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RESEARCH ARTICLE

MODELLING THE IMPACT OF DETERMINANTS OF MANUFACTURING OUTPUT IN INDIA: A PANEL DATA ANALYSIS

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Abstract

The objective of this paper is to find the determinants of manufacturing output and their long-term and short-term relationship. This paper adopts panel data for the period of 21 years from 2000 to 2020 in 25 Indian States. To examine the long- term and short-term relationship, panel ARDL model is applied. Second generation unit root tests have been applied to check the stationarity of the variables due to cross section dependency among the Indian states. The results show that the variables of total persons engaged, fixed capital, fuel consumed, working capital and service sector are positively and significantly impacted manufacturing output in long-run except agriculture production. In short- run, only total persons engaged, fuel consumed and output of service sector have a positive and significant impact on manufacturing output while other variables affected positively but insignificantly to the manufacturing output.

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Introduction:-

Without a second thought, it can be called as manufacturing sector act as a paramount to economic growth and development. In a country like India, when there is a vibrant economy, manufacturing sector plays a major role in creating forwarding and backward linkages among the economy, not only this expansion of manufacturing sector reverberates across whole economy through its multiplier effects. In addition to this, manufacturing sector creates varieties of job opportunities from lower-level staff to manager level staff and brings innovation through technology transfer across the countries via import and exports. Moreover, expansion of manufacturing sector accumulates huge capital and generates large economies of scale which is conducive for productive growth. Classical economists were in the favor of free trade in which Adam smith focused upon division of labor and specializes in countries by varying own product which again promotes industrial development. In the comparative advantage theory laid by David Ricardo, again highlighted the importance of trade and says in order to increase national income, production and trade are the two main pillars. Afterwards, Solow growth model incorporated capital accumulation, labor and innovative technology as basic components of economic growth which clearly signifies the pivotal role of industries. John Hicks in his general equilibrium theory illustrated that industries and other markets get inter connected to contribute overall economic stability and economic growth. As this study is based on panel data in which data of 25 states has been used for 21 years, it is important to note as per the Indian context where there is structural transformation, regional disparities and some areas of the country are more developed as compared with others. This

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study answers the few questions like what are the key determinants which affect the manufacturing output in the long- run and short- run. Is there a cross section dependency or not? All these are necessary to capture the influence of factors like labor force participation, energy consumption, fuel consumption and capital formation on manufacturing output for country's inclusive growth. To analyze the above questions this study employs ARDL model (Auto-regressive distributive lag model) to determine the long-run and short-term adjustment and also to capture the cointegration among the dependent and independent variables. This study will also aid in policy formation as this study will provide evidence for strategies which supports manufacturing output making it more efficient and productive which will further help in regional development and inclusive growth. This will also contribute to policies like make in India campaign and Atmanirbhar Bharat which aim at increasing manufacturing sector's output and promoting economic growth.

Literature Review:-

Given the importance of manufacturing sector at the state and central level, it has been a subject of long debate and learning for many economists and other authors who have contributed by examining many macro-economic as well as structural variables influencing the manufacturing sector's output in India as well as global level. One such study at a global level by Adebayo Augustine Kutu(2021) which investigated factors affecting industrial production in BRICS countries namely Brazil, Russia, India, China and South Africa in short-run and long- run. They took the monthly data from 1994:01 to 2013:02 and employed Panel ARDL model to examine the relationship. They found out that the labor, capital, per capita income and exports have a positive impact on the industrial production in the BRICS countries in the long- run while exchange rate had a negative influence on the industrial production in the long-run.

Another study by Caner Colak, SelmonTokpunar and YasinUzun (2014) examined the determinants of sectoral import in Turkey's manufacturing industry. The study used panel data model for the period 1998Q to 2012Q and employed Augmented mean group analysis. It also used unit root test to check the stationarity among the variables and cross-sectional dependency and parameter of heterogeneity. The results indicated that elasticities of import demand with respect to turkey's manufacturing output is different at sectoral level while real exchange rate was significant and positive for the same. One more study by Pinar Acar (2019) investigated the impact of power infrastructure quality on manufacturing output in OECD countries for the period 1995 to 2012. Since the study found the cross-sectional dependency therefore it employed second generation estimators namely Common Correlated effect mean group (CCEMG) and augmented mean group (AMG) which were used to estimate the causal relations. The results depicted that transmission losses and distribution losses both negatively affected manufacturing output even after several control variables were included in estimators.

RufaroGaridzirai and Paul Francois Muzindutsi (2020) studied the impact of productivity of various sectors namely construction, finance, trade, community service, transport, mining and tourism on economic growth in South African districts by employing the annual data for the period 1996 to 2015. The study used panel data model. The results showed that the productivity of construction, transport, trade, manufacturing and finance had a positive impact on the economic growth in long- run while productivity of tourism and mining impacted economic growthnegatively in long- run. Almost all the studies which have been reviewed are based upon global level and only few studies are based on regional level, many variables like fuel consumption, total labor consumption, agriculture production etc. have not been taken into account. Therefore to fill this gap, this study employed Panel Auto Regressive Distributed Lag model to analyze the data across 25 states for the period 2000 to 2020.

Research Methodology:-

To examine the long- term and short-term relationship between factors affecting manufacturing output and gross output of manufacturing sector, the variables that are considered in present study are gross output (GO) of manufacturing sector which is the dependent variable while total persons engaged (TPE), fixed capital (FIC), working capital (WC), agriculture production (AP), fuel consumed (FC) and output of service sector (SS) are the independent variables. Data has been taken for the period of 21 years from 2000 to 2020 for 25 Indian states namely Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerela, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand and West Bengal. The data has been sourced from Annual Survey of Industries, Economic Survey and RBI website.

To investigate the long term and short-term association among the variables the study adopts the Panel Auto Regressive Distributed Lag(PARDL) mode as it allows for both short-run and long- run equilibrium dynamics while considering heterogeneity and cross section dependency among the variables. ThePARDL model framework, which was propounded by Pearson and Chudik(2013), is suitable only when some variables are integrated at I(0) and some variables are integrated at I(1) but none of the variables is I(2). For applying the ARDL model, this study initially checks the cross-section dependency by CD bias test given by Pearson (2008) as if there is cross- section dependency, then second generation unit root tests will be applied to check the stationarity of the variables. Variables used in this study have been tabulated as below:

Variable	Measurement	Variable Specification	Expected sign
Manufacturing Output	Gross Output of manufacturing	Dependent variable------	
Total Persons Engaged	Labor Force Participation	Independent Variable	(+)
Fixed Capital	Gross fixed capital formation	Independent Variable	(+)
Working Capital	Gross Capital-Fixed capital	Independent Variable	(+)
Agriculture Production	Output of Agriculture sector	Independent Variable	(+)
Fuel Consumption	Total of Energy Consumption	Independent Variable	(+)
Service Sector Output	Output of Service Sector	Independent Variable	(+)

Estimation Techniques:-

Following Adebayo Augustine (2017), Caner Colar (2017) and DimitriosAsteriou (2021), this paper also adopts Panel Auto regressive Distributive Lag model (ARDL) to examine the long-run and short-run association between the Manufacturing output and factors affecting it in 25 states of India. The choice to adopt ARDL model is based upon number of advantages it offers like it can accommodate more than two lags and can be used for more than six variables, can be used with the mixture of I(0) and I(1) variables irrespective of their order of integration but not at I(2). Panel ARDL model can also be used to estimate short-run and long- run both parameters simultaneously and moreover it gives advantage as it is good for large as well as small samples.In a nutshell, Panel ARDL given by Chudik and Pearson(2013) allows for cross sectional dependency and suitable for one or two structural breaks when carryout unit root testing.

General Production Function Equation:-

The model has been specified as:

GO= f (TPE, FIC, WC, AP,FC, SS) ----------(1)

$LNGO_{it}=\alpha+\beta 1LNTPE_{it}+\beta 2LNFIC_{it}+\beta 3LNAP_{it}+\beta 4LNWC_{it}+\beta 5LNFIC_{it}+\beta 6LNSS_{it}+\mu_{it}$ ---------- (2)

TIn the above equation, variables that are incorporated are GO as gross output of manufacturing sector which is the dependent variable and TPE as total persons engaged, FIC as gross fixed capital, WC as working capital, AP as agriculture production, FC as fuel consumed and SS as output of the service sector. LN depicts the logarithamic value.

By adapting equation (2), the ARDL Bounds Test equation can now be written asunder:

$\Delta\ LNGO_{it}= \alpha_0 +\sum_{j=1}^{n} \alpha_{1it}\ \Delta\ LNGO_{it-j}+ \sum_{j=0}^{n} \alpha_{2it}\Delta LNTPE_{it-j} + + \sum_{j=0}^{n} \alpha_{3it}\Delta LNFIC_{it-j} + \sum_{j=0}^{n} \alpha_{4it}\Delta LNWC_{it-j} + \sum_{j=0}^{n} \alpha_{5it}\Delta LNAP_{it-j} + \sum_{j=0}^{n} \alpha_{6it}\Delta LNFC_{it-j}+ \sum_{j=0}^{n} \alpha_{7i}\ \Delta LNSS_{it-j} + \beta_1 LNGOit_{-1}+ \beta_2 LNTPE_{it-\ 1}+ \beta_3 LNFIC_{it-1} + \beta_4 LNWC_{it-1} + \beta_5 LNAP_{it-1} + \beta_6 LNFC_{it-1} + \beta_7 LNSS_{it-1} + + \mu_{it.}$ ---------- (3)

Where,Δ = (delta), potrays difference, α_0= intercept term, $\alpha_1$to α_7= short- run coefficients, $\beta_1$to β_7 = long- run coefficients and $\mu_{it.}$ = residual term.

Unit Root Test and Cross Section Dependency Test:-

We begin with testing unit root along with cross section dependency and cointegration. To analyze the presence of unit root stationarity among the variables, a robust version given by Im, Pearson and Smith (IPS) and Levin, Li, Chu (LLC), since IPS and LLC does not allow for heterogeneity in the auto regressive coefficients therefore this problem was solved by Pearson in 2007 which allows cross section and heterogeneity in auto regressive coefficients which is a second-generation unit root test.Since cross section affects the reliability of the model which can lead to biased results, it is important to investigate cross section dependency in panel data. The Lagrange Multiplier (LM) test developed by Breusch and Pagan in the year 1980 is commonly known for cross section dependency test.

Analysis of Results:-

The results of this study have bbeenanalysed as under:

Cross Section Dependency Test:-

Table 1: Cross section dependence test

TEST	STATISTICS	PROB. VALUE
Breusch Pagan LM test	633.0161	0.0000
Pearson Scaled LM test	13.59532	0.0000
Pearson CD	7.785391	0.0000

Source:Author's estimation

The null hypotheses for the above test that there is no cross-section dependence and alternative hypotheses is that there is cross section dependence and since p value (0.0000) is less than 0.05, we reject the null hypotheses and conclude that there is cross section dependency in panel data.

Panel Data Unit root test:-

Since the data holds cross section dependence, this paper adopts a second-generation unit root tests developed by Pearson in 2007, the results have bbeen shown in Table 2.

Table 2: Unit root test

Variable	None (p value)	Constant (p value)	Constant & trend (p value)	Stationarity at I(0) or I(1)
LNGO	0.00000	0.00000	0.00129	I(0)
LNTPE	0.00354	0.00247	0.00000	I(0)
LNFIC	0.00000	0.00000	0.00000	I(0)
LNAP	0.00000	0.00000	0.01833	I(0)
LNFC	0.00000	0.00000	0.00000	I(0)
LNWC	0.00044	0.00031	0.28487	I(1)
LNSS	0.00000	0.00000	0.00000	I(0)

Source:Author's estimation

The result of the unit root test indicates that the p values of LNGO, LNTPE, LNFIC, LNAP, LNFC and LNSS is less than 0.05, we reject the null hypotheses which says the data isstationarity at 5% significance level. The only variable which is integrated at I(1) is LNWC (for constant and trend) for which the p value is more than 0.05 and we accept the null hypotheses in this case. It is stationarity at first difference and rest all the variables are stationarity at level. Since the results of panel unit root test depicts that there is a mixture of I(0) and I(1) but none of the variables at I(2), this confirms the use of Panel ARDL to examine the short- and long-term relationship in the specified model related with 25 states of India.

Cointegration Test:-

Since some of the variables are integrated at level and some of the variables are integrated at I(1), it is important to know weather there is cointegration among the variables in the long- run.

Three tests were conducted to test cointegration:

1. Pedroni residual cointegration test (1999,2004)
   i. No intercept or trend
   ii. Individual intercept or individual trend
   iii. Individual intercept.
2. Kao (Eagle-Granger based test)
3. Johansen Fisher cointegration test

Pedroni Residual Cointegration Test:-

Table 3: Pedroni Residual Cointegration Test

Pedroni Residual Cointegration Test				
Deterministic Trend		No intercept or trend	Ind. Intercept or ind. Trend	Individual Intercept

Parameters		Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Panel v-statistic	Within dimension	-0.8903	0.8134	-2.5167	0.9941	-0.6903	0.7552
Panel rho statistic		3.0781	0.9990	4.8022	1.0000	2.0490	0.9798
Panel PP statistic		-7.0095	0.0000	-8.0225	0.0000	-5.8114	0.0000
Panel ADF statistic		-1.5879	0.0562	-1.0910	0.1376	-0.7803	0.2176
Panel v-statistic	Weighted Statistic	-1.2478	0.8939	-2.8740	0.9980	-1.0677	0.8572
Panel rho statistic		3.6882	0.9999	5.1950	1.0000	2.4419	0.9927
Panel PP statistic		-6.0888	0.0000	-5.5812	0.0000	-5.3140	0.0000
Panel ADF statistic		-2.2334	0.0119	-1.1812	0.1188	-1.5737	0.0578
Group rho-statistic	For between dimension	5.6129	1.0000	6.7669	1.0000	4.5025	1.0000
Group PP statistic		-9.9097	0.0000	-8.5552	0.0000	-9.3296	0.0000
Group ADF statistic		-1.4935	0.0677	-0.5903	0.2775	-1.6658	0.0479

Source: Author's estimation

The null hypotheses to test the pedroni residual cointegration is no cointegration and the alternative hypotheses is that there exist a long- term cointegration among panel variables, the test was performed under three deterministic trends namely no intercept or trend, Individual intercept or individual trend and individual intercept. Table 3 shows a strong evidence of cointegration among all the selected variables in the study supported by the group PP statistic, panel PP statistic and weighted ADF test as some of the tests show value which are not significant but most of the powerful test shows a significant value which offer a long term cointegration among the panel variables.

Kao Residual Cointegration Test:-

Table 4: Kao Cointegration Test

Test	t-statistic	Prob.
ADF	-8.698892	0.0000

Source: Author's estimation

Table 4 indicates the prob value is less than 0.05, therefore we reject the null hypotheses of no cointegration and reaffirms the Pedroni residual test and have a stronger proof of long term cointegration.

Johansen Fisher Panel Cointegration test:-

Table 5: Fisher cointegration test

Hypothesized No. of CE	Fisher stat* (trace test)	Prob.	Fisher stat* max. eigen test	Prob.
None	61.47	0.1283	117.2	0.0000
At most 1	312.2	0.0000	170.1	0.0000
At most 2	1070.	0.0000	834.6	0.0000
At most 3	1229.	0.0000	1088.	0.0000
At most 4	503.9	0.0000	364.3	0.0000
At most 5	256.0	0.0000	188.8	0.0000
At most 6	166.0	0.0000	166.0	0.0000

Source: Author's estimation

Above table depicts the rejection of null hypotheses of no cointegration as p value is less than 0.05 and we can conclude the existence ofcointegration among the panel variables.

The Panel ARDL Long-run Model:-

Table 6: Panel long:run ARDL Model

Panel ARDL long run estimates with lag (1,1,1,1,1,1)

Dependent variable: D (LNGO)				
Long run Equation				
Variable	Coefficient	Std. Error	t-statistic	Prob.
LNTPE	0.500938	0.047193	10.61456	0.0000
LNFIC	0.279710	0.042954	6.511778	0.0000
LNAP	-0.123244	0.040420	-3.049079	0.0025
LNFC	0.392752	0.049864	7.876459	0.0000
LNWC	0.109099	0.015467	7.053752	0.0000
LNSS	0.126625	0.053253	2.377781	0.0181

Source: Author's estimation

Estimation of results of panel ARDL model is represented in table 6 with the lag model (1,1,1,1,1,1) selected through the Akaike information criterion (AIC) as ARDL model is delicate towards the lag structure. The results of the table shows that all the variable shows a significant impact on the dependent variable and the prob value of all the variables are less than 0.05 which depicts all the variables are statistically significant at 5% significance level. Variables of total persons engaged, fixed capital, fuel consumed, working capital and service sector output are significant and positively affect the dependent variable which is gross output of manufacturing sector while agriculture production shows a negatively significant impact on the dependent variable. Thus, 1% increase in use of total persons engaged, fixed capital, fuel consumed, working capital and service sector will increase the productivity of manufacturing output by 0.50%, 0.28%, 0.39%, 0.10% and 0.13% respectively. On the contrary, the productivity of agriculture production showed an inverse relationship with manufacturing output. Quantitively if the productivity of agriculture production increases by 1%, manufacturing output will decrease by 0.12%. This suggests that focal point should be on promoting more employment and more capital investment in service sector like trade, commerce and tourism.

The Panel ARDL Short- run Model:-

Table 7: Panel ARDL Short- run Model

Panel ARDL short run estimates with lag model (1,1,1,1,1,1)				
Dependent variable: D (LNGO)				
Short-run Equation				
Variable	Coefficient	Std. Error	t-statistic	Prob.
COINTEQ01	-0.390708	0.054079	-7.224819	0.0000
D(LNTPE)	0.312613	0.089825	3.480249	0.0006
D(LNFIC)	0.034401	0.055021	0.625232	0.5323
D(LNAP)	-0.086022	0.066687	-1.289938	0.1981
D(LNFC)	0.174146	0.044994	3.870433	0.0001
D(LNWC)	0.020099	0.018151	1.107339	0.2691
D(LNSS)	0.213274	0.109996	1.938928	0.0535
C	-0.431780	0.073579	-5.868260	0.0000

Source: Author's estimation

The above Table 7 presents the results of short- run panel analysis which shows that results are not alike long- run as here some of the variables show insignificant results. Here variables like total persons engaged, fuel consumed and service sector contribute positively and significantly to gross output of manufacturing sector while fixed capital and working capital contributed positively but insignificantly to manufacturing output. Noteworthy is that fixed capital and working capital significantly affect manufacturing output in long- run but not in short- run. On the contrary, agricultural output contributes negatively and insignificantly to manufacturing output in short- run while in long- run it affects negatively but significantly. Hence we concludethhat total persons engaged, fuel consumed and service sector output show the same results in both short--run and long- run, all three of them contribute to

manufacturing output positively and significantly. Furthermore, confirming the existence of cointegration parametric value of COINTEQ01 of short- run equation is both negative and statistically significant. The rate of adjustment towards long- run equilibrium is 0.3907 which indicates that inclusive growth's deviation from the previous was reduced by 39.07% in the following years.

Conclusion:-

This paper enables one to find the true determinants of manufacturing output in India which further helps in revolutionizing economic growth and increasing regional equality. This paper adopts panel data for the period of 21 years from 2000 to 2020 for 25 Indian states namely Andhra Pradesh, Assam, Bihar, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerela, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Odisha, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, Uttarakhand and West Bengal. To determine the long- term and short- term relationship, in this paper panel ARDL model is applied.

As there exists cross section dependency among the panel variables, second generation unit root tests was applied to check the stationarity of the variables and found out to be there was a combination of I(0) and I(1) order. As per the cointegration results which was tested through three test namely Pedroni residual cointegration test, Kao residual cointegration test and Johansen fisher cointegration test, there was a strong evidence of cointegration among the variables.Results of ARDL regression model suggest that all the variables have a significant impact on the manufacturing output in the long- run, variables of total persons engaged, fixed capital, working capital , fuel consumed and output of service sector have the positive impact on manufacturing sector, this suggest that policy implications by the government should be in the favor of promoting capital investment towards manufacturing sector which will further help in promoting employment generation and increase productivity of manufacturing sector.

As per the short-term panel ARDL analysis, there exist a significant and positive impact of total persons engaged, fuel consumed and service sector on gross output of manufacturing sector as the prob value is less than 0.05 which is 5% level of significance. Only the variable agriculture output had a negative and insignificant impact on manufacturing output. This paper contributes immensely to policy makers, government and manufacturing units in determining various aspects which will increase their respective growth, as per the results government should increase the spending on employment generation and on fixed assets so that it will further increase capital productivity of manufacturing sector and also promote service sector like trade, tourism and transport which will contribute to increase India's GDP and economic growth.

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