Impact of Cargo Traffic Growth on Shipping Performance at Major Ports in India (1994-95 to 2009-10)

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Abstract

This paper examines the impact of the growth in the overall cargo traffic performance over the shipping performance at the major ports of India during the period 1994-95 to 2009-10. Some statistical tools like Bivariate and Multiple Regression Analyses with diagrammatical representations are used for the purpose. The paper concludes with the major findings that the shipping performance in terms of the growth of total vessels is significant in response to both the growth of total and category—wise cargo traffic respectively over the said period. This may be primarily due to the dominant rise in the total bulk cargo vessels rather than the container cargo vessels, though there is a significant growth in container traffic. In particular, the liquid bulk cargo has a greater impact on the growth of total shipping, though there is a significant growth of liquid bulk cargo in total cargo traffic.

Keywords: Ports, Cargo Traffic, Shipping, Regression Model

Introduction

Ports form an important infrastructure in the Indian economy in facilitating the international trade and commerce by providing an interface between the ocean transport and the land-based transport system. Despite the tremendous growth of the multi-modal transport system within the country such as roadways, railways and airways, ports and shipping still continue to be the major mode and means of transport respectively in the delivery of cargo compared to other modes, to handle the bulk of world trade, particularly, in bulk cargo. India has a coastline of 7600 kilometers with a well established port infrastructure covering 13 major ports (12 government and 1 corporate) and 187 notified minor and intermediate ports, spreading across 9 coastal states of the country (http:// www.teriin.org). Of them, these major ports serve as the gateways to country's international trade by sea and handle sizeable volumes of physical cargo traffic with most of them operating over or near saturation levels of their handling capacities. The total principal commodity wise traffic primarily comprises of bulk cargo (both solid and liquid) and containerised cargo. These ports in India have been conventionally handling mainly bulk and break – bulk cargoes in pre liberalisation period since independence. But in response to the new emerging trend in global sea–trade with a decisive shift towards containerisation in the mode of cargo delivery, container traffic is also increasing faster at these ports in post liberalisation period (http:// www.shipping.nic.in). Cargo traffic also has registered a phenomenal growth in their volumes in post-liberalisation period as compared to that in pre liberalisation period. Due to this higher traffic growth and, particularly, to the shifting importance of different commodity composition in cargo traffic and in the mode of their delivery, in response to the diversification of commodity composition in India's EXIM trade, whether the shipping performance of India is at par with the cargo traffic performance over time, is a question. This is because, higher the traffic growth, greater the Indian shipping sector will need to update its fleet performance to meet the rising demand of total cargo fleet and also that of the different category -wise cargo fleet in effective evacuation of their respective cargo at these major ports. Hence, against the backdrop of the above economic explanation, such a positive relationship is likely to be expected between the growth of cargo traffic and shipping performance, which is a major focus of this paper. So, the primary objective of this paper is to examine the relationship between the cargo traffic performance (measured in terms of the growth of total and different types of cargo) and the shipping performance (measured in terms of the growth of total and different types of vessels), in order to assess the impact of the growth of the

cargo traffic performance over the shipping performance at the Major Ports of India in the post liberalisation era during the period (1994-95 to 2009-10).

Now, total cargo (TC), (measured in '000 tonnes) is made up of total bulk cargo (BC) and containerized cargo (CC). The former is again subdivided into solid bulk cargo traffic (SBC) and liquid bulk cargo traffic (LBC). Solid bulk cargo includes the principal commodities as iron ore, fertilizers (finished and raw) and coal (thermal and coking); liquid bulk cargo includes crude oil and other petroleum, oil, lubricants (POL) and products. All types of cargo (BC, CC, SBC, LBC), (also measured in '000 tonnes) are defined as category wise cargo. Here, Cargo traffic performance defines the growth in the volumes (measured in tonnage) of the total cargo (TC) as well as those of the above mentioned category wise cargo (BC, CC, SBC, LBC) traffic over time. Similarly, shipping performance defines vessel performance (measured in numbers) i.e. the growth in the number of the total vessels (TV), meant for total cargo traffic as well as those of the different category - wise cargo vessels, such as bulk vessels (BV), container vessels (CV), solid bulk vessels (SBV) and liquid bulk vessels (LBV) for the above mentioned category wise cargo ((BC, CC, SBC, LBC) traffic over time. For this, it deals both mathematically and graphically to examine the above role of shipping in traffic performance.

Review of Literature

Although there are many literatures on international ports (Suárez-Alemán, Campos & Jiménez, 2015; Jensen & Bergqvist, 2013; Panayides & Polyviou, 2011; Li, Wang, Yamaguchi, Nagai, Masuda, & Jiménez, 2010; Bossche, Gujar & Vanden, 2010), but few studies are only available on Indian port literature which reveals that it had been a relatively neglected branch of Indian economic literature till mid 60's. Suárez-Alemán *et al.* (2015), in their paper empirically studied the competitiveness of selected Short Sea Shipping (SSS) corridors by comparing the generalised costs of different alternatives to move cargo from Spain to several European destinations either by road or by using an SSS multimodal corridor. The paper by Panayides and Polyviou (2011) addresses whether logistics-related attributes and services provided by a port enhance the business and supply chain performance of shipping firms.

Mukherjee (1968) had made the first major attempt to write the history of Calcutta Port. Banerjee (1975), Ray (1993), Chakraborty (1995) (ed.) and Sau (1997) too had made important studies on Calcutta Port and Haldia Port and focused on the history and developmental issues concerning Calcutta Port Trust. Panda (1991), Ray (1993), Chakraborty (1995) (ed.) and Sau (1997) had examined various issues involving cargo handling in major ports of India. Chittar (1973), however, first dealt with the history and developmental issues of Bombay Port Trust. De (1999), however, had studied the overall performance of Indian Ports. Later, many other important studies were related to the global impact on the Indian ports in the beginning of the 21st century. Bose (2001) had analysed the performance of cargo handling of major ports in India, with particular focus on the Calcutta-Haldia Port. Ghosh and De (2001) was concerned with the economics of Indian Ports in the context of globalisation. Iyer and Balaji (2001) focused on the relationship between the development of container traffic and the Indian eastern coasts. Ramkrishnan (2003) had dealt with the scenario and vision of Indian Ports. Sasikumar and Bhasi (2004) had made a comparative study of the performance of major Indian sea ports. Raghuram (2006) had made a 'diagnostic study' of the Jawaharlal Nehru Port Trust. Tan (2007) also had made a comparative historical study between the ports of Calcutta and Singapore and their impact on the economy in the era of globalisation. Raghuram and Gangwar (2010) had focused on the containerisation. Monteiro (2010) focused on the impact of Mormugao Port on the developmental parameters of Goa from both the historical and economic perspectives. Sriraman (2010) studied the port and connectivity as one of the determinants of performance of ports. Besides these, Tan (2007) had made a comparative study of Singapore and Calcutta. Rodrigue and Notteboom (2010) had focused on the port regionalisation with the development and changes in port hinterlands. Theys, Notteboom, Pallis and Langen (2010) studied the economics behind the awarding of terminals in seaports.

Apart from these books, other research reports of the Official Committees, Transport Research Division in the Ministry of Shipping and Transport had surveyed different aspects of traffic development and prospects of major ports of India. So far, major attention has been given only to the ports and their developmental issues with very little importance to the role of the water transport system (shipping) in the overall cargo traffic performance at the ports in India in the existing port literature.

Objectives

Against the above theoretical backdrop, the main aim of this paper is to examine the role of shipping in cargo traffic performance at the Major ports of India over the period (1994-95 to 2009-10). For this, it will first examine

1. the growth of i) total and category wise cargo traffic performances (growth of cargo traffic) and ii) total and category wise cargo shipping performances (growth of vessels) over time.

   In response to the above performances, it will then examine the impact of the growth of

2. i) total cargo traffic as well as that of ii) category wise cargo traffic (BC, CC, SBC, LBC) on the total shipping performance [growth of total vessels (TV)].
3. category wise cargo traffic (BC, CC, SBC, LBC) on their respective category wise cargo shipping performance [growth of (BV, CV, SBV, LBV)].

The structure of this paper is as follows: Besides, Introduction in first section, second section will cover Literature Review, third section will cover Objective, fourth section will cover Material and Methodology, fifth section will cover Calculation Section, sixth section will cover Results and Discussions and, finally, seventh section will end up with the Conclusions.

Materials and Methodology

The data on total shipping, (total vessels) and category wise cargo shipping, (different categories of vessels), and also those related to the total and different types of cargo in our study are all secondary data. They are taken mainly from various issues and publications and also from various websites of the following sources such as (i) Economic Survey, (ii) Statistical Abstract, (iii) Basic Port Statistics of India, (iv) Transport Statistics of India, (v) Indian Ports Association [18-20].

As methodologies objective 1 is dealt graphically while objectives 2 and 3 are captured mathematically in Calculation Section.

To test the objectives 2 and 3 respectively, and also its validity, our methodology includes primarily Ordinary Least Square (OLS) Regression Analysis [both Multiple Regression Analysis, Bivariate Regression Analysis] and that of hypothesis testing of the Regression Coefficients (slope coefficients) to test the significance of all the regression coefficients (slope coefficients) for both our Multiple Regression Models and Bivariate Regression Models.

In case of Regression Analysis, a time series analysis of a Classical Linear Multiple Regression Model (CLMRM) with one dependent variable (Y), and more than one independent variable (Xs), linear in their parameters, is constructed with the following Multiple Regression equation of the form,

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + u_t \quad (1)$$

where β_0 is the intercept which measures the mean or the average value of (Y) when both X_1 and X_2 are set equal to zero. β_1, β_2 are the individual partial regression coefficients (slope coefficients) of X_1 and X_2 respectively, which measure the change in the mean value of (Y) per unit change in one independent variable, (say, X_1 or X_2), holding the value of the other independent variable constant. That is, it gives the "direct" or "net" effect of a unit change in X_1 (or X_2) on the mean value of Y, net of any effect that X_2 (or X_1) have on mean Y for β_1 (or β_2). In case of OLS Regression Analysis, the quantity known as Coefficient of Determination denoted by r^2 (Bivariate regression model) and R^2 (Multiple regression model) will be used to analyze the measure of the goodness of the fit of our regression equations. R^2 measures how far the percentage of the total variations in the dependent variable (here, the growth of TV, BV, SBV, LBV or CV) will be explained either, individually (here, TC, BC, SBC, LBC, or CC) or jointly, by all independent (explanatory) variables (here, different types of cargo simultaneously).

Under hypothesis testing, two mutually complementary approaches i) Confidence Interval Approach (CIA) and Test of Significance Approach (TOSA) (t-test), yielding the same results and conclusions, and ii) Analysis of Variance (ANOVA) Approach (F-test) (for the Overall Significance of both the Estimated Bivariate and Multiple Regression Models) will be used for deciding whether to reject or accept the null hypothesis.

In the language of hypothesis testing, a stated hypothesis or a null hypothesis (H_0) is constructed and usually tested against the alternative hypothesis testing (H_1) in all the above tests. In case of CIA, if the unknown parameter β (β_1, β_2, β_3, β_4) under (H_0: $\beta = 0$) falls within the confidence interval, (H_0) is not rejected and it is said that our finding is statistically insignificant. But, if it falls outside those confidence limits, then (H_0) is rejected and our finding is statistically significant. Secondly, under (TOSA) approach (t test) or in ANOVA technique, from a two- tailed test, with the given critical values (table values) of $t_{\alpha/2,n-k}$,

and $F_{\alpha, (k-1,n-k)}$, if the computed (absolute) t or F value of our estimated slope coefficients(β*s) exceeds their respective critical values at chosen level of significance (α = 5%), then (H_0) is rejected with β*s being statistically significant: otherwise (H_0) is not rejected with their values being statistically insignificant. Alternatively, if the p-value (probability value) of the t statistic is sufficiently low, then also (H_0) is rejected and all the β*s are then said to be statistically significant with increasing confidence (Gujrati & Sangeetha, 2008)

Calculation Section

Underlying the above mentioned primary objective, over the period (1994-95- 2009-10), in response to the cargo trade and cargo shipping performances (objective 1), this paper will examine objectives 2 and 3.

Under the above impact of the growth of total cargo traffic over time, it will study the impact of

2. (i) the growth of total cargo traffic (TC) as well as

2. (ii) the individual growth of the different types of cargo traffic (BC, SBC, LBC and CC) on the growth of total vessels (TV) respectively.

2. (iii) the simultaneous change in different category wise cargo traffic (BC, SBC, LBC and CC) on the growth of total vessels (TV)

For 2(i) and (ii), time series analyses of a Classical Linear Bivariate Regression Model is constructed over the given period, with the following regression equation structures (I) [equations (1-5)].

$TV_t = \beta^0_i + \beta_{it} X_t + u_t$ …….(I) [t=1,2,3,……16,

i=1,2,..5 for X=TC, BC, SBC, LBC and CC respectively]

For 2(iii), a time series analysis of a Classical Linear Multiple Regression Model (CLMRM) is constructed over the said period, with the following regression equation structures (II) [equations (6 -8)] respectively.

$$TV_t = \beta_0 + \beta_1 BC_t + \beta_2 CC_t + u_t \quad (6)$$

$$TV_t = \beta_0 + \beta_1 SBC_t + \beta_2 LBC_t + u_t \quad (7)$$

$$TV_t = \beta_0 + \beta_1 SBC_t + \beta_2 LBC_t + \beta_3 CC_t + u_t \quad (8)$$

For objective 3 also, a time series analysis of a Classical Linear Bivariate Regression Model is constructed over the given period, with the following regression equation structures (III) [equations (9 -12)],

$Y_t = \alpha^0_k + \alpha_k X_t + u_t$ ……(III) [t=1,2,3,……16, k=2,..5 for Y= BV, SBV, LBV and CV and for X= BC, SBC, LBC and CC respectively].

Next, to test the above regression coefficients (βs) the null hypotheses (H_0: $\beta s = 0$) are constructed against the alternative hypotheses (H_1: $\beta s \neq 0$) for the respective equations.

For the equation structure I,

H_0^1: Individual change in Xs (TC, BC, SBC, LBC or CC) has no linear influence on TV respectively.

For the equation structure II,

H_0^2: Change in BC (or CC), holding CC (or BC) constant, has no significant influence on TV respectively.

H_0^3: Change in SBC (or LBC or CC), holding LBC, CC (or SBC) constant, has no significant influence on TV respectively.

To test the overall significance,

H_0^4: Simultaneous change in Xs (BC and CC or SBC, LBC and CC) has no linear influence on TV respectively [(H_0: $\beta s = 0$) as against (H_1: $\beta s \neq 0$)].

For the equation structure III,

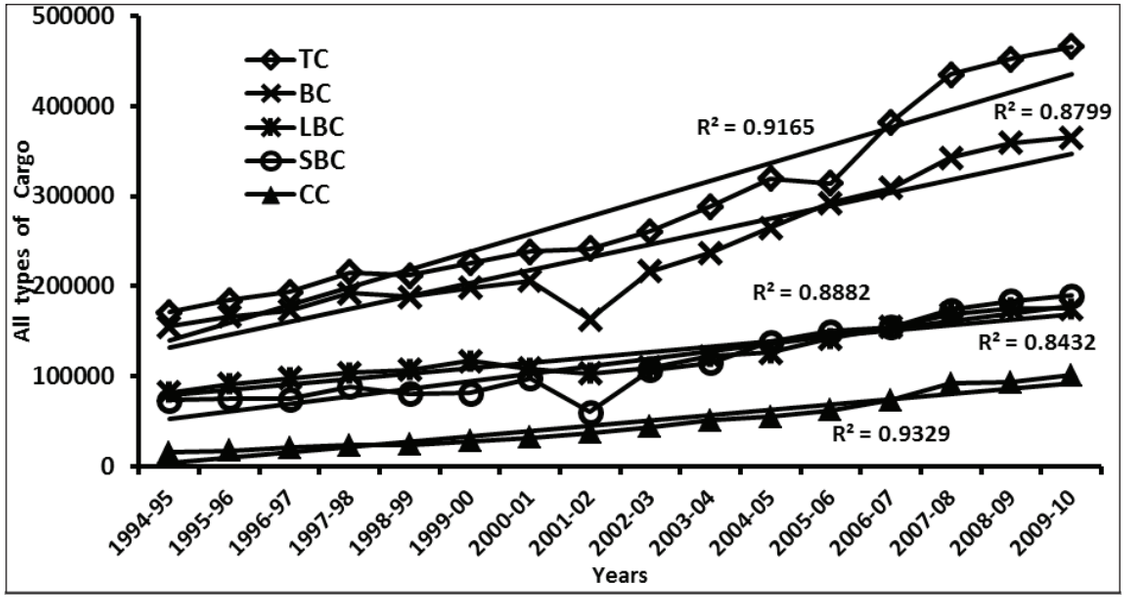
H_0^5: Individual change in Xs (BC, SBC, LBC or CC) has no linear influence on Ys (BV, SBV, LBV and CV) respectively.

Results and Discussion: Data Analysis

Regarding the growth of cargo traffic performance during the period (1994-95- 2009-10) (objective 1 (i)), Figure 1 has shown a higher growth in the volumes of total (TC) cargo traffic and all types of category wise cargo traffic (BC, CC, SBC, LBC) over the said period. However, of the growth of category-wise cargo traffic performance, the growth of volume of BC is very much higher than CC; of the total bulk cargo, the growth of LBC is very slightly higher than SBC for the past decades but it is either more or less same or slightly lower than that of SBC for the present decades.

It is also evident from Figure 1 which reveals the sharp rising trend lines of total and all types of cargo traffic growth (BC, CC, SBC, LBC), explaining much higher variations in their growth traffic over time (R^2 {all above 80 percent}). But container cargo (CC) has explained a greater variation (R^2=93.2 percent) in its growth traffic

Figure 1: Growth of All Types of Cargo Traffic (Measured in Thousand Tonnes) Over Time

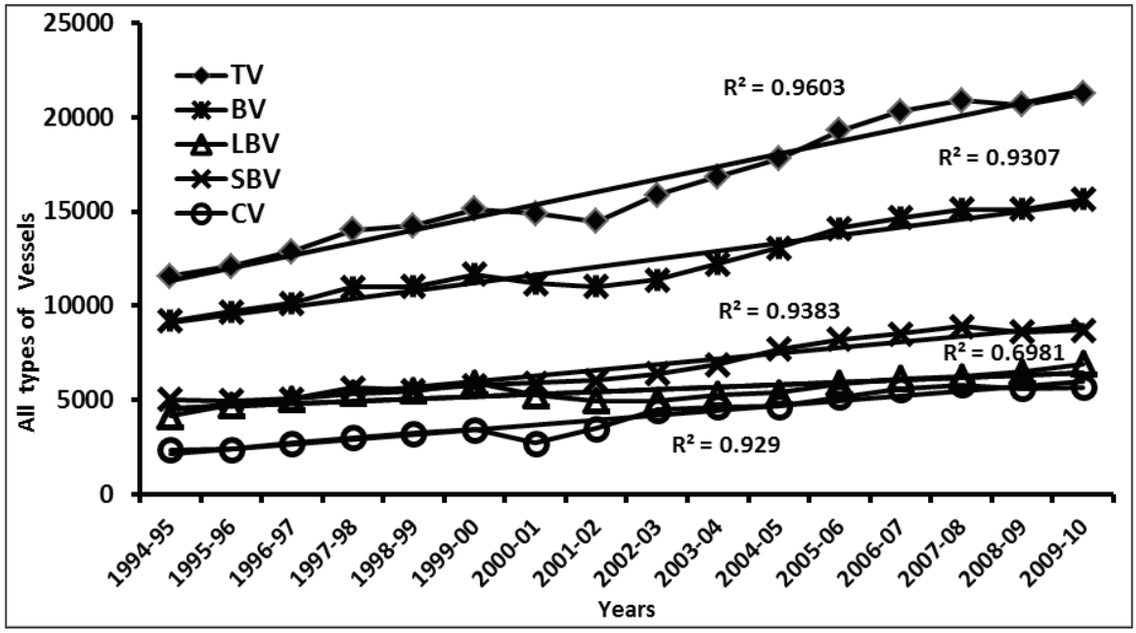


Source: Indian Ports Association, http://www.ipa.nic.in,http://www.shipping.nic.in

than the bulk cargo (BC) (R^2=87.9 percent), in spite of its lowest volume in total cargo traffic (TC). Again, of the total bulk cargo, Liquid bulk cargo (LBC) has explained a greater variation [R^2=88.8 percent] in its growth traffic than solid bulk cargo (SBC) [R^2=84.3percent], despite the opposite trend in its volume growth in total cargo traffic (TC) in recent years.

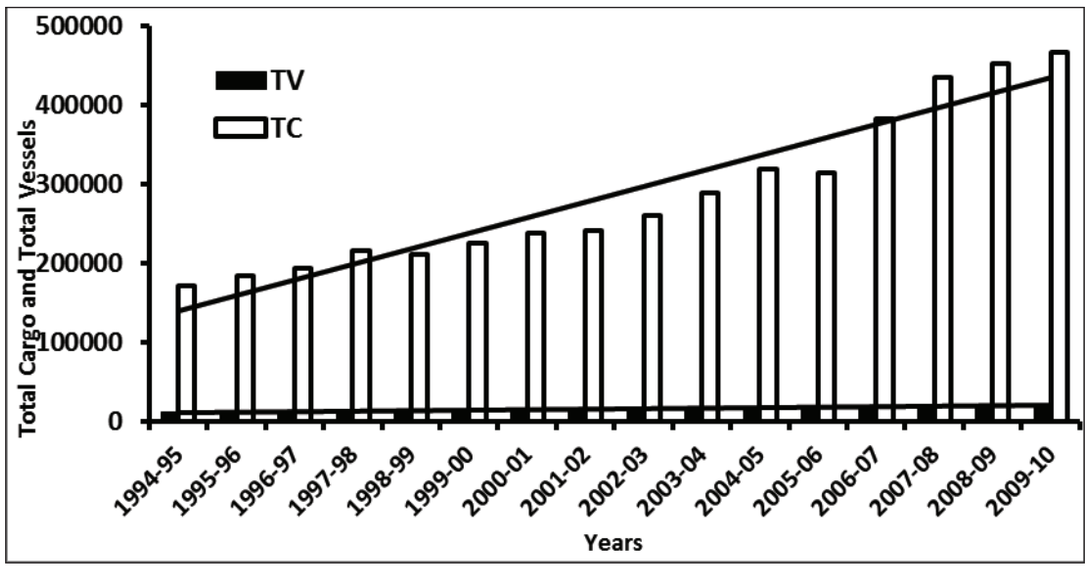
Regarding the growth of shipping performance during the period (1994-95- 2009-10) (objective 1 (ii)), Figure 2 has shown a higher growth in the number of total vessels and all types of category wise cargo vessels (BV, CV, SBV, LBV) over the said period. Figure 2 also reveals the rising trend lines of the growth of total and all types of vessels (BV, CV, SBV, LBV), explaining much higher

Figure 2: Growth of All Types of Cargo Vessels (Measured in Numbers) Over Time



Source: Indian Ports Association, http://www.ipa.nic.in,http://www.shipping.nic.in

Figure 3: Growth of Both the Total Cargo Traffic and Also the Total Cargo Vessels Over Time



Source: Indian Ports Association, http://www.ipa.nic.in,http://www.shipping.nic.in

variations in their growth over time (high values of R^2). Of the category wise cargo shipping performance over time, the growth of the volume of BV is found to be very much higher than CV, together, with a very slight higher variation in BV (R^2=93.0 percent) than CV (R^2=92.9 percent), to keep at par with the above respective cargo traffic growth. Again, of the total bulk cargo, the growth of the volume of SBV is very slightly higher than LBV for the past decades, but it is much higher than that of LBV for the present decades. Even, SBV has explained very much greater variation (R^2=93.8 percent) in its growth than LBV (R^2=69.8 percent) over time, despite there being greater variations in the growth of liquid bulk cargo (LBC) in total cargo traffic (TC) performance over time.

Not only that, Figure 3 has shown a much flatter trend in the growth of the total vessels (TV) in response to the relatively steeper growth trend of the total cargo, TC over the said period.

Next, for objectives 2 and 3, the estimated regression equation structures for both MRM and SRMs are given and are verified with the help of the Regression analysis in this section. Then, under the Theory of Hypothesis Testing, the significance of all the regression coefficients are tested with the help of the above methods, CIA, TOSA (t- test) and ANOVA (F-test) respectively. The summary statistics of regression models are shown in Tables 1, 2 and 3 respectively for both Bivariate and Multiple Regression Models..

In case of Bivariate Regression Models, corresponding to equations (1) - (5) (Table 1), the following estimated simple regression equations are

$TV_t = 7152.62 + 0.032TC_t$ (1)

$TV_t = 5966.74 + 0.043BC_t$ (2)

$TV_t = 8134.49 + 0.072SBC_t$ (3)

$TV_t = 3318.78 + 0.105LBC_t$ (4)

$TV_t = 11117.65 + 0.110CC_t$ (5)

In response to the above trade performance over time, regarding the impact of the growth of total cargo traffic (TC), and different types of cargo traffic (BC, SBC, LBC, CC) respectively on the total shipping performance (growth of total vessels, TV), Table 1 reveals that both the regression analysis and TOSA have explained a higher growth in the total vessels, TV. From the R^2 values of the above equations (1)-(5), it is found that TC and other types of cargoes (BC, SBC, LBC and CC) individually has significantly explained higher growth in TV (with R^2 = above 90 percent). It is also evident from their positive slope coefficients (β*). From (1), TC alone has explained 94 percent of the total variation in the total vessels, TV, with a 3.2 percent rise per unit change in total cargo, TC [β*=0.032]. The same results are also supported by the TOSA analysis. Corresponding to the equation (1), β* of TC is highly statistically significant at 5 percent level of significance as β = 0 fall outside the confidence intervals

Table 1: Summary statistics of Bivariate Regression Analysis and ANOVA Equation Structure [I]

Equation No.	Variables	Coefficients	Lower 95 percent	Upper 95 percent	t stat	p-value	F	R^2	Adjusted R^2
1	Intercept	7152.62	5691.45	8613.8	10.5	5.09E-08	203.87	0.9357	0.9311
	TC	0.03212	0.03	0.04	14.28	9.76E-10			
2	Intercept	5966.74	4513.72	7419.75	8.81	4.4E-07	257.22	0.9483	0.9447
	BC	0.04353	0.04	0.05	16.04	2.09E-10			
3	Intercept	8134.49	6585.94	9683.04	11.27	2.09E-08	148.14	0.9136	0.9074
	SBC	0.072	0.06	0.08	12.17	7.79E-09			
4	Intercept	3318.78	1558.415	5079.146	4.04	0.0012	267.61	0.9503	0.9467
	LBC	0.1053	0.091494	0.119106	16.4	1.61E-10			
5	Intercept	11117.65	10232.84	12002.46	26.95	1.83E-13	218.23	0.9397	0.9354
	CC	0.109685	0.093761	0.12561	14.77	6.23E-10			

Source: Indian Ports Association, http://www. ipa.nic.in., http://www.shipping.nic.in

[0.03, 0.04]. Not only that, β* of TC is highly statistically significant at 5 percent level of significance as the computed (absolute) t value of TC [14.28] is higher than that of the critical value or table value $t_{.025,14} = 2.15$. The same result is also obtained from ANOVA, with computed F value of TC (203.87) is higher than the critical value of $F_{.05,\ 1,14} = 4.60$. Moreover p value of t for TC (9.76E-10) is also very low to reject the null hypothesis (H_0^1) and accept the corresponding H_1 to arrive at a statistical significance for TC, to raise total vessels, TV.

Regarding the individual impact of the growth of the category - wise cargo traffic performance on the total shipping performance from equations (2)-(5) (Table 1), it is found that, the bulk cargo, BC, has explained a slightly higher significant variation in the total vessels TV (R^2 =0. 9483) than the container cargo, CC (R^2 =0.9397). Of the total bulk cargo, BC, again, the liquid bulk cargo, LBC (R^2 =0.9503) has shown a much higher variation in the total vessels, TV, than the solid bulk cargo, SBC (R^2 =0.9136), with the highest contribution of LBC, in response to the growth of the higher volumes of the bulk cargo, particularly, liquid bulk cargo in total cargo traffic over time. However, from the estimated slope coefficients, β*s of the above equations, (2) – (5), it is found that, the rise in the total vessels, TV, per unit rise in the container cargo, CC (0.11), is higher than the bulk cargo, BC, (0.04). Again, of the total bulk cargo, BC, per unit rise in the liquid bulk cargo, LBC (0.10), is higher than the solid bulk cargo, SBC, (0.07), with the highest contribution of CC in raising TV among the different types of cargo traffic over time. The same results are also supported by the TOSA analysis. Corresponding to the equation (2) - (5), all β* of them are highly statistically significant at 5 percent level of significance as their βs = 0 fall outside their respective confidence intervals. Not only that, all β* of TC are highly statistically significant at 5 percent level of significance as their computed (absolute) t values are higher than that of the critical value or table value $t_{.025,14} = 2.15$. The same results are also obtained from ANOVA, with all their computed F values being higher than the critical value of $F_{.05,\ 1,14} = 4.60$. Moreover, all their p values of t are also very low to reject the null hypothesis [H_0^1] and accept the corresponding H_1 to arrive at a statistical significance for them, to raise TV. But, $t^*_{BC}(16.04) > t^*_{CC}(14.77)$] and $t^*_{LBC}(16.4) > t^*_{SBC}(12.17)$; again, $F^*_{BC}(257.22) > F^*_{CC}(218.23)$ and $F^*_{LBC}(267.61) > F^*_{SBC}(148.14)$. Hence, highest t^*_{LBC}, F^*_{LBC} and its lowest p value has led to a greater statistical significance for LBC in raising TV for the equation structure I.

Next, in case of Multiple Regression Models, corresponding to equations (6) - (8) (Table 2), the following estimated simple regression equations are

$$TV_t = 7953.96 + 0.03BC_t + 0.45CC_t \quad (6)$$

$$TV_t = 4466.53 + 0.02\ SBC_t + 0.8LBC_t \quad (7)$$

$$TV_t = 6235.54 + 0.032SBC_t + 0.014LBC_t + 0.06CC_t \quad (8)$$

Regarding the joint impact of the change in the category - wise cargo traffic performance on the total shipping performance (growth of TV), equations (6) – (8) (Table 2) reveal that almost 96 percent of variations in the total vessels, TV, are explained jointly either by bulk cargo, BC and container cargo, CC (equation (6)) or by the solid

Table 2: Summary statistics of Regression Analysis and ANOVA Equation Structure [II]

Equation No.	Variables	Coefficients	Lower 95 percent	Upper 95 percent	t stat	p-value	F	R^2	Adjusted R^2
6	Intercept	7953.96	4694.379	11213.54	5.27	0.000151	140.08	0.9556	0.9488
	BC	0.026229	1.74E-05	0.052441	2.16	0.049869			
	CC	0.044848	-0.0215	0.111197	1.46	0.167953			
7	Intercept	4466.528	1977.909	6955.147	3.88	0.001906	143.34	0.9566	0.9499
	SBC	0.020504	-0.01165	0.052653	1.38	0.19152			
	LBC	0.077008	0.030644	0.123372	3.59	0.003305			
8	Intercept	6235.545	1555.855	10915.24	2.90	0.013247	95.54	0.9598	0.9498
	SBC	0.031831	-0.03919	0.10285	0.97	0.34806			
	LBC	0.013727	-0.0221	0.049555	0.83	0.420161			
	CC	0.056726	-0.0084	0.121856	1.89	0.082054			

Source: Indian Ports Association, http://www. ipa.nic.in.,http://www.shipping.nic.in

bulk cargo, SBC, the liquid bulk cargo, LBC and even container cargo, CC (equation (7) and (8)). Again from the β* values of equation (6), β^*_{CC} (0.045) > β^*_{BC} (0.03) and from equations (7)- (8), $\beta^*_{LBC} > \beta^*_{CC} > \beta^*_{SBC}$,, with highest β^*_{LBC} in both cases. This implies that, per unit rise in the liquid bulk cargo, LBC, (or container cargo for equation (6)) leads to the greater rise in the total vessels, TV, with respect to others, i.e. holding SBC, and CC constant (for equation (8)). The same results are also obtained from TOSA. However, from equations (6) and (7), both t^*_{BC} (2.16) and t^*_{LBC} (3.59) are only statistically significant at 5 percent level of significance as their computed (absolute) t values are higher than that of the critical value or table value $t_{.025,13} = 2.16$, with t^*_{LBC} being highest for equation (7). The same results are also obtained from ANOVA, with all their computed F values being higher than the critical value of $F_{.05,\ 2,13} = 3.80$. Moreover, all their p values of t are also very low to reject the null hypothesis (H_0^2 and H_0^3) and accept the corresponding H_1s to arrive at a statistical significance for them, to raise TV. Hence for the overall significance of the MRMs, it is found that both BC and CC or both SBC and LBC jointly have led to the significant rise in TV than others to reject all H_0s (H_0^2, H_0^3, H_0^4) and accept H_1s of both the equations (6) and (7) to arrive at a greater statistical significance of SBC and LBC. From equations (6) - (8), F* of equation (7) being > than others. Hence, highest t^*_{LBC} and F* together with lowest value p value of LBC (0.0033), therefore implies greater statistical significance for LBC in raising TV for the equation structure II.

Again, in case of SRMs, corresponding to equations (9) - (12) (Table 3), the following estimated simple regression equations are

$$BV_t = 5572.66 + 0.03BC_t \quad (9)$$

$$SBV_t = 3031.05 + 0.032SBC_t \quad (10)$$

$$LBV_t = 2814.11 + 0.022LBC_t \quad (11)$$

$$CV_t = 2064.80 + 0.042CC_t \quad (12)$$

Regarding the individual impact of the growth of the category-wise cargo traffic performance on the category - wise shipping performance over time from equations (9)-(12) (Table 3), it is found that $R^2_{BC} > R^2_{CC}$ and $R^2_{SBC} > R^2_{LBC}$, with $R^2_{BC,}$ particularly, R^2_{SBC} being the highest, because of its greater volume in the total cargo traffic over time. However, from β* of the equations (9) and (12), the rise in the container vessels, CV, per unit rise in the container cargo, CC is higher than the rise in the total bulk vessels, BV, per unit rise in that of bulk cargo, BC. Again, from the β* values of equations (10) and (11), β^*_{SBC} (0.03) > β^*_{LBC} (0.02), with highest β^*_{CC} in all cases. The same results are also obtained from the TOSA analysis. Corresponding to the equation (9) - (12), all β* of them are highly statistically significant at 5 percent level of significance as their βs = 0 fall outside their respective confidence intervals. Not only that, all β* of the above equations are highly statistically significant at 5 percent level of significance as their computed (absolute) t values are higher than that of the critical value or table value $t_{.025,14} = 2.15$. The same results are also obtained from ANOVA, with all their computed F values being higher than the critical value of $F_{.05,\ 1,14} = 4.60$. Moreover, all their p values of t are also very low to reject the null hypothesis (H_0^5) and accept the corresponding H_1 to arrive

Table 3: Summary Statistics of Bivariate Regression Models, Regression Analysis and ANOVA Equation Structure [III]

Equation No.	Variables	Coefficients	Lower 95 percent	Upper 95 percent	t stat	p-value	F	R^2	Adjusted R^2
9	Intercept	5572.662	4740.448	6404.876	14.36	9.03E-10	323.86	0.9586	0.9556
	BC	0.027977	0.024642	0.031311	17.99	4.48E-11			
10	Intercept	3031.054	2353.295	3708.813	9.59	1.56E-07	156.84	0.9180	0.9122
	SBC	0.032242	0.02672	0.037764	12.52	5.4E-09			
11	Intercept	2814.114	2182.387	3445.842	9.55	1.64E-07	89.22	0.8644	0.8547
	LBC	0.021819	0.016865	0.026774	9.44	1.88E-07			
12	Intercept	2064.801	1611.453	2518.148	9.77	1.25E-07	129.77	0.8961	0.88887
	CC	0.041807	0.033648	0.049967	10.99	2.87E-08			

Source: Indian Ports Association, http://www. ipa.nic.in.,http://www.shipping.nic.in

at a statistical significance for them, to raise TV. But t^*_{BC} (17.99) > t^*_{CC} (10.99) and t^*_{SBC} (12.52) > t^*_{LBC} (9.44); again, F^*_{BC} (323.86) > F^*_{CC} (129.77) and F^*_{SBC} (156.84) > F^*_{LBC} (89.22). So, highest t^*_{BC}, particularly, t^*_{SBC} and their F* values, together with their lowest value p values, therefore, implies a greater statistical significance for BC, particularly, SBC, in raising their respective category wise cargo vessels for the equation structure III. Hence, the bulk cargo, BC has a greater impact on shipping, in raising the total bulk vessels, BV, (R^2 =0.9586, t*=17.99 and F*=323.86), together with that of solid bulk cargo, in raising solid bulk vessels, SBV.

Conclusion

Regarding the growth of cargo traffic performance during the period (1994-95-2009-10), total cargo, TC, has significantly increased over time, with the rise in both the bulk cargo and the container cargo. But dominance of the bulk cargo in the total cargo traffic is primarily caused by the higher volumes of the solid and the liquid bulk cargoes rather than the container cargo over time. Bulk cargo has dominated the Indian trade scenario since independence. In particular, despite the dominant rise in the liquid bulk cargo over time, solid bulk cargo has either reached the volume of such higher level of the liquid bulk cargo or even has exceeded it in the recent years. This is mainly because of the trade pattern and the nature of commodity composition of trade within the country, depending upon the trade policy changes over time. Similarly, the container cargo, although, being lower in volume than the bulk cargo, has increased sharply over time because of the onset of economic liberalisation in 1991, which has established the new era of containerisation in the mode of cargo delivery from the dominance of the era of bulk and break bulk trade in response to the new global trade patterns.

Regarding the shipping performance during the said period, in response to the greater dominance of the bulk cargo than the container cargo in the above category wise cargo traffic performance, there is a dominant rise in the bulk cargo vessels than the container cargo vessels over time. But it is found from trade performance that, there is a significant variation in the growth traffic of both the liquid bulk cargo as well as that of the container cargo over time. Not only that, per unit rise in container cargo leads to a greater rise in the growth of total vessels (Tables 1and 2) and also to that of container cargo vessels (Table 3). Such above significant explanations caused by the container cargo in the growth of the total vessels, therefore, implies a higher demand for the container cargo vessels, to meet the rising trend in containerisation of cargo traffic at these major ports.

Again, per unit rise in liquid bulk cargo leads to a greater rise in the growth of total vessels in both cases (Tables 1 and 2). In spite of that, liquid bulk cargo has explained a least variation in raising the growth of total vessels (Table 3) and also liquid bulk cargo vessels has explained the same in its growth over time (Figure 2).

But in reality, the total vessels has significantly increased, primarily, due to the dominant rise in the bulk cargo vessels and, particularly, the solid bulk cargo vessels rather than the container cargo vessels against the significant growth in container traffic over time. Thus, as a result, it can be said that the higher demand for both the container cargo vessels and the liquid bulk cargo vessels in the growth of the total vessels, as, against their significant role in the total cargo traffic (in response to the higher volume of

the liquid bulk cargo over time), therefore, have, reflected a poor shipping performance. Moreover, in response to the higher growth trend in the cargo traffic performance, a relatively much flatter trend in the growth of the total vessels, against the much rising trend in the total cargo traffic, over time, thus, has shown a stagnant performance in shipping. This paper, finally, concludes with the fact that the overall shipping performance in terms of the growth of total vessels is, although, significant but is not highly satisfactory in response to the overall growth of the cargo traffic over time. Hence, this paper suggests the following future research directions.

Future Research Directions

In this era of economic liberalisation, in order to cope with the world trade scenario, a thrust is needed for a country like India to improve the shipping performance with the growth in the total number of vessels to meet the world cargo demand in the coming future. Hence, further researches are needed and so suggested in different core (trade and transport) sectors in order (i) to increase, particularly, the growth (both number and volume (in tonnage)) liquid bulk vessels and the container cargo vessels and also (ii) to invent suitable, new modern production techniques in the transport engineering sector so as to format the sizes of the above mentioned category wise cargo vessels as per their high world demand in this era of containerisation.

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