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Determinants of Port Performance – Evidence from Major Ports in India – A Panel Approach

T. Rajasekar*, Malabika Deo

Department of Commerce, Pondicherry University, Pondicherry, India
* Corresponding author: rajakudal@gmail.com

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Abstract The present study's motivation is to identify the determinant factors for port efficiency of major ports in India during 1993 – 2011. For identifying the factors panel data models like pooled ordinary least square method, fixed effect model and random effect model are used. The hypothesis tested here is outside factors also influence port performance. The results of the study indicated that berth throughput, operating expenses and number of employees affect port efficiency in a significant positive manner, whereas cargo equipment's and idle time shows negative but significant effect on port efficiency. From the study the inference drawn that only inside factors of the ports are the major determining factors of the performance of ports compare with outside factors.

Keywords: *determinants of port performance, major ports in india, panel data, fixed effect model, random effect model*

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1. Introduction

In India, awareness towards the factors determining the port efficiency on its infrastructure and its trade has increased in recent years. The importance of determinants of factors for port efficiency is the linkage between growth, performance of individual ports and overseas transportation leading to exports as well as imports since the liberalization initiated in 1991(Indian Port Report). The effect of poor port performance reflects on its countries economic developments. Port efficiency varies widely from country to country and, specifically from region to region. It is well known that some of the Asian countries (Singapore, Hong Kong) are having the most efficient ports in the world, while some of the most inefficient ports are located in Africa (Ethiopia, Nigeria, Malawi) or South America (Colombia, Venezuela, Ecuador) (Wu, J., & Lin, C, 2008, Wu, et al., 2009). It seems geographical location plays a determinant role of ports efficiency. Even some ports become inefficient because of lack of integrated services, outdated work practices or the obsolete facilities. These can have telling effect on the country's economic growth in the borderless world. Increasing incidences of inefficient ports have forced the governments all over the world to deregulate the port operating system. (o). Many governments have begun to deregulate port activities and decentralize decision making system, with the objective of increasing financial viability and productive efficiency of the ports along with de liberalizing the respective economies. Towards this direction, governments across the world are presently reformulating the way of controlling, managing and regulating the ports with the general principle of reducing direct intervention and, where feasible, the use of the private sector for typical port operations is also being introduced. According to Thomas and Monie (2000), the efficiency of ports and terminals must measure the performance of the economy and its foreign trade. The measurement of ports or terminal efficiency is of particular importance because they are vital to the economy of the country and to the success and welfare of its industries and citizens.

Number of studies (Tongzon and Heng 2005, Tongzon 1995) have taken place container indicating handling efficiency as a major factor affecting the volume of total throughput of a port. To test the relationship between the factors related efficiency in terms of traffic volume, the present piece of work has attempted to built a panel-data model of the Indian major ports. While taking the variables for finding out factors determining the port efficiency some of the important points were kept in mind they are: port location (Veldman and Vrookmen 2007, Zohil and Prijon 1999, Tongzon 1995) the volume of export/import or total traffic (Veldman and Vrookmen 2007, Zohil and Prijon, 1999) the number of equipments obtainable for the ports (Gouvernal, et al., 2005) feeder service costs (Veldman and Vrookmen, 2003) and cargo handling costs at port (Tongzon, 1995) as well as the state wise net domestic product and its categorization are considered.

The present study attempted to address to these issues of determinant of ports efficiency in the context of Indian major ports. Some of the earlier studies which have tried to investigate in to relationship between transport costs, infrastructural development and port efficiency (Clark et al. 2004, Sanchez et al. 2003). But no study has conducted the factors determining port efficiency considering several important variables inside as well as outside the ports. In this direction the present study has made a humble attempt to find out the factors determining port efficiency of Indian major ports with inside and outside factors of the ports under consideration.

The reason for attempting this study on Indian Major Ports is that India in an effort to increase the efficiency of ports India has been attempting to deregulate its port sector. At the same time Indian ports are not considered noteworthy in terms of their efficiency as they are characterized by the existence of obsolete and poorly maintained equipment, hierarchical and bureaucratic management structures, weak coordination between the port trusts and users of the ports hence there is a need to study the Indian ports and the factor influence their efficiency in depth. Secondly, considering the country's entry into the second stage reform, the analysis will help to assess potential benefits of moving to a deregularized port sector under a liberal trading region when more than 75% of the country's foreign trade passes through seaports. For instance, the determinant factors if taken care of can stimulates traffic, and then the benefits of performance augmenting factors might be responsible not only redistribution of existing traffic but also for attracting new manufacturers. Hence there is a stray justification for analyzing factors determining the efficiency of the Indian ports sector.

2. Methodology

2.1. Objective and Data

The main objective of this paper is to find out the factors determining port efficiency of Indian Major Ports using panel approach. The dependent and explanatory variables included in the model are: Total traffic (TOTTRAFFIC), Turnaround time (TRT), Idle time (IDLE), Berth occupancy (BOCCU), Berth throughput (BTHROUGH), Operating surplus per ton (OSPT), Rate of return on turnover (RROT), Number of employees (NOE), Cargo equipments (CAREQUIP), Operating expenses (OPEXP), Net state domestic product (NSDP), Net state domestic product in agriculture (NSDPAGRI), Net state domestic product in industry (NSDPINDUS), Net state domestic product in services (NSDPSERVICE), in the analysis. In order to find out the determining factor for port efficiency the period of study spans nineteen years i.e. from 1993 to 2011 has been considered. The whole study is based on secondary data, which was collected from the port authorities, Indian Ports Association, CMIE and India Stat databases.

2.2. Basic Specification of the model

To measures the factor determining the port efficiency basic panel data used the following formula

$$Y_{it} = f\{\alpha_{it} + \beta X_{it} + \varepsilon_{it}\} \quad (1)$$

i = 12 Major Port of India, t = 19 years (1993 to 2011)
Where,
Y_{it} is the Volume of Total Traffic in the selected Ports

X it is the Independent variables that are considered such as Turnaround time, Idle time, Berth occupancy, Berth throughput, Operating surplus per ton, Rate of return on turnover, Number of employees, Cargo equipments, Operating expenses, Net state domestic product, Net state domestic product in agriculture, Net state domestic product in industry, Net state domestic product in services.

α is the intercept and β is parameters to be estimated

ε error term.

The natural log function has been used for making the data normal.

2.3. Econometric Model

The structure of the available dataset allowed the use of panel data methodology for the present empirical research. This type of analysis can control firm heterogeneity, and reduce collinearity among the variables that are contemplated (Arellano and Bover, 1995). This technique enables to eliminate the potential biases in the resulting estimates due to correlation between unobservable individual effects and the explanatory variables included in the model. Hsiao (2003) and Klevmarken (1989) list several benefits of panel data. These include:

1. Panel data give more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency.
2. Panel data are better able to study the dynamics of adjustment. Cross- sectional distributions that look relatively stable hide a multitude of changes.
3. Panel data are better able to identify and measure effects that are simply not detectable in pure cross-section or pure time-series data.
4. It reduces the identification problems.
5. Controlling for individual heterogeneity. Panel data suggests that individuals, firms, states or countries are heterogeneous. Time-series and cross-section studies not controlling this heterogeneity run the risk of obtaining biased results.

Panel data are of two types; balanced panel data which has equal number of observations for each individual (cross-section), as well as unbalanced panel data not having equal number of observations for each individual. Panel data models in macroeconomic have become popular since last decades. The idea of a panel data set is that a cross-section of observational units, typically individuals or economic entities, are selected and a response or explanatory variables are observed for each unit. So panel data set contains observations on multiple phenomena observed over multiple time periods. Panel data sets generally include chronological blocks or cross-sections of data, within each of which resides a time series. The port data under study holds the above mentioned characteristics, which gives a lead to panel data analysis of the performance of major ports of India.

Primary reason for making a panel data analysis is that it offers opportunity for controlling unobserved individual and/ or time specific heterogeneity, which may be correlated with the included explanatory variables. Both time series and cross-section when combined, enhances the quality and quantity of data in ways that would be impossible using only one of these two dimensions (Gujarati, 2003). As per Klevmoarken (1989), Hsiao

(2003, 2005), Woolridge (2002), Baltagi (2005), Greene (2005), etc., benefits for using panel data, are multifarious, as it increases the precision of parameter estimates, allows to sort out model temporal effects without aggregation bias, gives more informative data, less collinearity among variables, more efficiency, etc. As per Hausman and Taylor (1981) combining time-series and cross-sectional data, individual-specific unobservable effects (may be correlated with other explanatory variables) can be controlled.

The earlier researchers using panel data analysis reveal that, Hsiao (2004) used the panel data models with slope heterogeneity under various testing. The study suggested for simulation equation random coefficient model as it is the most recent development for common framework. Frees et al. (2001) studied the illustration of panel data models that can be applied to different functional areas and their features. They also pointed out that the data could provide opportunity to enhance the model specification. Greene (2001) specifies the selection of random and fixed effects with the panel data. This study suggested that the estimation of fixed effects model is quite feasible even in panel with large number of groups. According to Baltagi (2005) panel data problem may arise when designing surveys which include design, data collection problem and cross section dependence.

In the present part of the analysis Pooled Ordinary Least Square (OLS), Fixed Effect Model (FEM) and Random Effect Model (REM) have been used for estimating the determining factor for port performance of major ports in India. A balanced panel data set is used which has equal number of observations for each individual (cross-section) and for best model selection, for best model testing, Hausman specification test are used (see Breusch and Pagan, 1979, Gujarati, 2003, Hsiao, 2003 etc).

2.3.1. Pooled OLS Model

While using the assumption that all coefficients are constant across time and individuals, it is assumed that there is neither significant individual nor significant temporal effects, and all the data were pooled and an ordinary least squares (*OLS*) regression model was employed. The panel consists of data for the all Indian major ports, over the period of 1993 to 2011. The pooled ordinary least square panel regression takes the following form;

$$\begin{aligned} TOTTRAFFIC_{it} = {} & \alpha_0 + \beta_1 TRT_{it} + \beta_2 IDLE_{it} \\ & + \beta_3 BOCC_{it} + \beta_4 BTHROUGH_{it} + \beta_5 OSPT_{it} \\ & + \beta_6 RROT_{it} + \beta_7 NOE_{it} + \beta_8 CAREQUIP_{it} \\ & + \beta_9 OPEXP_{it} + \beta_{10} NSDP_{it} + \beta_{11} NSDPAGRI_{it} \\ & + \beta_{12} NSDPINDUS_{it} + \beta_{13} NSDPSEVICE_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

Where *i* stands for *i*th individual unit (cross-section) *t* stands for *t*th time period. The below table shows the final list of variables for determinants of port efficiency and its expected signs.

The selected variables used for the panel data models have been listed below table with description and expected sign. The variables like turnaround time and idle time sign are expected to be negative, because it is obvious that if turnaround time and idle time reduces it will be indicative of higher traffic. The variables like berth occupancy, berth throughput, operating expenses are expected to having the positive relationship because the increase in the above variables are expected to be associated with higher traffic. Operating surplus may or may not lead to higher traffic, similar is the case with rate of return on turnover. A higher number of employees some time lead to higher activity, otherwise also is equally possible. Hence the expected sign is unpredictable. A large number of cargo equipment may lead to higher cargo traffic handling but sometime large number of equipments leads to higher congestion, less movement, less flexibility thus less activity. Hence the sign is unpredictable. The net domestic product from state and sector wise may have undefined sign as it is not definite what way they affect the container traffic. Thus the variables having ambiguous expected signs have to be seen after fitting into the estimated model and they can be interpreted according to the results of the model.

Table.

S. No	Variable	Description	Expected sign
1	TRT	Turnaround time	Negative
2	IDLE	Idle time of the port	Negative
3	BOCC	Berth occupancy	Positive
4	BTHROUGH	Berth throughput	Positive
5	OSPT	Operating surplus per ton	Ambiguous
6	RROT	Rate of return on turnover	Ambiguous
7	NOE	Number of employees	Ambiguous
8	CAREQUIP	Cargo equipments	Ambiguous
9	OPEXP	Operating expenses	Positive
10	NSDP	Net state domestic product	Ambiguous
11	NSDPAGRI	Net state domestic product in agriculture	Ambiguous
12	NSDPINDUS	Net state domestic product in industry	Ambiguous
13	NSDPSEVICE	Net state domestic product in services	Ambiguous

2.3.2. Fixed Effect Model

The Fixed effects method treats the constant as group (section)-specific, i.e. it allows for different constants for each group (section). The Fixed effect is also called as the Least Squares Dummy Variables (LSDV) estimators, because it allows for different constants for each group and it includes a dummy variable for each group. The model takes the following form.

$$Y_{it} = a_{it} + \beta_1 X1_{it} + \beta_2 X2_{it} + ... + \beta_k Xk_{it} + \mu_{it} \quad (3)$$

Where, the dummy variable takes different group-specific estimates for each of the constants for every different section.

2.3.3. Random Effect Model

The Random effects method is an alternative method of estimation which handles the constants for each section as random parameters rather than fixed. Hence the variability of the constant for each section comes from the fact that:

$$a_i = a + v_i \quad (4)$$

Where v_i is a zero mean standard random variable.

The Random effects model therefore takes the following from:

$$Y_{it} = (\alpha + v_i) + \beta_1 X1_{it} + \beta_2 X2_{it} + ... + \beta_k Xk_{it} + \mu_{it} \quad (5)$$

$$Y_{it} = \alpha + \beta_1 X1_{it} + \beta_2 X2_{it} + ... + \beta_k Xk_{it} + (v_i + \mu_{it}) \quad (6)$$

2.3.4. Model Specification Test

The fixed effects and random effects can be the taken in the same model, having different assumptions about Cov (β_i, X_{it}). There are also different tests available for fixed and random effect models. The most popular test that can be used F-test and Hausman – Taylor (1978) to check whether fixed or random effect model should be considered better for interpreting the results.

Hausman – Taylor Test

The most commonly used specification test is Hausman specification test, which tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If they are insignificant, then it is safe to use random effects and if P – value is significant it is better to use fixed effects. The Hausman test is a kind of Wald χ^2 test with k-1 degrees of freedom (where k = number of regressors) on the different matrix between variance-covariance of the LSDV with that of the Random Effect Model. The Wald statistic is

$$W=(\beta_{FE} - \beta_{RE})' (V_{FE} - V_{RE})^{-1} (\beta_{FE} - \beta_{RE}) \quad (7)$$

3. Results and Discussion

Table 3.1. Summary Statistics of the Sample

	Mean	SD	Max	Min	Skewness	Kurtosis	N
TOTTRAFFIC	16.929	0.693	18.221	14.915	-0.413	2.418	228
TRT	1.513	0.413	2.701	0.531	-0.190	2.817	228
IDLE	3.349	0.438	4.091	1.960	-0.853	3.710	228
BOCCU	4.187	0.2090	4.582	3.371	-0.797	3.904	228
BTHROUGH	14.270	0.805	15.936	11.990	-0.675	3.531	228
OSPT	3.540	0.905	5.171	0.000	-1.486	7.094	228
RROT	-1.087	0.538	0.000	-3.483	-1.428	6.743	228
NOE	8.433	0.727	10.189	7.297	0.506	2.470	228
CAREQUIP	3.110	1.221	5.303	0.000	-0.914	3.220	228
OPEXP	21.230	0.762	22.771	19.028	-0.369	2.778	228
NSDP	13.835	1.180	16.100	9.704	-0.996	4.414	228
NSDPAGRI	2.843	0.490	3.701	1.173	-0.840	3.792	228
NSDPINDUS	3.470	0.254	4.077	2.951	0.160	2.432	228
NSDPSERVICE	4.009	0.146	4.276	3.605	-0.349	2.382	228

The dependent and explanatory variables included in the model are: Total traffic (TOTTRAFFIC), Turnaround time (TRT), Idle time (IDLE), Berth occupancy (BOCCU), Berth throughput (BTHROUGH), Operating surplus per ton (OSPT), Rate of return on turnover (RROT), Number of employees (NOE), Cargo equipments (CAREQUIP), Operating expenses (OPEXP), Net state domestic product (NSDP), Net state domestic product in agriculture (NSDPAGRI), Net state domestic product in industry (NSDPINDUS), Net state domestic product in services (NSDPSERVICE), included in the correlation matrix.

Table 3.1 presents the summary statistics of the determinant variables considered for evaluating the performance of Indian major ports for the overall period during 1993 to 2011. The dependent variable is the total traffic flows from sample ports considered in the study. The nature of the panel data taken is strongly balanced in the sense that during 1993 to 2011 for 12 major ports of India (i.e. 13 units because Kolkata port is operating as Kolkata and Haldia dock system and the present study have not considered port of Port Blair due to lack of data availability, because the port got status of major port in the year 2010) and 13 independent variables were taken. The summary statistics presented in table 6.3.1 depict that the variables like Operating expenses, Total traffic and Berth throughput had a highest mean value during the study period. On the other hand Rate of return on turnover shows negative mean value. From the standard deviation, the variables like Cargo equipment and Net state domestic product showed high deviation from the average and the entire set of variables shows positive deviation from the average during the study period. The highest mean value were observed among the variables like Operating expenses, Total traffic, Berth throughput and Net state domestic product. From this table it can also be noted that all the variables except Net state domestic in industry are negatively skewed during the study period. From the results it is observed that the standard deviation are not abnormally high and majority of the variables are skewed negatively. The above data average value falls between the maximum and minimum observation and deviation is more in positive direction from the average value. It shows the reliability of the data for the above analysis.

Table 3.2. Correlation Matrix of the Model Variables

	TOTTRAFFIC	TRT	IDLE	BOCCU	BTHROUGH	OSPT	RROT	NOE	CAREQUIP	OPEXP	NSDP	NSDPAGRI	NSDPINDUS	NSDPSERVICE
TOTTRAFFIC	1.0000													
TRT	-0.1159	1.0000												
IDLE	-0.3911	0.4988	1.0000											
BOCCU	0.2756	0.4058	-0.0146	1.0000										
BTHROUGH	0.6665	-0.1993	-0.4504	0.3850	1.0000									
OSPT	0.0033	-0.1045	-0.1333	0.0433	0.0383	1.0000								
RROT	0.1166	-0.1058	-0.1719	0.1781	0.2454	0.2245	1.0000							
NOE	0.1235	0.4646	0.4085	0.0348	-0.4263	-0.1711	-0.3504	1.0000						
CAREQUIP	0.1033	0.0723	0.0076	-0.0514	-0.3655	0.1260	-0.0652	0.4422	1.0000					
OPEXP	0.6140	-0.1745	-0.2456	-0.0233	0.0885	0.1121	-0.1606	0.3956	0.4049	1.0000				
NSDP	0.3871	-0.3058	-0.3244	-0.1474	-0.1631	0.2032	0.0949	0.0301	0.5244	0.5894	1.0000			
NSDPAGRI	-0.3724	0.3132	0.4014	-0.0858	-0.4599	0.1896	0.1059	0.1905	0.1306	-0.2081	-0.0079	1.0000		
NSDPINDUS	0.3646	0.1990	-0.3639	0.3692	0.5719	-0.1310	0.0911	-0.2232	-0.2662	-0.1798	-0.2306	-0.5686	1.0000	
NSDPSERVICE	0.2105	-0.5926	-0.2233	-0.2747	0.0071	-0.0752	-0.1414	-0.0501	0.2759	0.4443	0.4295	-0.5559	-0.1752	1.0000

The dependent and explanatory variables included in the model are: Total traffic (TOTTRAFFIC), Turnaround time (TRT), Idle time (IDLE), Berth occupancy (BOCCU), Berth throughput (BTHROUGH), Operating surplus per ton (OSPT), Rate of return on turnover (RROT), Number of employees (NOE), Cargo equipments (CAREQUIP), Operating expenses (OPEXP), Net state domestic product (NSDP), Net state domestic product in agriculture (NSDPAGRI), Net state domestic product in industry (NSDPINDUS), Net state domestic product in services (NSDPSERVICE), included in the correlation matrix.

The correlation matrix of dependent and explanatory variables is presented in the table 3.2 and is used to examine the possible degree of collinerarity among variables. As it is observed from the above table, the correlation coefficients are not large enough to cause collinearity among the variables and these coefficients are statistically significant at the usual level of significance hence they qualify to be considered as independent variables influencing the port performance in terms of total traffic. The dependent variable TOTTRAFFIC is highly as well as positively correlated with BTHROUGH, OPEXP, NSDPINDUS and BOCCU. The dependent variable is correlated negatively with TRT and IDLE variables. From the correlation coefficient matrix table, it was observed that independent variable are not highly correlated with other explanatory variables. The existence of high correlation independent variables have been removed through initial stage of correlation test because high correlation among independent variables will lead multicollinearity problem.

Table 3.3. Determinants of Port Efficiency: Panel Data Estimation Based on Pooled OLS

Determinants of Port Efficiency (A Panel Data Approach) Dependent Variable: Total Traffic, estimation period 1993 to 2011				
Explanatory Variable	Co-efficient	Std Error	t-statistic	P-value
Cons	-6.8565	1.1619	-5.90	0.000 ***
TRT	-0.0760	0.0573	-1.33	0.186
IDLE	-0.1005	0.0436	-2.30	0.022 **
BOCCU	0.1556	0.0744	2.09	0.038 **
BTHROUGH	0.7753	0.0275	28.22	0.000 ***
OSPT	-0.0425	0.1463	-2.91	0.004 **
RROT	0.0529	0.2564	2.06	0.040 **
NOE	0.4859	0.0306	15.86	0.000 ***
CAREQUIP	-0.0452	0.0142	-3.18	0.002 **
OPEXP	0.0986	0.0320	3.08	0.002 **
NSDP	0.3110	0.0179	17.42	0.000 ***
NSDPAGRI	0.1463	0.0565	2.59	0.010 **
NSDPINDUS	0.5148	0.1063	4.84	0.000 ***
NSDPSERVICE	0.2010	0.1746	1.15	0.251
Prob>F	0.0000 (250.91)			
R^2	0.9384			
Adjusted R^2	0.9347			

** - denotes 5% level of significance, *** - denotes 1% level of significance.Table 3.3 estimates the pooled OLS regression for the study period. The robustness of parameter coefficient is used to explain the relationship between Total traffic and the selected independent variables. The growth rates of Berth throughput, Number of employees, Net state domestic product and Net state domestic product in industry were found strongly and positively influencing the dependent variable in pooled OLS model. On the other hand idle time and cargo equipments have strong negative effect on the growth rates of total traffic. The outcome of the model shows that one percentage increase in Berth throughput leads to a rise in the growth of total traffic by 0.77 percentage points. Similarly, one percentage change in the growth of net state domestic product in industry leads to change in the growth of total traffic by 0.51 percentage points. The results of the regression also points out that one percentage change in number of employee's leads to 0.48 percentage change in total traffic.

The table also shows that a one percentage reduction in the growth of idle time (i.e. non working time of the port) leads to rise in the growth of total traffic by 0.07 percentage, and, one percent decrease in the growth of cargo equipments leads to 0.04 percent increase in the growth of total traffic. From this pooled OLS results it can be inferred that the independent variable like berth occupancy, berth throughput, rate of return on turnover, number of employees, operating expenses, net state domestic product, net state domestic product in industry, net state domestic product in services are positively contributing towards growth of total traffic. At the same time the other variables like idle time, operating surplus per ton and cargo equipments shows negative influence on the total traffic.

Table 3.4. Determinants of Port Efficiency: Panel Data estimation Based on Fixed Effect Model (FEM)

Determinants of Port Efficiency (A Panel Data Approach) Dependent Variable: Total Traffic, estimation period 1993 to 2011				
Explanatory Variable	Co-efficient	Std Error	t-statistic	P-value
Cons	-2.7794	1.3134	-2.12	0.036 **
TRT	-0.7653	0.4303	-1.78	0.077 *
IDLE	-0.2116	0.6945	-3.05	0.003 **
BOCCU	0.0210	0.0695	0.30	0.763
BTHROUGH	0.8689	0.4363	19.91	0.000 ***
OSPT	0.0229	0.0117	1.96	0.051
RROT	0.0507	0.0180	2.82	0.005 **
NOE	0.2200	0.0769	2.86	0.005 **
CAREQUIP	-0.0725	0.0164	-4.41	0.000 ***
OPEXP	0.2618	0.0551	4.75	0.000 ***
NSDP	0.0510	0.0534	0.96	0.340
NSDPAGRI	0.0120	0.0477	0.25	0.801
NSDPINDUS	-0.1067	0.1149	-0.09	0.926
NSDPSERVICE	-0.0884	0.1368	-0.65	0.519
Prob>F	0.000 (27.14)			
R^2	0.7808			

*, ** and ***- denotes 10%, 5% and 1% level of significance.

The Fixed Effect Model is designed to control for omitted variables that differ across individuals but are constant over time. This is equivalent to generating dummy variables for each individual-cases and including them in a standard linear regression to control for these fixed individual-effects. The estimation of Fixed Effect model results have been presented in the table 3.4. The growth rates of Berth throughput, Rate of return on turnover, Number of employees, Operating expenses were found strongly and positively influencing the dependent variable in pooled OLS model. On the other hand turnaround time, idle time and cargo equipments depicted strong negative effect on growth of total traffic. The result of the model shows that one percentage increase in Berth throughput leads to raise in the growth of total traffic by 0.86 percentage points. In the same line, one percentage change in the growth of operating expenses leads to change in the growth of total traffic by 0.26 percentage points. The results of the regression also points out that one percentage change in number of employee's leads to 0.22 percentage change in total traffic.

This table also reveal that one percentage decrease in turnaround time leads to increase 0.76 percentage total traffic growth. However one percentage decrease in the idle time (i.e. non working time of the port) leads to increase 0.21 percent growth of total traffic. In the similar fashion one percentage decrease in the cargo equipments leads to increase 0.07 percentage growth of total traffic.

From the Fixed Effect Model regression results, it can be inferred that the factors like berth throughput, number of employees and operating expenses are the strong determining factor for port efficiency i.e. total traffic, which have a effect such that any percentage increase in this variables leads to higher traffic. The other variables like turnaround time, idle time and cargo equipments are the factors of determining the port efficiency in an inverse fashion i.e. any decrease in these variables leads to higher traffic. The variables like berth occupancy, operating surplus per ton, net state domestic product, net state domestic product in agriculture, net state domestic product in industry and net state domestic product in services were found to be insignificant in the said model. From the results it may noted that none of the variables were different on their effect on total traffic. All the variables were found associated with expected sign.

Table 3.5. Determinants of Port Efficiency: Panel Data Estimation Based on *Random Effect Model (REM)*

Determinants of Port Efficiency (A Panel Data Approach) Dependent Variable: Total Traffic, estimation period 1993 to 2011				
Explanatory Variable	Co-efficient	Std Error	t-statistic	P-value
Cons	-6.8565	1.1619	-5.90	0.000 ***
TRT	-0.7598	0.5726	-1.33	0.185
IDLE	-0.1005	0.0436	-2.30	0.021 **
BOCCU	0.1556	0.0744	2.09	0.037 **
BTHROUGH	0.7753	0.0275	28.22	0.000 ***
OSPT	-0.0425	0.0146	-2.19	0.004 **
RROT	0.0529	0.0256	2.06	0.039 **
NOE	0.4858	0.3064	15.86	0.000 ***
CAREQUIP	-0.4522	0.0142	-3.18	0.001 **
OPEXP	0.0986	0.0320	3.08	0.002 **
NSDP	0.3110	0.0179	17.42	0.000 ***
NSDPAGRI	0.1463	0.0565	2.59	0.010 **
NSDPINDUS	0.5148	0.1063	4.84	0.000 ***
NSDPSERVICE	0.2010	0.1746	1.15	0.250
Prob>Chi2	0.0000			
R2	0.9384			

*, ** and ***- denotes 10%, 5% and 1% level of significance.

The Random Effect Model is used if there are reasons to believe that some omitted variables may be constant over time but vary between cases, and others may be fixed between cases but vary over time. Table 3.5 estimates the Random Effect Model regression for the determinants of total traffic of major ports of India during the period. The result reveals that the growth of Berth throughput, Berth occupancy, Number of employees, Operating expenses, Net state domestic product and Net state domestic product in industry are strongly and positively influential on port efficiency. On the other hand idle time and cargo equipments have strong negative effect on the total traffic as the coefficients are significant. In the random effect regression result only turnaround time was the only variable found insignificant though negatively correlated. The variable of net state domestic product in service found insignificant but positively correlated.

Table 3.6. Hausman Specification Test

Variables	Coefficient		Difference	S.E.
	Fixed (b)	Random (B)	(b-B)	
TRT	-0.7653	-0.7598	-0.0055	
IDLE	-0.2116	0.1005	-0.3121	0.0194
BOCCU	0.0210	-0.1556	0.1766	
BTHROUGH	0.8689	0.7753	0.0937	0.0339
OSPT	0.0229	-0.0425	0.0655	
RROT	0.0507	0.0529	-0.0022	
NOE	0.2200	0.4858	-0.2658	0.0705
CAREQUIP	0.0725	-0.4522	0.5246	0.0082
OPEXP	0.2618	0.0986	0.1632	0.4485
NSDP	0.0510	0.3110	-0.2600	0.5030
NSDPAGRI	0.0120	0.1463	-0.1343	0.4041
NSDPINDUS	-0.1067	0.5148	-0.6216	0.0437
NSDPSERVICE	-0.0884	0.2010	-0.2894	
Prob>Chi2	0.000 (154.14)			

Hausman (1978) had provided a test for discriminating between the fixed effects and the random effects estimators. The test is based on comparing the difference between the two estimators of the coefficient vectors, where the random effects estimators of the coefficient consistent under the null hypothesis and inconsistent under the alternative hypothesis. The fixed effects estimator is consistent under both the null hypothesis. If the null hypothesis is true then the difference between the estimators should be close to zero. The calculation of test statistics (distributed chi-square) requires the computation of the covariance matrix of $\beta_1 - \beta_2$. Where β_1 is the fixed effects estimator and β_2 is the random effects. The robustness of parameter coefficients are used to explain the relationship between total traffic and the selected independent variables. Since the results of pooled OLS regression and Random effects model confirm the robustness with fixed effect model. The Random effect model is rejected in the analysis based Hausman specification test (1978). Which indicates that the result is better expressive is fixed effect model and interpretation based on the said model should be preferred to fixed effect model.

4. Concluding Remarks

In this study attempt was made to investigate the factors determining the efficiency of Indian Major Ports during the study period 1993 – 2011. In this part of analysis the three panel data models i.e. a) Pooled OLS regression b) Fixed effect model and c) Random effect model regression were used. For identifying the determinants of ports efficiency, total traffic was considered as dependent variable and the independent variables like turnaround time, idle time, berth occupancy, berth throughput, operating surplus per ton, rate of return on turnover, number of employees, operating expenses, net state domestic product, net state domestic product in agriculture, net state domestic product in industry and net state domestic product in services were considered based on the correlation matrix analysis. From the above analysis it was found that Berth throughput, Number of employees and Operating expenses showed a positive influence under all the models. The variables like idle time and cargo equipments showed negative coefficient indicating a reverse influence of them on the dependent variable improving the port efficiency. Hausman test was applied to choose the appropriate model. It strongly supported the Fixed Effect model.

The hypothesis tested in this study is outside factors also equally affect the port performance. From the analysis it was seen that, the variables those have shown significant effect on the efficiency of ports were all inside factors like Berth throughput, Number of employees, Operating expenses, idle time and Cargo equipments. Thus it can be concluded that both factors inside and outside affect efficiency of a port as they have significant relationship. But conspicuous factors are mostly inside factors, because the variable inside the ports were having significant coefficient, thus indicating more influence than outside factors where the regression coefficients were not significant. This result was the outcome of fixed effect model. Hausman test suggested the fixed effect model application for better interpretation of result.

The overall inference from the result is that the efficient port operations depends heavily on independent variables like Berth throughput, Number of employees and Operative expenses as these variables are having significant positive influence on the port efficiency. This shows that every increase in these variables have positive effect on the growth of total traffic. The variables like Idle time and Cargo equipments available in the ports were found negatively and strongly effecting port efficiency. This shows that any percentage decreases in the above variables will lead to increase the growth of total traffic. The result indicate that the port efficiency is effected by the above variables, and the port management should give more importance to these variables for getting better efficiency and also to overcome operational inefficiency if exists.

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