THE EFFECT OF POLLUTION ON WORKER PRODUCTIVITY: EVIDENCE FROM IT INDUSTRY IN INDIA

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COURSE PROJECT

ECO342A

INTRODUCTION

- Air pollution is a major environmental issue with a significant impact on human health worldwide.
- According to the World Health Organization, air pollution is responsible for over 4.2 million deaths annually.
- India has experienced high levels of air pollution due to rapid industrialization and urbanization, particularly in major cities such as Delhi.
- The impact of air pollution on worker productivity is not fully understood, particularly in the IT industry.
- This study aims to investigate the relationship between air pollution and worker productivity using panel data analysis.
- The findings of this study have important implications for public policy and workplace management.
- Governments may need to implement policies to reduce air pollution levels to promote economic growth and development.
- Workplace management may need to consider the impact of air pollution on worker productivity when designing workspaces and schedules.
- Reducing air pollution levels can lead to improved worker productivity and better economic outcomes for both workers and employers.

LITERATURE REVIEW

- Pollution's effect on worker productivity is a growing topic of interest in academia and policy circles.
- Previous studies have shown that higher levels of pollution lead to lower levels of productivity and increased absenteeism.
- Chen and Song (2013) found that a one standard deviation increase in pollution reduced worker productivity by 0.86% in a Chinese manufacturing firm.
- Lu et al. (2015) found that higher levels of pollution decreased cognitive function and increased absenteeism in the electronics manufacturing industry in China, particularly among older workers.
- Recent studies, such as Zhang et al. (2020), have expanded the scope of research to include the service sector, finding that higher levels of pollution decrease productivity among call center workers.
- Evidence suggests that the negative impact of pollution on productivity is at least partially attributable to decreased physical and cognitive health, as well as increased stress and fatigue among workers.
- Age-specific interventions may be necessary to address the impact of pollution on productivity among older workers
- The exact mechanisms underlying the relationship between pollution and productivity require further research.

OBJECTIVES

- Quantify the effect of pollution on worker productivity
- Identify the threshold levels of pollution at which worker productivity begins to decline.
- Evaluate the role of individual-level factors such as age, gender, and tenure in moderating the effect of pollution on worker productivity.

SIGNIFICANCE

- Understanding the impact of pollution on worker productivity in the IT industry is crucial for improving worker well-being and productivity.
- India is one of the most polluted countries in the world, and the adverse impact of pollution on human health is well-established.
- This study contributes to the growing body of literature on the impact of pollution on worker productivity, particularly in developing countries.
- The study can provide insights into the effectiveness of policies implemented to reduce pollution levels and mitigate the adverse impact of pollution on worker productivity.
- The findings of this research paper can help firms understand the cost of pollution in terms of lost worker productivity and take steps to mitigate its impact.
- The study has important implications for policymakers, firms, and workers in polluted environments.

METHODOLOGY-I

POOLED OLS MODEL

$$Productivity_{it} = \beta_0 + \beta_1 Pollution_{it} + \beta_2 Controls_{it} + \varepsilon_{it}$$

where:

- $Productivity_{it}$ is the productivity of the i-th state at time t
- $Pollution_{it}$ is the level of air pollution experienced by the i-th state at time t
- $Controls_{it}$ is a set of control variables that may affect productivity such as total mandays employed, working capital, total input, total output, fuels consumed, materials consumed, and net income
- ε_{it} is the error term that captures all other factors that may affect productivity but are not included in the model.

METHODOLOGY-II

FIXED EFFECTS MODEL

$$y_{it} = \beta_0 + \beta_1 P_{it} + \alpha_i + \varepsilon_{it}$$

where:

- y_{it} is the productivity of worker i at time t
- P_{it} is the level of air pollution at the location of the worker at time t
- α_i is the individual fixed effect for worker i
- ε_{it} is the error term

METHODOLOGY-III

RANDOM EFFECTS MODEL

$$Y_{it} = \beta X_{it} + \alpha_i + \varepsilon_{it}$$

where:

- Y_{it} is the productivity of worker i at time t
- X_{it} is the vector of independent variables for individual i at time t
- α_i is an unobserved time-invariant individual-specific effect
- ε_{it} is the error term

DATA

y=wage(Rs. lakhs)

P=PM10 Concentration in μg/m3

C_1=Total Mandays Employed (in '000)

C_2=Working Capital

C_3=Total Inputs

C_4=Total output

C_5=Fuels Consumed

C_6=Materials Consumed

C_7=Net Income

CODES

```
egen states= group(state)
global states states
global year year
global ylist wagerslakhs
global xlist PM10Concentrationinµgm3 workingcapital totalmandaysemployedin000 totalinputs totaloutput fuelsconsumed materialsconsumed netincome
describe $states $year $ylist $xlist
summarize $states $year $ylist $xlist
sort $states $year
xtset $states $year
xtdescribe
xtsum $states $year $ylist $xlist
reg $ylist $xlist
xtreg $ylist $xlist, fe
xtreg $ylist $xlist, re theta
quietly xtreg $ylist $xlist, fe
estimates store fixed
quietly xtreg $ylist $xlist, re
estimates store random
hausman fixed random
quietly xtreg $ylist $xlist, re
xttest0
```

MANUFACTURE OF COMMUNICATION EQUIPMENT

POOLED OLS

. reg $ylist $xlist

Source	SS	df	MS
Model	1.0133e+11	8	1.2666e+10
Residual	745468235	51	14617024.2
Total	1.0208e+11	59	1.7301e+09

Number of obs	=	60
F(8, 51)	=	866.55
Prob > F	=	0.0000
R-squared	=	0.9927
Adj R-squared	=	0.9916
Root MSE	=	3823.2

wagerslakhs	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PM10Concentrationinµgm3	11.3212	10.98522	1.03	0.308	-10.73255	33.37495
totalmandaysemployedin000	1.964581	1.040034	1.89	0.065	-.1233737	4.052535
workingcapital	-.0035982	.006185	-0.58	0.563	-.016015	.0088187
totalinputs	-.4559776	.0605173	-7.53	0.000	-.577471	-.3344841
totaloutput	.4890969	.0602961	8.11	0.000	.3680475	.6101463
fuelsconsumed	4.521843	1.39083	3.25	0.002	1.729634	7.314051
materialsconsumed	-.0351852	.0071908	-4.89	0.000	-.0496213	-.0207491
netincome	-.4180222	.0514369	-8.13	0.000	-.5212861	-.3147583
_cons	190.5608	1527.078	0.12	0.901	-2875.176	3256.298

RANDOM EFFECTS

Random-effects GLS regression
Group variable: **states**

Number of obs = 60
Number of groups = 15

R-sq:
within = 0.8334
between = 0.9959
overall = 0.9925

Obs per group:
min = 4
avg = 4.0
max = 4

Wald chi2(8) = 4917.94
Prob > chi2 = 0.0000

corr(u_i, X) = 0 (assumed)
theta = .26504629

wagerslakhs	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PM10Concentrationinµgm3	14.21982	12.47765	1.14	0.254	-10.23591	38.67556
totalmandaysemployedin000	1.921291	.9885765	1.94	0.052	-.016283	3.858866
workingcapital	-.0009546	.0056825	-0.17	0.867	-.012092	.0101829
totalinputs	-.4472542	.0547954	-8.16	0.000	-.5546511	-.3398572
totaloutput	.4747802	.0544492	8.72	0.000	.3680618	.5814986
fuelsconsumed	5.276662	1.334622	3.95	0.000	2.660852	7.892472
materialsconsumed	-.0296581	.0071605	-4.14	0.000	-.0436924	-.0156238
netincome	-.4044417	.0462751	-8.74	0.000	-.4951392	-.3137443
_cons	-551.3253	1705.122	-0.32	0.746	-3893.303	2790.653

FIXED EFFECTS

Fixed-effects (within) regression
Group variable: **states**

Number of obs = 60
Number of groups = 15

R-sq:
within = 0.9239
between = 0.8418
overall = 0.8101

Obs per group:
min = 4
avg = 4.0
max = 4

F(8,37) = 56.15
corr(u_i, Xb) = 0.7533
Prob > F = 0.0000

wagerslakhs	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PM10Concentrationinµgm3	-15.76848	19.52825	-0.81	0.425	-55.33648	23.79952
totalmandaysemployedin000	4.33331	.8340774	5.20	0.000	2.643309	6.023311
workingcapital	-.0014039	.004114	-0.34	0.735	-.0097397	.006932
totalinputs	-.2131622	.0573614	-3.72	0.001	-.3293874	-.096937
totaloutput	.1878848	.0619929	3.03	0.004	.0622753	.3134942
fuelsconsumed	6.522652	1.135326	5.75	0.000	4.222264	8.823041
materialsconsumed	.0260485	.0092388	2.82	0.008	.0073289	.0447682
netincome	-.1682461	.0488955	-3.44	0.001	-.2673178	-.0691745
_cons	10095.76	3088.68	3.27	0.002	3837.502	16354.02
sigma_u	28171.212					
sigma_e	2098.6706					
rho	.99448083	(fraction of variance due to u_i)				

F test that all u_i=0: F(14, 37) = 9.45 Prob > F = 0.0000

MANUFACTURE OF COMMUNICATION EQUIPMENT

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. hausman fixed random

Note: the rank of the differenced variance matrix (7) does not equal the number of coefficients
        being tested (8); be sure this is what you expect, or there may be problems computing the
        test.  Examine the output of your estimators for anything unexpected and possibly consider
        scaling your variables so that the coefficients are on a similar scale.

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
PM10Concen~3 |   -15.76848     14.21982       -29.9883        15.02202
totalman~000 |     4.33331     1.921291       2.412019               .
workingcap~l |   -.0014039    -.0009546      -.0004493               .
 totalinputs |   -.2131622    -.4472542        .234092        .0169645
 totaloutput |    .1878848     .4747802      -.2868954        .0296378
fuelsconsu~d |    6.522652     5.276662        1.24599               .
materialsc~d |    .0260485    -.0296581       .0557067        .0058381
   netincome |   -.1682461    -.4044417       .2361956        .0157919
------------------------------------------------------------------------------
                          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(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       62.10
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
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HAUSMAN TEST

MANUFACTURE OF COMPUTER AND PERIPHERAL EQUIPMENTS

. reg $ylist $xlist

Source	SS	df	MS
Model	1.9126e+11	8	2.3907e+10
Residual	2.4265e+09	39	62218851.2
Total	1.9368e+11	47	4.1209e+09

Number of obs	=	48
F(8, 39)	=	384.24
Prob > F	=	0.0000
R-squared	=	0.9875
Adj R-squared	=	0.9849
Root MSE	=	7887.9

wagerslakhs	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PM10Concentrationinμgm3	33.88938	20.3069	1.67	0.103	-7.18521	74.96396
totalmandaysemployedin000	8.52732	5.941521	1.44	0.159	-3.490541	20.54518
workingcapital	-.2040867	.0391171	-5.22	0.000	-.2832085	-.1249649
totalinputs	-.2475163	.3005947	-0.82	0.415	-.8555265	.360494
totaloutput	.2525207	.3020832	0.84	0.408	-.3585003	.8635417
fuelsconsumed	-8.419832	2.605096	-3.23	0.003	-13.68914	-3.150527
materialsconsumed	-.0372144	.0398981	-0.93	0.357	-.1179158	.0434871
netincome	.7706598	.3675899	2.10	0.043	.0271391	1.514181
_cons	-4828.203	2862.419	-1.69	0.100	-10617.99	961.5867

POOLED OLS

Random-effects GLS regression — Number of obs = 48
Group variable: **states** — Number of groups = 12

R-sq:
within = 0.8017
between = 0.9916
overall = 0.9858

Obs per group:
min = 4
avg = 4.0
max = 4

Wald chi2(8) = 1408.17
Prob > chi2 = 0.0000

corr(u_i, X) = 0 (assumed)
theta = .46209758

wagerslakhs	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PM10Concentrationinμgm3	38.74241	28.71078	1.35	0.177	-17.52969	95.0145
totalmandaysemployedin000	6.896317	6.76878	1.02	0.308	-6.370249	20.16288
workingcapital	-.1977793	.0390559	-5.06	0.000	-.2743274	-.1212312
totalinputs	-.1366859	.2520062	-0.54	0.588	-.630609	.3572372
totaloutput	.1601471	.253484	0.63	0.528	-.3366723	.6569666
fuelsconsumed	-8.245311	2.629316	-3.14	0.002	-13.39868	-3.091947
materialsconsumed	-.0386241	.0435746	-0.89	0.375	-.1240287	.0467805
netincome	.7877498	.3206048	2.46	0.014	.159376	1.416124
_cons	-5266.658	4078.422	-1.29	0.197	-13260.22	2726.903
sigma_u	2952.4068					
sigma_e	3767.7186					
rho	.38043603	(fraction of variance due to u_i)				

RANDOM EFFECTS

Fixed-effects (within) regression — Number of obs = 48
Group variable: **states** — Number of groups = 12

R-sq:
within = 0.9249
between = 0.8850
overall = 0.8392

Obs per group:
min = 4
avg = 4.0
max = 4

F(8,28) = 43.10
Prob > F = 0.0000

corr(u_i, Xb) = 0.7879

wagerslakhs	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PM10Concentrationinμgm3	-1.883367	60.09405	-0.03	0.975	-124.9805	121.2137
totalmandaysemployedin000	17.12272	6.521884	2.63	0.014	3.763246	30.48219
workingcapital	-.0768184	.0359062	-2.14	0.041	-.150369	-.0032678
totalinputs	-.5326016	.1748358	-3.05	0.005	-.8907364	-.1744667
totaloutput	.5544324	.1750065	3.17	0.004	.1959477	.912917
fuelsconsumed	-6.412584	2.262026	-2.83	0.008	-11.04613	-1.779034
materialsconsumed	.0596556	.0426317	1.40	0.173	-.0276714	.1469826
netincome	-.3868293	.2658418	-1.46	0.157	-.9313814	.1577229
_cons	9902.79	7680.46	1.29	0.208	-5829.919	25635.5
sigma_u	42919.218					
sigma_e	3767.7186					
rho	.9923525	(fraction of variance due to u_i)				

FIXED EFFECTS

MANUFACTURE OF COMPUTER AND PERIPHERAL EQUIPMENTS

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. hausman fixed random
```

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
PM10Concen~3	-1.883367	38.74241	-40.62578	52.79192
totalman~000	17.12272	6.896317	10.2264	.
workingcap~l	-.0768184	-.1977793	.120961	.
totalinputs	-.5326016	-.1366859	-.3959156	.
totaloutput	.5544324	.1601471	.3942852	.
fuelsconsu~d	-6.412584	-8.245311	1.832728	.
materialsc~d	.0596556	-.0386241	.0982797	.
netincome	-.3868293	.7877498	-1.174579	.

```
             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(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =      105.11
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
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HAUSMAN TEST

THANK YOU

Presentation by Shruti Agarwal