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Pushpa Choudhary
Ph.D. 2nd Semester,
Jawaharlal Nehru University,
New Delhi, Delhi, India

Corresponding Author:
Pushpa Choudhary
Ph.D. 2nd Semester,
Jawaharlal Nehru University,
New Delhi, Delhi, India

Analysis of variables affect the average productivity of labour of the manufacturing industry (From 2004-05 to 2017-18)

Pushpa Choudhary

Abstract
Worker's productivity is a highly significant part of Indian industries and their efficiency. The objective of this paper is how average labour productivity is influenced, as such productivity is a measure of internal and external efficiency of the whole system. Productivity can be shown with the help of input, output and other total material in the form of total output to total cost occurred. It is also known as the efficiency of the internal organization of four-factor of resources. ILO defines it as the ratio of the total output of volume production to total labour input. According to the Japanese view, it is a comprehensive holistic phenomenon for the requirement of improving output and related input. Ultimately worker productivity is a synonym for various economic indicators because it is a continuous and comprehensive phenomenon for the growth of the nation and standard of living of the nation. For the period from 2003-04 to 2008-09 the industry sector experienced a rapid rise in the employment of industries. That is because different factories in the private sector had more labour-intensive technology. That would lead to a large share in employment in the organized sector (Goldar, 2011).

Keywords: Worker's productivity, manufacturing industry, average productivity, organized sector

Introduction
The Indian manufacturing structure transformation had not followed the path of the classical theory of development while developed countries followed manufacturing growth as well as the service sector. A large proportion of Indian agriculture is involved in primary activity, while service sector with 58% contribution and around 27% of employment generation. While in both employment and GDP contribution of the manufacturing sector was 13% and 16% respectively (Gose, 2016) [9]. There was an increase in the number of contract-based workers (47%) in the organized manufacturing sector. From that half were self-employed, one third was a casual worker and minuscule or one fifth was a regular worker (Mehta, 2018) [13]. Although the income level for the worker was low from a substantial level.

After industrial policy in 1991, the major focus upon less control of the bureaucratic area. Up to 51% FDI in foreign equity in major industries groups require more investment and technology advancement needed. In December 2004 the public sector extended to rupees 478 billion (Ahluwalia, 1991) [1]. After announcing the reform in India in 1991, it was expected that the industrial sector would boost the Indian economy (Ministry of Finance, Economic Survey, 2001). Overall, some flagship programs introduce the industry as the engine of growth. Results of reform on the firm's productivity for the period from 1991 to 2001 were significant, and the firm had improved input of material imports (Goldar, 2015) [10]. For any economy share of manufacturing in GDP is the leading indicator of significance for the growth of the industry. In the recent period, the total percentage of 14% in the economy's GDP is lower than other developed countries like the USA, Japan, China, and South Korea. Gross value added is considered to be the better measurement for identifying the capacity of the economy. From the reform period to 2019-20 manufacturing sector faced a decrease rate of average annual growth from 8.3% to 6.0% (Ministry of Finance, Indian Government, 2020). In the agriculture and forestry showing increased growth rate in GVA at factor cost while overall GVA shows increases trend from 1990-91 periods to 2019-20 as 3.1%, 3.6%, and 3.3% by divide decade into three time periods (Ministry of Finance, Indian Government, 2020). However, the productivity of workers had a significant role in making an economically sustainable environment for workers, and growth of that is the status of developing income of the nation.

Empirical Review of literature

LG Burange (Burange, 1999) [6], in his article "Industrial Growth and Structure, Manufacturing Sector in Maharashtra," describes various elements of industry growth and affected variable for particular agriculture and non-agriculture industry. He used multiple methods such as the Hirschman Herfindahl index for the concentration of different industries and concluded that the agriculture industry shares declined over 1979-80 to 1994-95. Specify an additional allocation of industrial output to all over industrial growth rate. Maharashtra is the dominant industrial State, but its share decreased relative to other states because of exogenous factors, but it showed significant output until that period. In terms of structure, it was showing a negative correlation between employment growth and labour productivity. The cost was also positively related to a decline in labour by employment decline over the year. Although wages and its productivity had higher costs and growth of industrial development need a more competitive environment for shaping appropriate government policy

CP Chandrasekhar (Chandrasekhar, 1996) [8], in his article, titled "Explaining Post-Reform Industrial Growth", analysis growth of the industry by using the average growth rate of the index of industrial production and three broad areas such as manufacturing, mining and quarrying, and electricity with the help of gross capital formation and savings of different sectors. It includes a comparison of private and public sector savings and concludes that private investment is significant before the reform period than the general growth rate. Similarly, gross capital formation declined over time from 1985-86 to 1994-95 on an average annual basis. For saving and investment, data was used from the budget manual and calculate the yearly different growth rates of variables separately. It concludes that the industry's recovery in the post-reform paradox with the phenomena of animal spirit and "credit-fuelled consumption." It was also supported by aggregate increases in savings and private investment by linking reform and industrialization, but gross capital formation estimates no linkage was presented. At last, detailed liberalization favoured the consumption boom with the consumer credit surge, and alternative favoured export growth in the balance of payment account.

LG Burange (Burange L, 2000) [5], in his article titled "Growth and structure of manufacture of the textile product in India: An Analysis of Four Major Industrial States", includes particular textile industry with references to States like Gujrat, Maharashtra, Tamil Nadu, and West Bengal from 1979-1980 to 1994-95. The article contains nine-part for analysing the textile industry. It includes the growth of the textile industry by using the annual compound growth rate formula, output elasticity, and employment elasticity. It also provides the Herfindahl index for four-digit classification to analyse the concentration of industry. The last part used a kinked exponential model to foresee the impact of liberalization. Similarly, employees calculate compound growth rates individually for those four states for a variable like output capital and labour. It concludes that Tamil Nadu states had a better position than the other three states.

Yin Yuxuan and Gu Wenlin, in the article titled "An empirical study on factors influencing the capital structure of pharmaceutical listed corporations", analysed the capital structure of China's pharmaceutical industry from 2010 to 2013 and described a positive correlation between size and capital structure of the industry. It used ownership concentration, ability to pay debt, and profitability as a proxy of capital structure. Using the fixed-effect model for 119 companies, calculate the F test value for the hypothesis and conclude that variables like profitability, ability to pay the debt, and ownership concentration are negative, and variables like debt tax shield effect, development, and operational ability are not significant with the capital structure of companies.

SK Baliyan (Baliyan, 2016) [4], in his article titled "Economic Growth and Structural Change of Industrial Sector in Uttar Pradesh", describes structure ratio and industrial growth in Uttar Pradesh state from 1998-99 to 2012-13. It used significant variables in proportion for the number of factories, fixed capital net value-added, employee emolument, and total output. It measures output elasticity and employment elasticity for different years for the State and then defines primary industrial structural ratio and efficiency changes. It also calculates technological progress and total factor productivity changes using the Malmquist productivity index for industrial output. It would help in policy determination. It concludes that the growth rate of the organized sector is very high except for the year from 2010-11 to 2013-14, and similarly, the technological growth pattern was also significant.

The objective of the study

1. To analyse the diversification of growth of average labour with other variables that affect the efficiency of workers.
2. Whether it will affect industrial policies and output.

Hypothesis question

H_0 = Labour productivity is not affected by capital intensity, wage rate, number of factories, and amount of loan

H_1 = Labour productivity is affected by capital intensity, wage rate, number of factories, and amount of loan

Data source

For analysing the productivity of labour consider the value of real fixed capital per worker, wages to worker, outstanding of loan and number of factories are obtained from various ASI manuals published by Central Statistical Office for previous periods of 2008 and for after 2008 periods data released by National Statistical Office (NSO). The including industries are detailed in Table1.

Variables

Labour productivity: It is defined as the ratio of gross value added to the number of workers and is also known as the average productivity of labour. Similarly, in ASI data there are two parts of labour as skilled and unskilled workers. Worker is defined as labour engaged directly or indirectly in the production process while on the other hand employees along with supervisor and managerial worker. This study does not include the later part.

Number of Factories, it represented as a proxy of growth in the number of factories. ASI includes only the registered factories act, 1948 under section 2 m(1) and 2 m(2). It means to include all factories that give employment to 10 or more for I day or 12 months, and if 20 or more indulge workers for any day of 12 months. It would be representative of the strength of the manufacturing sector

(GC Manna, 2010) [12].

Capital intensity: Here we follow the Sindhu, Hina (2008 P: 249-261) capital intensity proxy for technology and it is the measured ratio of fixed capital to the total worker. The capital is described as a function of long-run interest rate and depreciation. In many developing countries due to imperfect competition, the social discount rate is used as a proxy of interest rate at the margin of the public sector. Therefore, capital is ultimately showing summation of Net fixed capital with depreciation. Capital intensity is used in the form of fixed capital to the total worker.

Outstanding Loans-It includes all outstanding loans according to the value of the book of the factory. It is used in the absolute sense only. That leads to the financial aspect of the industry that affects industry cost and then affects the productivity of labour. Loans are showing the credit-related issue of industries (Angelini, 2008) [2].

Wages rate-It includes wage to worker along with worker contribution in provident fund, bonus, and welfare expense (Muralidharan *et al*. (2013) [14].

Theoretical Model

In this model the number of observations of cross-section units are greater than the time periods (N>T). While doing panel regression with fixed effect the basic assumption of regression analysis such as non-autocorrelation, normality, and homoscedasticity of residual.

So, incorporating this we used robust standard error. In using the Hausman test for selecting between random effect and fixed-effect model. Since the chi-square value is greater than the 0.05 significance level than using the random-effect model. Although in the fixed-effect model there is no need for individual specific time unit heterogeneity and it allows for correlation between α_i and x_{it} [$E(x'_{it}, \alpha_i)\neq 0$]. So there needs to be a strictly exogenous assumption.

There is the alternative of panel robust standard error for correlation and heteroscedasticity problems. Since in random effect model will be biased in terms of time-constant unobserved heterogeneity for non-scientific research. But the random effect is more efficient if we take it as $E(x'_{it}, \alpha_i) = 0$. There is a contradiction between biased and efficiency since we use random effect because it includes endogenous variation. Sometimes it creates a biasness but it is more efficient than the fixed effect model.

Hausman test (Table 2).

H_0: β_{RE} appropriate.

H_1: β_{EF} appropriate.

Theoretical framework.

Fixed effect model-

Y_{it}: $\{\alpha_i + u_i\} + \beta 1F^1_{it} + \beta_2 F^2_{it} + \ldots\ldots\ldots + \beta_n F^k_{it} + e_{it}$

Y_{it}: $\{\alpha_i + u_i\} + \beta 1F^1_{it} + \beta_2 F^2_{it} + \ldots\ldots\ldots + \beta_n F^k_{it} + + \epsilon_{it}$

Here, i= 1…n, j = 1…. T, ϵ_{it}= composite error term, u_i = error term for cross-section and e_{it}=error term (for time series). Also, Z is output per worker for t time periods, β represents coefficient for explanatory variable.

Random effect model-

$$Y_{it} = \alpha_{ij} + \beta_1 F_{1it} + \ldots + \beta_n F_{nit} + \alpha_n + u_{it} + \varepsilon_{it}$$

Here εit represents within entity error, and "u_{it}" for between entity errors for explanatory variables. Other variables are the same as above.

Empirical estimation

For analyzing the effect of industries in regression we used fixed effect panel regression and for combining the error effect with the constant term used a random-effect model. Then we also used OLS regression for observing individual industries' significance levels effect model regression –

Y_{it}: -4968.358 + 1855.853*F_{it} +1.541325*G_{it}+ 0.0414257* H_{it} + 0.7636574*O_{it} + 104268.14 + 71159.133

Y_{it}: 1855.853*F_{it} +1.541325*G_{it}+ 0.0414257*H_{it} + 0.7636574*O_{it} + .68224201

Here, ϵ_{it}= composite error term ($\alpha_{it} + u_{i)}$, u_i = error term for cross-section (104268.14) and e_{it} (error term)= 71159.133 (for time series). Also, Z is output per worker for t periods, β represents coefficients for explanatory variables, and F, G, H, O for the number of factories, wage rate, capital intensity, and outstanding loan. Here, α is the unknown intercept term for each entity, t represents a time period, and i belongs to the entity. Here wage rate increases with the increases in the average labour productivity although in the ASI data the difference of working hours is not defined. That would lead to equality between different working hours, labours and wage rates. The bigger establishment or factories is taken as the number of firm units not the size of the measuring unit. That again showed that if n number of small size firms leads to greater establishment, then less or single big size of the firm in the industry. The analysis depicts a positive trend with relation to labour productivity and changes 1855.853 per unit change. For seeing the financial effect on labour productivity outstanding loans showing positive relation with the coefficient of 0.76. (Table 3).

For random effect model equation is used as

Y_{it}: 897.6538F^1_{it} +1.290666F^2_{it} + 0.0100978F^3_{it} +0.763654F^4_{it} +91160.025 + 71159.133

Y_{it}: 897.6538F^1_{it} +1.290666F^2_{it} + 0.0100978F^3_{it} +0.763654F^4_{it} + 1.06819

Here εit represents within entity error (1.068196), and "u_{it}" (91160.025) for between entity error for n variables log of the number of factories, wage rate, capital intensity, and outstanding loan (Table3).

Further industries significantly are more for industries tobacco, leather product, wood material, coke oven product, other chemical product, fabric metal, special machinery, and waste material are insignificant at any level. While on the other side capital intensive industries like chemical products, iron, and steel, metal, machinery, and the building of ships and boats are highly significant.

In terms of cost of labour absolute amount of loan is used for the financial cost of factor. It is positively related to labour productivity means more rises in the loan amount for the industry and more hired factors could be fulfilled. Further leads to higher labour productivity. Although financial leverage is negatively related to labour productivity it is used with asset ratio. In ASI data all loans amount is used whether it is paid or unpaid, even no difference between the long-run loan amount and short-run amount. That shows the continuously higher value of amount and increases with the labour productivity not showing repayment capacity. The wage rate is used for the

demand-side labour market. While loans represent credit of factories and positively increase labour productivity and also raise the financial burden of factories (Cabral 2003) [7]. There was decentralization of the power loom industry by taking mills and hand spinning as two tails of complex industry. Although textile industry is a major one among them with coefficient value at negative 54607.4. On the other hand, the furniture industry had great potential for foreign market at a coefficient value of 0.01. The significance level is negative 24139.42. This industry grew more incredible than the other manufacturing industry, not the wage rate per worker for the above period.

Table 1: Industry details

Group 89 mining and quarrying N.E.C.
Group 110 Manufacture of beverages
Group 120 Manufacture of tobacco product
Group 131 Spinning, weaving, and finishing of textiles
Group 139 Manufacture of other textiles
Group 141 Manufacture of wearing apparel, except fur apparel
Group 142 Manufacture of articles of fur
Group 143 Manufacture of knitted and crocheted apparel
Group 151 Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, and harness; dressing and dyeing of fur
Group 152 Manufacture of footwear
Group 161 Sawmilling and planning of wood
Group 162 Manufacture of products of wood, cork, straw, and plaiting materials
Group 170 Manufacture of paper and paper products
Group 181 Printing and service activities related to printing
Group 182 Reproduction of recorded media
Group 191 Manufacture of coke oven products
Group 192 Manufacture of refined petroleum products
Group 201 Manufacture of basic chemicals, fertilizer and nitrogen compounds, plastics, and synthetic rubber in primary forms
Group 202 Manufacture of other chemical products
Group 203 Manufacture of man-made fibres
Group 210 Manufacture of pharmaceuticals, medicinal chemical, and botanical products
Group 221 Manufacture of rubber products
Group 222 Manufacture of plastics products
Group 231 Manufacture of glass and glass products
Group 239 Manufacture of non-metallic mineral products N.E.C.
Group 241 Manufacture of basic iron and steel
Group 242 Manufacture of basic precious and other non-ferrous metals
Group 243 Casting of metals
Group 251 Manufacture of structural metal products, tanks, reservoirs, and steam generators
Group 259 Manufacture of other fabricated metal products; metalworking service activities
Group 261 Manufacture of electronic components
Group 263 Manufacture of communication equipment
Group 325 Manufacture of medical and dental instruments and supplies
Group 329 Other manufacturing N.E.C.
Group 381 Waste collection
Group 382 Waste treatment and disposal
Group 281 Manufacture of general-purpose machinery
Group 282 Manufacture of special-purpose machinery
Group 291 Manufacture of motor vehicles
Group 292 Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers
Group 293 Manufacture of parts and accessories for motor vehicles
Group 301 Building of ships and boats
Group 302 Manufacture of railway locomotives and rolling stock
Group 303 Manufacture of air and spacecraft and related machinery
Group 309 Manufacture of transport equipment N.E.C.
Group 310 Manufacture of furniture

Table 2: Hausman test and Breusch and Pagan test

	fe	re	Difference	S.E.
FC/w	1855.853	897.6538	-133.2534	62.92886
NumberOfFa~s	1.541325	1.290666	-.0468946	.
Outstandin~s	.0414257	.0100978	-.0011622	.0008796
Wage rate	.7636574	.7619402	.0039665	.0049813

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic
chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 1.81
Prob>chi2 = 0.6137

Breusch and Pagan Lagrangian multiplier test for random effects
GVAw[code,t] = Xb + u[code] + e[code,t]
Estimated results:

	Var	sd = sqrt(Var)
GVA/w	1.32e+11	363021.9
e	5.06e+09	71159.13
u	8.31e+09	91160.02

Test: Var(u) = 0
chibar2(01) = 1357.68
Prob > chibar2 = 0.0000

Table 3: Fixed effect model and random effect model

(N = 630, 45 industries, from 2004-05 to 2017-18)

Random effect model					fixed effect model			
GVA/w	Coef.	Std. Err.	t	P>|t|	Coef.	Std. Err.	t	P>|t|
capital intansity	897.6538	190.6689	4.71	0.000	1855.853	426.1253	4.36	0.000
No Of Factories	1.290666	.1782007	7.24	0.000	1.541325	.2638805	5.84	0.000
Outstanding Loans	.0100978	.00322	3.14	0.002	.0414257	.0071793	5.77	0.000
Wage rate	.7619402	.0555331	13.72	0.000	.7636574	.1300565	5.87	0.000
_cons	-263841.6	36913.1	-7.15	0.000	-4968.358	17568.54	-0.28	0.779
within R-sq	0.6526				0.7528			
between R-sq	0.7146				0.8115			
overall R- sq	0.6958				0.7935			

Table 5: Summary and Comparison of GLS of FE, GLS of RE and OLS

Variable		Mean	Std. Dev.	Min	Max	Observations
GVA/w	overall	228902	363021.9	30.7619	2687055	N = 630
	between		319574	350.0192	1520374	n = 45
	within		178236.1	-655107.6	1395583	T = 14
FC/w	overall	21.93545	44.37407	.3754271	442.6925	N = 630
	between		40.05438	.9365661	262.8382	n = 45
	within		19.94649	-125.4841	201.7897	T = 14
Numbe~es	overall	3347.949	8293.33	3	185940	N = 630
	between		4081.039	20.85714	20800.07	n = 45
	within		7243.526	-10135.27	175801.7	T = 14
Outst~s	overall	1349545	2916105	6	2.79e+07	N = 630
	between		2581621	3475.857	1.60e+07	n = 45
	within		1405932	-9202010	1.32e+07	T = 14
Wage ra~	overall	172977.1	225755	26	1534557	N = 630
	between		184951.1	888.5	839215.4	n = 45
	within		132156.6	-303655	868318.8	T = 14

Variable	fixed	random	ols
FCw	1855.8535***	897.6538***	1855.8535***
NumberOfFa~s	1.5413251***	1.290666***	1.5413251***
Outstandin~s	.04142568***	.0100978***	.04142568***
WagesperWo~s	.76365741***	.7619402***	.76365741***
_Icode_110			46906.555
_Icode_120			-61503.741*
_Icode_131			-56307.4
_Icode_139			-38298.527*
_Icode_141			-240096.33***
_Icode_142			-3954.4518
_Icode_143			-75213.097**
_Icode_151			-28511.741
_Icode_152			-50811.691***
_Icode_161			1379.3086***
_Icode_162			-8729.2252
_Icode_170			26377.489*
_Icode_181			2723.0199*
_Icode_182			-16432.034*
_Icode_191			-34574.36
_Icode_192			215990.01***
_Icode_201			378303.71***
_Icode_202			50183.308
_Icode_203			-23444.457***
_Icode_221			5734.0839**
_Icode_222			41855.274*
_Icode_231			8331.5464*
_Icode_239			226126.12***
_Icode_241			158966.01***
_Icode_242			-105170.17***
_Icode_243			-17454.192*
_Icode_251			-67979.276*
_Icode_259			-71218.503
_Icode_261			-17095.23**
_Icode_263			-18241.271
_Icode_281			-41550.539***
_Icode_282			-38424.279
_Icode_291			288222.1***
_Icode_292			-17647.755
_Icode_293			92734.814**
_Icode_301			-95692.968***
_Icode_302			-14704.896*
_Icode_303			-19761.63
_Icode_309			-7372.4038
_Icode_310			-24139.417***
_Icode_325			-26070.637*
_Icode_329			-35483.135*
_Icode_381			-8063.8657***
_Icode_382			-7790.8086
_cons	-4968.3584	-263841.6	-11014.921
N	630	630	630
r2	.85277035		.96450877
r2_a	.85182808		.96157662

legend: * p<0.05; ** p<0.01; *** p<0.001

Table 6: Some diagnostic test

Pesaran's test of cross sectional independence = 1.508, Pr = 0.1316
Average absolute value of the off-diagonal elements = 0.382

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation F(1, 44) = 6.936
Prob > F = 0.0116

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
FCw	630	0.39898	249.113	13.401	0.00000
NumberOfFa~s	630	0.25904	307.117	13.909	0.00000
Outstandin~s	630	0.43279	235.101	13.260	0.00000
WagestoWor~s	630	0.71206	119.347	11.614	0.00000

Conclusion

The above-mentioned analysis shows that overall labour productivity is affected by capital intensity as well as the size of the factories. But similarly, the impact would be higher if the time increases because skill labour force demand increases. Also, as new technology comes it does not affect existing employment but it would affect by advance in the form of jobs. There would be a major challenge of the quality of the structure of the manufacturing sector. Because resources are limited and the share of the number of factories in the manufacturing sector is constant. Although the Indian government is taking many steps like encouraging MNCs, investment encouraging structure, skill India and skill development program to encourage development in the structure of the manufacturing sector. There are some exogenous variables like technical skill, entrepreneurs' technique and efficiency of workers, these variables also highly significant for measuring labour productivity.

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