1950-2008	Descriptive	Gross Domestic Product	No Relation
Tang, C. F. (2013)	Malaysia	1975-2010	Bootstrap Simulation Causality Test, Rolling Regression-Based Causality Tests	Imports	ELG
				Industrial Production Index	ELG
Bosupeng, M. (2015)	Botswana	2003-2012	Johansen Cointegration Test, Granger Causality Test	Gross Domestic Product	GDE
Bilas, V., Bošnjak, M., & Franc, S. (2015)	Croatia	1996-2012	Granger Causality Test, Cointegration	Gross Domestic Product	ELG
				Personal Consumption	ELG
				Government Consumption	ELG
Tang, C. F., Lai, Y. W., & Ozturk, I. (2015)	Four Little Dragons (Hong Kong, South Korea, Singapore and Taiwan)	Hong Kong (1973-2007) South Korea (1960-2007) Singapore (1966-2007) Taiwan (1961-2007)	Cointegration, Rolling Causality Analyses	Real Gross Domestic Product	ELG
				Exchange Rate	ELG

Note: ELG - export-led growth, GLE - growth-led export, GDE - growth driven export

Appendix Table 1 continues…

Study	Country/Region	Study Period	Methodology	Variables	Research Outcome
Ahmad, N., Kostelić, K., & Ahmad, A. (2016)	Pakistan & Europe	1977-2012	Unit Roots Tests, ARDL	GDP Per Capita Foreign Direct Investment Exchange Rate Infant Mortality Rate Inflation	ELG No Relation No Relation No Relation No Relation
Ee, C. Y. (2016)	Sub-Saharan African (SSA) countries (Botswana, Equatorial Guinea and Mauritius)	1985-2014	Panel Unit Root, Panel Cointegration, Fully Modified OLS (FMOLS), Dynamic Ordinary Least Square (DOLS)	Investment Government Expenditure	ELG ELG
Kalaitzi, A. S., & Cleeve, E. (2017)	United Arab Emirates	1981–2012	Unit Root Tests, Johansen Cointegration Test, Multivariate Granger Causality Test, Modified Version Of Wald Test	Gross Domestic Product Gross Fixed Capital Formation Imports of Goods and Services Population	ELG ELG ELG ELG
Raghutla, C., & Chittedi, K.R. (2019)	BRICS Countries (Brazil, Russia, India, China, South Africa)	1979-2018	Johansen Cointegration, Granger Causality Test	Import Gross Domestic Product	GLE (India, South Africa, and China) ELG (Brazil and Russia) GLE (India, South Africa, and China) ELG (Brazil and Russia)
Furuoka, F. (2019)	Benin, Democratic Republic of the Congo, Madagascar and Sudan	1960–2015	Fisher-Type Causality, Unit Root, ARDL, Three Causality Tests	Gross Domestic Product	No Relation

Note: ELG - export-led growth, GLE - growth-led export, GDE - growth driven export

Appendix Table 2: Total Engineering export, Foreign Exchange Reserve, Gross Domestic Product, Total Export (Goods) and Total Import (Goods)

Year	Eng. Exp USDM	FX Reserve USDM	GDP USDM	Total Exports USDM	Total Imports USDM
1999	4380	32667	458820.41	36877	50550
2000	6761.16	37902	468394.93	43248	59818
2001	6960.12	45871	485441.01	44794	56829
2002	9014.50	67666	514937.94	51153	60723
2003	12361.53	98938	607699.28	60895	75537
2004	14600	126593	709148.51	77939	105975
2005	19180	131924	820381.59	102175	149430
2006	26150	170738	940259.88	123768	184944
2007	33700	266988	1216735.44	153784	231629
2008	39260	247420	1198895.58	198599	323919
2009	38947.10	265180	1341886.60	168220	275227
2010	58384.56	275280	1675615.34	230980	360142
2011	68685.61	271290	1823050.41	307483	475285
2012	66930.01	270590	1827637.86	301982	503519
2013	71328.36	276490	1856722.12	319719	482296
2014	78834.65	303460	2039127.45	328387	472433
2015	66170.97	334310	2103587.81	272353	409238
2016	72901.87	341150	2290432.08	268615	376124
2017	84748.98	346920	2652242.86	290543	416493
2018	92021.34	351130	2718732.23	294406	427665

Source: EEPC, Indiastat, World Bank

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