International Journal of Business, Economics and Management
2017 Vol. 4, No.1, pp. 1-15
ISSN(e): 2312-0916
ISSN(p): 2312-5772
DOI: 10.18488/journal.62/2017.4.1/62.1.1.15

IMPACT OF FDI ON ENVIRONMENTAL QUALITY OF CHINA

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ABSTRACT

Considering the case of China the present study necessitates to highlight the environment quality of the country in the wake of increasing trends of FDI. This study attempts to present both the empirical as well as technical approach to explain the consequences of FDI and factors in relation to environments. In this study critical review of the empirical studies on the subject has been presented and following that cross years and province study among Chinese provinces was done by using time series and panel data regression to define the significance of environment quality in terms of sulphur dioxide emission and water pollutants emission due to increased FDI. Time period considered was 2003-2014. Lastly, the impact of foreign direct investment on the environmental degradation was analyzed by dividing the provinces of China in four economic regions, namely the east, center, west and North East region. The results from the analysis revealed a significant, but weak positive relation between FDI and sulphur dioxide, however, rejected the association of water pollutant emission with same. On the aggregate level as well, panel data analysis throws similar relation of all provinces in the analysis. Lastly, in case of cross region analysis, the eastern region has been encountered as contributing towards water emission only, where center, northeast and west region as contributing towards both water waste and sulphur mission. This study suggests that uniform environmental regulation in all the regions, focusing on foreign firms which use latest technology to reduce both the emission of air and water pollution and strengthening the legal system and market mechanism of property rights protection can be helpful to reduce and control environmental problems in China.

Keywords: FDI, Economic growth, Environmental quality, Sulphur dioxide emission, Water pollutants, China.
JEL classification: F21, Q53, B23, C87, M21.

Received: 5 November 2016/ **Revised:** 1 December 2016/ **Accepted:** 19 December 2016/ **Published:** 5 January 2017

Contribution/ Originality

This study is one of very few studies which have investigated impact of FDI in the environmental degradation deeply by originating new control variables .The earlier studies focus only on air pollution or water pollution and very few studies has taken both indicators for this impact.

1. INTRODUCTION

1.1. FDI and its Impact on Environmental Quality

For the last two decades, many emerging economies have been experiencing a growing inflow of Foreign Direct Investment (FDI), regarded now as an important tool for expanding the economic activities and overall

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progress. In the present era or globalization and privatization, both developing as well as developed nations has witnessed an enormous flow of FDI. However, the recent studies over FDI have underlined both positive and negative impacts of FDI on economic progress as prevalent in recent cases (Zilinske, 2010). In the view of Romančíková and Mikócziová (2011) the FDI intervention in a country is carried with a view to attain a growth number which is applicable for short term period, however, policy makers often ignore the negative effects of FDI based economic activities which hinder the long term economic progress of a country. Among them, environment degradation has been coined as one of the most prominent shortcomings of excessive FDI inflows in a country (Wang, 2010). FDI inflows have risen in countries with three major forces; market seeking force, efficiency seeking force and strategic asset seeking force, however, Hornberger *et al.* (2011) have added an additional natural resource seeking force that is contested to gain access to natural resource available in another country. The natural resources sector has gained importance for foreign investments and also listed as sector responsible for pollution. Further, the link between FDI and abundant natural resources with relaxed environment polices effects negatively towards the overall environmental quality (Asghari et al., 2014). Therefore, apart from the industries seeking unhealthy production process through the funding from FDI, attraction towards natural resources sector also have contributed towards increased pollution level. Also, environmental degradation led by FDI has long term impacts on growing levels of carbon dioxide emissions, as that is the most common pollutant generated through economic activities (Acharyya, 2009).

1.2. Environmental Quality and FDI in China over the Past 20 Years

Predicted to be the world's largest economy in near future, China has been continual in expanding the trade opportunities and investment demands. From implementing free market reforms in 1979 to promoting China-Australia Trade Agreement, the Chinese economy has devised a number of strategies to invite foreign investment (Morrison, 2014). In the wake of these developments, the present section aspires to review the China's environment quality that has been affected due to the advent of foreign investments.

Figure-1. Trend of So2 from 2003-2014

Source: China Statistical Yearbook (n.d.), Researcher

Looking towards the available literature on China's environmental quality, according to Guoming *et al.* (1999) major FDI projects in China are confined to pollution intensive industries and hence environmental damage has been at increasing scale. However, identifying the scale of FDI-led pollution level is difficult to attain. Further, being a country of 23 provinces, Zhang (2008) has also considers the detrimental effects of FDI over environment in China by stressing the role of regional environmental regulations on impacting the environmental quality.

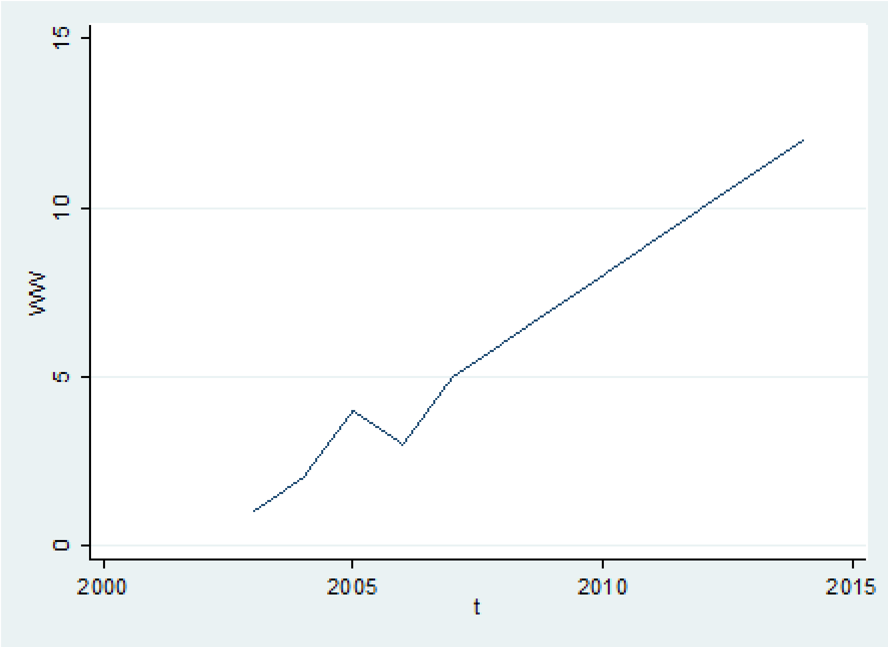

Figure-2. Waste water trend curve from 2003-2014
Source: China Statistical Yearbook (n.d.), Researcher

However, notwithstanding with the above view, He (2011) has emphasized the important role of FDI in reinforcing environmental regulations in Chinese provinces. The study highlights the positive effects of FDI through strengthening the environmental laws and protecting the environment quality. Further, recent studies have also stressed the differences in regional environmental quality across China. According to Cole *et al.* (2011) among the major 112 cities of China, only Hong Kong, Macao and Taiwan experienced either reduced pollution or insignificant pollution levels through FDI invested firms or industries, however, the rest of provinces showed increasing water and air pollutants emission level with increasing economic growth. Therefore, proposing different views of overall China's environmental quality and FDI numbers, existing studies suggest a variety of possibilities regarding FDI impacts on environmental qualities.

2. LITERATURE REVIEW

Foreign Direct Investment has been recognized as the tool for bridging the investment-saving gap in both developed and developing nations (Ganioglu and Cihan, 2015). Where developing countries have experienced a consistent growth pattern in terms of FDI inflows till 2015, developed countries have been continual in recording low levels of FDI inflows, recorded a total reduction by 28% (UNTCAD, 2015). According to Asghari *et al.* (2014) environmental regulations have significant impacts on FDI numbers, however, it will be ambiguous to mention whether these impacts are beneficial or detrimental. Towards this, Shujing (2014) explained the conducive effects of FDI on environmental protection. FDI effects on environment concerns with everything that either upgrade or diminish the quality of natural resources or living beings. The factors may consist of diminishing natural resources, threat to living beings and contribution towards environmental degradation. The deterioration of environment is the pre-requisite of all these factors that ultimately lead towards increasing costs and depleting capitals. Therefore, the importance of environmental quality is realized upon the rising cost of business in terms of capital loss.

Additionally, environment has crucial bearing on clean air and water levels that makes it an important issue to be dealt with. Therefore, environmental quality has critical importance in case of health of both individual and business. Since, FDI inflows explain a great part of economically progressed business and institutions, an environmental check over the same is of immense importance. The environmental quality that is relatable to FDI inflows can be understood by three main factors, environment regulations, pollution level and industry-specific FDI.

Apart from being bounded by the tax structure of home country, foreign investors are also liable to follow established environmental regulations. However, considering this as the indication of environmental strictness within a given country, FDI inflows have been researched as to have important association with environmental regulations (Kheder, 2006). Also by Rivera and Oh (2013) countries with lax regulations tend to attract more FDI and contribution towards increasing pollution levels. Therefore, the environmental quality can be largely explained by environmental legislations in home country. Further, the level of water and air pollution is also significant to assess the environmental quality. Towards this, a negative relation between air pollution and FDI inflow (Liang, 2006) and negative association of overall pollution level and FDI (Yang and Wang, 2016) both are prevalent in existing literature. Further, Adi and Adimani (2014) suggested FDI in primary and secondary industries are majorly responsible for increasing pollution. Industrial progress has contributed significantly towards increase in flow of pollutants like carbon dioxide, sulphur dioxide, particulates and nutrients and other toxic substances that have necessary bearings towards life. Therefore, pollution level through these industries is also a determinant of environmental quality changes in the wake of FDI led development.

Hakimipour and Damakeshideh (2013) have explained the consequence of increasing FDI levels in contribution towards more chemical as well as air pollutants substances. However, the study was based on non OECD countries, and thus restricted in terms of explaining the overall scenario of environmental impact. However, an opposing view on impact of FDI on environment has been given by Frankel and Rose (2005) where improvement in environmental quality also arises from diffusion of trade and foreign investments. With the development of technology, both developing and non-developing nations tends adopt new technologies to attain clean and green environment and sustainable growth levels. Further, FDI-led output generation is said to have positive effects on local environment and is controlled for industrial output and composition, however, FDI has measurable impacts on air pollution (Liang, 2006). Lastly, Wan-Ping *et al.* (2008) suggested the technology spillover to be the rationale behind increasing adoption of environment friendly policies through FDI and increasing investment in primary and secondary industries are reason explaining for growing levels of pollution. Therefore, impact of FDI in environmental quality can be beneficial as well as harmful, depending on the case of country and technology traded. In the case of China several studies were done and got different results. He (2011) did an empirical study to examine the impact of inflow of Foreign Direct Investment in the environmental degradation of China and found that most of the FDI inflow in China is in the production platform and the pollution regulation and lax cost is lower in this category which support the pollution haven hypothesis. Shen (2008) studied the relationship between the FDI and emission in China but authors did not find any significant impact of FDI on the emission of CO2 in China. Similarly the study by Cole *et al.* (2011) shows that the entry of the multinational companies in the developing countries are not responsible for increasing pollution in China since these firms used favorable high-tech which are more efficient than the traditional firms in most of the developing countries. Lan *et al.* (2012) examined the relationship between the emission of pollution, inflow of FDI and human capital in China. Findings from the study show that impact of FDI in environmental quality in China is significantly dependent on level of existing human capital and pollution emissions. Dean *et al.* (2009) conducted a study from 1993- 1996 to examine the existence of the pollution level in

China. Results were obtained using the panel data regression analysis and showed that the foreign firms which were funded through Macao, Taiwan and Hong Kong are attracted by the weak environmental regulations. On the other hand the firms which are funded through non ethnic sources in China are not drawn by the lax environmental regulations. Another study by Fu and Zhang (2011) also supports and confirm the pollution heaven related to China by studying inter-regional analysis to measure how FDI is to governmentally enact and put environmental controls.

3. HOW TO MEASURE THE IMPACT OF FDI ON ENVIRONMENTAL QUALITY

To measure the impact of FDI on environment quality, the literature suggests number of methods and techniques. The popular Environment Kuznets Curve (EKC) can be the base of analyzing the environmental changes through FDI. EKC suggests a hypothesized relationship between environmental indicators and income indicators, which can be useful in measuring the variation in environmental quality due to FDI inflows (Stern, 2004). The literature suggest the usefulness of EKC theory by deriving the inverted U shaped of EKC between growth rates and environmental quality considering FDI to be the prime factor (Wang *et al.*, 2015). Moreover, Jinjin and Qing (2003) suggest the measurement of FDI effects on environment can be disintegrated in terms of scale effect, structure effects and technical effects. The scale effects simple underline the overall effect of FDI on economic growth where technical effects consider the technological transfer through FDI which can be used as a proxy to generate overall environmental effects. Lastly, the structural effects consider regional distribution of FDI, where different industry receive different rate of investment and contribute to the environment accordingly.

4. METHODOLOGY

The aim of this study, as mentioned earlier, is to examine the impact of FDI on environmental quality of China. For the purpose of this study, the researcher as chosen to initiate both time series regression and panel data regression. The time series regression analysis has been carried for the period 2003- 2014 to assess the contribution of FDI towards environmental degradation over the years. Afterwards, panel data regression has been conducted between all Chinese provinces over the time span of 2003- 2014 to ascertain the FDI effect over different regions of China. Similarly to compare the results from the developed regions with the developing or underdeveloped regions in China, the Chinese provinces has been divided in four economic regions namely the eastern, western, northeastern and central regions according to division which is done in China statistical year book .The main reason behind selecting the time period comes in two main reasons .Firstly, because of reality that in this time period ,large inflow of Foreign direct investment has moved toward China and secondly, changing pollution control goals during this period has been done. Government policy and strategy of the 11thFive-year plan 2006–2011 and following that the 12th Five-Year Plan which set by the Chinese government in March 2011 put favorable attention to energy and climate change and appoint a new set of goals and policies for 2011-2015. But as data for 2015 is still unavailable, the latest available data which is 2014 is considered in time frame. The data for the analysis has been collected from the National Bureau of Statistics of China. In the current research the emission of the sulphur dioxide (SO2) has been taken as the proxy for the air pollution as it is one of the highest in the world and also emission of SO2 in China is highly due to burning coal which is used mostly in the industrial sector that is leading sector in terms of receiving FDI, and the emission of waste water (WWW) as the proxy for the water pollution. The main independent variable is the inflow of foreign direct investment. Other control variables for the study include per capita gross domestic product, unemployment rate, and literacy rate, share of exports, government expenditure, industrial share and total population.

5. DISCUSSION

5.1. Time Series Regression

To find the impact of FDI on emission of the SO2, time regression analysis has been conducted considering FDI, unemployment, population, labor force participation, exports, literacy and log of income as explanatory variables. The regression equation formulated to capture the effect sulphur dioxide on FDI is

$$\ln SO_2 = \alpha i + \gamma i + \beta 1 yit + \beta 2 yit^2 + \beta 3 yit^3 + \beta 4 INDit + \beta 5 EXit + \beta 6 IMit + \beta 7 \ln FDI$$
$$+ \beta 8 POPit + \beta 9 LIT + \beta 10 Unemp + \beta 11 Urb + \beta 12 lab + \beta 13 pop(p) + eit$$

Where,

FDI is the total amount of FDI inflow in China at time period t,

SO2 is the proxy variable for the environment regulation in time period t;

Ln Yit – is the log of per capita GDP in time period t,

(Ln Yit) ^{2} – is the square of the log of per capita GDP in time period t,

Opt – is the trade openness of China in time period t, which is a proxy of share of exports

Tit – province specific trends

Road – total length of the road

Skilled lit- literacy rate

Pop den- population density of each province

Ext –is the total exports from China in time period t (instrumental variable) and

et- is the error term

Table-1. Impact of FDI on emission of sulphur dioxide in China (2003-2014)

Source	SS	df	MS		Number of obs = 11	
Model	3.25758746	9	.361954162		F(9, 1) = 2251.36	
Residual	.000160771	1 .000160771			Prob > F = 0.0164	
					R-squared = 1.0000	
Total	3.25774823	10.325774823			Adj R-squared = 0.9995	
					Root MSE = .01268	
logso2	Coef.	Std. Err.	t	P>ItI	[95% Conf. Interval]	
FDI1	0.0000176***	1.46E-06	12.10	0.052	-8.77E-07	0.0000362
Log yt	-146.3489	36.37208	-4.02	0.155	-608.5	315.8022
Unemp	0.3107579	0.0623373	4.99	0.126	-0.4813128	1.102829
popl	-0.0875339	0.0485892	--1.80	0.323	-0.7049178	0.52985
laborforcel	-0.0148377	0.0041083	-3.61	0.172	-0.0670389	0.0373635
exports1	-0.0119363	0.0056796	--2.10	0.283	-0.0841025	0.0602299
lit	0.3384369**	0.0408088	8.29	0.076	-0.1800883	0.8569621
logyt3	-0.7489909	0.1747351	-4.29	0.146	-2.969211	1.471229
logyt2	18.08075	4.354422	4.15	0.150	-37.24743	73.40894
_cons	388.5013	100.3316	3.87	0.161	-886.3321	1663.335

Source: National Bureau of Statistics of China

The coefficient table of the above shows the effect of FDI on the emissions of SO2, with the coefficient being 0.000017 with the significance value being 0.052, which shows that the coefficient is highly significant but the correlation is quite low. Similarly, the effect of per capita GDP on the emission of SO2 is high with the coefficient being -146.34, which shows that the net effect of increase in GDP is negative on the emission of sulphur dioxide in the economy. It shows that the increase in GDP per capita by 1% decreases the sulphur dioxide emissions by 146.34%. However, the value is insignificant at the significance value of 0.155.

Similarly in this case lnyt is negative, lnyt 2 is positive and lnyt3 is again negative we can say that opposite N shape relationship exists between the per capita income and environmental degradation (when SO2 is taken as the proxy for the environmental degradation) the condition for various shapes are explained in the research methodology section.

Similar to the regression analysis of Sulphur dioxide, the analysis on the discharge of waste water has also been carried out to contemplate and comprehend the effects of various macro variables on the waste water discharge across different provinces of China. The explanatory variable taken under the case are FDI, unemployment, population, government expenditure, industrial share, exports, literacy and log of income as explanatory variables. The regression equation formulated to capture the effect water waste emission effect on FDI is

$$\ln WW_2 = \alpha i + \gamma t + \lambda 1 yit + \lambda 2 yit^2 + \lambda 3 yit^3 + \lambda 4 INDit + \lambda 5 EXit + \lambda 6 IMit + \lambda 7 \ln FDI$$
$$+ \lambda 8 POPit + \lambda 9 LIT + \lambda 10 Unemp + \lambda 11 Urb + \lambda 12 lab + \lambda 13 pop(p) + eit$$

Table-2. Impact of FDI in emission of waste water in China (2003-2014)

Source	**SS**	**df**	**MS**		Number of obs = 11	
Model Residual	.140420817 7.9400e-06	9 1 7.9400e-06	.015602313		F(9, 1) = 1965.02 Prob > F = 0.0175	
Total	0.140428757	10.014042876			R-squared = 0.9999 Adj R-squared = 0.9994 Root MSE = .00282	
lnww	Coef.	Std. Err.	t	P>ItI	[95% Conf. Interval]	
FD11	9.23E-06**	6.69E-07	13.79	0.046	7.26E-07	0.0000177
unemp	0.3855734**	0.0271099	14.22	0.045	0.0411093	0.7300375
popl	-0.4317488***	0.0568815	-7.59	0.083	-1.154497	0.2909994
exportsl	-0.0336427**	0.0015612	-21.55	0.030	-0.0534798	-0.0138057
logyt3	0.1018267**	0.0055641	18.30	0.035	0.0311286	0.1725247
logyt2	-1.219259**	0.0629238	-19.38	0.033	-2.018781	-0.4197365
govtexp	0.000013***	1.53E-06	8.53	0.074	-6.37E-06	0.0000324
lit	0.354354**	0.0186475	19.00	0.033	0.1174155	0.5912925
indushare	0.0460411**	0.0025762	17.87	0.036	0.013307	0.0787752
_cons	27.46332**	0.5485639	50.06	0.013	20.49315	34.43349

Source: China Statistical Yearbook (n.d.), Researcher

The coefficient values are again aiding in understanding the individual effect of variables on the waste water emissions. Again, the results are showing that the per capita GDP is having the maximum effect on the emission of waste water. The coefficient in such case is -1.21, which is significant at the significance value of 0.033. The negative coefficient shows that inverse relationship found between them and exhibits that with increase in 1% of the per capita GDP, the emission of waste water decreases 1.21%. Still the coefficient value is quite lower to establish any relationship between the per capita GDP and the discharge of waste water. Along with per capita GDP, the effect of population, unemployment and literacy can too be observed on the waste water emissions but again such effect is quite low. The coefficient values in such cases are -0.431, 0.385 and 0.354 at the significance values of 0.083, 0.075 and 0.033 respectively. Only the effect of literacy is significant in such case.

5.2. Panel Data Regression

For the present section, the inferential analysis is conducted through generating panel data regression tools. The hypothesis built for the section represents externality of FDI in terms of pollution across different provinces of China. Further, in this section also, the pollutants variables undertaken to show environmental effects are sulphur emission and water waste. Also, in order to reflect the impact of these variables, two separate panel data regression has been undertaken, one for sulphur emission taking all the provinces in consideration and other for water waste considering the same.

Table-3. Impact of FDI in emission of sulphur dioxide in China (2003-2014)

Source	**55**	**Df**	**MS**		Number of obs	= 302
model Residual	212.655825 4.42802545	37 264 .016772824	5.74745473		F(37, 264) Prob > F	= 342.66 = 0.0000
Total	217.08385	301.721208805			R-squared Adj R-squared Root MSE	= 0.9796 = 0.9767 . .12951
lnso2	Coef.	std. Err.	t	P>ItI	[95% Conf.	Interval]
lnfdi	-0.1238811*	0.02955	-4.19	0.000	-0.1820648	-0.0656973
road	0.0072916***	0.0041789	1.74	0.082	-0.0009365	0.0155198
unemp	-0.0135415	0.0298769	-0.45	0.651	-0.0723688	0.0452858
urbpop	-0.0003021*	0.0000524	-5.77	0.000	-0.0004053	-0.000199
lit	-0.0002127	0.0002587	-0.82	0.412	-0.000722	0.0002967
lnyt	-0.2545979	0.1859784	-1.37	0.172	-0.6207875	0.1115918
lnyt2	0.0870844	0.0545423	1.60	0.112	-0.0203088	0.1944776
lnyt3	-0.0082834***	0.004961	-1.67	0.096	-0.0180515	0.0014847
Beijing	-3.787354*	0.3559695	-10.64	0.000	-4.488254	-3.086453
Tianjin	-3.302193*	0.3804107	-8.68	0.000	-4.051218	-2.553168
Hebei	-1.056121*	0.2115423	-4.99	0.000	-1.472646	-0.6395963
shanghai	-2.504452*	0.3545429	-7.06	0.000	-3.202544	-1.806361
Jiangsu	-0.5364992**	0.1882624	-2.85	0.005	-0.907186	-0.1658124
Zhejiang	-1.501366*	0.2456661	-6.11	0.000	-1.985081	-1.017652
Fujian	-2.4395*	0.3022848	-8.07	0.000	-3.034696	-1.844304
Shandong	-1.648444*	0.1409043	--11.70	0.000	-1.925884	-1.371005
Hainan	-5.794209*	0.3843871	-15.07	0.000	-6.551063	-5.037354
Shanxi	-1.605092*	0.3056038	-5.25	0	-2.206823	-1.003361
Anhui	-2.171062*	0.237505	-9.14	0	-2.638707	-1.703417
Jiangxi	-2.258529*	0.2738977	-8.25	0	-2.797831	-1.719227
Henan	-0.8375828*	0.1497463	-5.59	0	-1.132432	-0.542734
Hubei	-1.909831*	0.2587003	-7.38	0	-2.419209	-1.400452
Hunan	-1.762295*	0.2408306	-7.32	0	-2.236488	-1.288102
Guanxi	-1.693782*	0.3525041	4.8	0	-2.387859	-0.999704
inner Mongolia	-2.05997*	0.2675155	7.7	0	-2.586706	-1.533234
Chongqing	-2.271677*	0.3248149	-6.99	0	-2.911235	-1.63212
Sichuan	-1.297706*	0.2079033	-6.24	0	-1.707065	-0.888346

Source: China Statistical Yearbook (n.d.), Researcher

In the pooled regression analysis, both the variables as well as various provinces have been taken into consideration to understand their individual effects on Sulphur dioxide emission. A very high square value of 0.97 has been analyzed, which shows that 97.5% of the variance is explained by above variables. The contemplation of the effect of various variables on the emission of SO2shows that the effect of per capita GDP is highest at -0.5 which exhibits that the SO2 emission increases as the per capita GDP (log value)is decreased and vice versa. But, the significance value is higher than 0.05 that infers about the statistical insignificance of the coefficient value. Along with it, the coefficient value of FDI (log value) is -0.123, which shows that with the increase in FDI by 1%, the SO2 emission too increases by 0.12%. The coefficient value is quite significant at the significance value of 0.000. It shows that the FDI in the country puts a negative impact on the sulphur dioxide emission in the economy.

Table-4. Impact of FDI in emission of water waste discharge in China (2003-2014

Random-effects GLS regression				Number of obs =	302
Group variable: id				Number of groups =	30
R-sq: within = 0.5177				Obs per group: min =	10
between = 1.0000				avg =	10.1
overall = 0.9831				max =	11
Random effects u_i N Gaussian				wald chi2(38) =	15296.58
corr(u_i, x) = 0 (assumed)				Prob > chi2 =	0.0000
lmww	Coef,	Std. Err.	t	P>|z|	
lnfdi	0.1192561*	0.0267844	4.45	0.000	0.1717525
pop	0.128	139	0.98	0.325	2111
road	0.0016552	0.003785	0.44	0.662	0.0090737
umemp	-0.0378257	0.0273443	-1.38	0.167	0.0157682
urbpop	1.903**	0.000056	3.40	0.001	0.0003001
lit	-0.000246	0.000234	-L05	0.293	0.0002127
1 nyt	-0.2132942	0.1716628	-1.24	0.214	0.1231588
lmyt2	0.0604401	508191	1.19	0.234	0.1600436
lnyt3	-0.0051329	0.004652	-L10	0.27	0.0039849
Beijing	-0.110496	0.1767393	-0.63	0.532	0.2359066
Tianjin	-0.4630912**	0.1993619	-2.32	0.02	0.0723491
Hebei	0.2424996	2413244	1.00	0.315	0.7154867
shanghai	0.003428136**	0.1746104	1.96	0.05	0.6851036
Jiangsu	0.3400913	0.2622949	1.30	0.195	0.8541798
Zhejiang	4906011*	0.1239635	3.96	0.00	0.7335712
Fujian	0.4561081*	81114	5.58	0.000	.616382i
Shandong	0.0504868	3844231	0.13	0.896	0.8039434
Guangdong	0.1712251	0.437465	0.39	0.695	1.028641
hairier	-0.8345573*	2009201	-4.15	0.00	-0.44076
Shanxi	-0.0245134	0.0682648	-0.36	0.72	0.1092831
Anhui	0.2056819	0.1797359	1.14	0.252	0.5579578
Jiangxi	0.1666911	0.0997082	1.67	0.095	0.3621156
Henan	0.003154445	4384418	0.86	0.392	1.234786
Hubei	0.3987685**	0.1431685	2.79	0.005	0.6793737
human	4261969	0.1993255	2.14	0.0320000000	8114611
Guangxi	-0.25602	0.1060592	-2.41	0.016	481418
Inner Mongolia	0.7331169**	1105166	6.63	0.0005000000	0.9498431
Chongqing	0.2190405**	0.083362	2.63	0.009	382421
Sichuan	0.2289885	0.3135711	0.73	0.465	0.8435766
Guizhou	-0.2129857**	0.0882293	-2.41	0.016	0.0400596

Source: China Statistical Yearbook (n.d.), Researcher

In the current analysis, the dependent variable is the waste water drainage and the independent variables are various variables (including FDI) as well as the all provinces on which the analysis is carried out (which are taken as the dummy variables). Out of all the variables, the highest coefficient value of 0.1192 is present in the case of FDI, the results of which are also significant at the correlation value of 0.00. The positive coefficient value in the case shows that as the FDI in the country rises by 1%, the corresponding waste water drainage too increases by 0.1192%. It can easily be inferred in such case that as the FDI level the country increases, the waste water discharge is also increased due to the negative impact the companies have on environment. As far as all other variables are concerned, either the significance value is higher than 0.05 or the coefficient values are quite lower to determine any considerable effect.

5.3. Cross-Region Regression

The impact of foreign direct investment on the environmental degradation was also analyzed by dividing the provinces of China in four different regions namely the east, center, west and North East region. The results for the regression analysis have been shown in the Appendix of the chapter. Two separate regression for each province has been conducted, first by taking SO_2 as the measure of the environmental degradation and secondly by taking emission of the waste water as the measure of the environmental degradation. Results from the analysis shows that in the east region for most of the provinces the FDI shows negative association with the emission of SO_2 which suggests that with increase in the FDI in the east region the level of SO_2 declines. However when the waste water was taken as the proxy for the environmental degradation then the inflow of FDI led to higher emission of waste water. For the center region provinces the results show that with per unit increase in FDI then the emission of SO_2 increases which means that FDI has negative impact on environment in this region. However for the waste water regression coefficients do not show any particular trend for FDI. For some provinces the FDI has positive impact and for some provinces it has negative impact. Similar pattern follows when waste water is taken as the dependent variable. The west region includes the highest number of provinces and the results in the west region indicate that the out of 11 provinces, in 6 province FDI led to higher emission of SO_2 which means environmental degradation. For rest of the provinces the inflow of FDI led to decrease in the SO_2 emission. Results from the waste water showed that for 10 out of 11 provinces the FDI have positive regression coefficient suggesting that the FDI has led to environmental degradation. The last region included in the analysis is the north east region which consists of only 3 provinces. Results from this provinces shows that for 2 of the provinces FDI has negative impact on emission of SO_2 and also has negative impact on the emission of waste water indicating that the FDI has actually led to improvement of the environment.

6. CONCLUSION

The foregone arguments were aimed to highlight the implications of foreign direct investment in terms of environmental quality. The upshots of the empirical study are that the environmental effects of FDI in case of China have been significant and important to manifest in policy making decision. The underlining factors stressing these implications are lax environmental regulations, increase in pollution level, and industry wise contribution towards environmental degradation. The study further confiscated the analysis by proposing two sets of regression analysis; Time series analysis and Panel data analysis. From the time series regression analysis, the results highlighted a significant positive relation between FDI and Sulphur dioxide emission, hence contribution towards environmental degradation. However, in case of water waste emission, no significant association with FDI has been encountered. For Panel data regression analysis, the study confirmed a country wide effects FDI over sulphur emission and water waste. Further, region wise regression analysis has been conducted for four classified regions; east, west, north east and center of China. The eastern region encountered contributing towards water emission where center, northeast and west region as contributing towards both water waste and sulphur mission. With underlining the interaction between FDI and Environment, the present study would also like to suggest that Chinese government should focus on ensuring uniform environmental regulation in all the regions. Chinese government should focus on attractive FDI which ensure use of the latest technology to reduce both the emission of air and water pollution. It is worth nothing that different domestic regions should avoid competition for foreign capital for the sake of local economic development and they ought to choose high-quality investments. Finally, property rights protection which is new in China and surely exists large variations across various regions of country can be a big reason to environmental degradation. Chinese governments should manage FDI by strengthen their legal systems and encouraging the development of intermediaries and market mechanisms which can be helpful to reduce and control environmental problems.

7. LIMITATION AND FUTURE GUIDELINES

Even though all the efforts have been made to include all the aspects in the current study but still, the research possesses some limitations and therefore the same are required to be worked upon in the future studies. It is highly important to do research which type of corporate governance structure will lead to decrease environmental output. Moreover, city level data should be used to get wide understanding of foreign direct investment impact on environmental issue in china. Furthermore, other proxy variables for pollution can be taken into consideration to get more precise view in this area of research. Also, it would be interesting to do research over firm level data like export-oriented and market –oriented firms in China to get knowledge about strategically view of these types of companies based on kind of technology which has direct implications on environment. Finally, it would be critically important to assess whether it is beneficial or not that Chinese government move some polluted industries to lax-regulated countries truly like a pattern which many years ago happened in china via developed countries.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

REFERENCES

Acharyya, J., 2009. FDI, growth and the environment: Evidence rom India on CO2 emission during the last two decades. Journal of Economic Development, 34(1): 43. *View at Google Scholar*

Adi, A. and E. Adimani, 2014. Effect of foreign direct investment on China economic growth: A Granger causality approach. IOSR Journal of Economics and Finance, 2(4): 56–63. *View at Publisher*

Asghari, M., S. Ashrafi and N.H. Centre, 2014. FDI effects on economic growth : The role of natural resource and environmental policy. Topics in Middle Eastern and African Economies, 16(2): 85–104.

Cole, M.A., R.J.R. Elliott and J. Zhang, 2011. Growth, foreign direct investment, and the environment: Evidence from Chinese cities. Journal of Regional Science, 51(1): 121–138. *View at Google Scholar | View at Publisher*

Dean, J.M., M.E. Lovely and H. Wang, 2009. Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China. Journal of Development Economics, 90(1): 1–13. *View at Google Scholar | View at Publisher*

Frankel, J.A. and A.K. Rose, 2005. Is trade good or bad for the environment? Sorting out the causality. Review of Economics and Statistics, 87(1): 85–91. *View at Google Scholar | View at Publisher*

Fu, X. and J. Zhang, 2011. Technology transfer, indigenous innovation and leapfrogging in green technology: The solar-PV industry in China and India. Journal of Chinese Economic & Business Studies, 9(4): 329-347. *View at Google Scholar | View at Publisher*

Ganioglu, A. and Y. Cihan, 2015. Domestic savings-investment gap and growth: A cross-country panel study. Central Bank Review, 15(1): 39. *View at Google Scholar*

Guoming, X., Z. Cheng, Z. Yangui, J.X. Zhan and G. Shunqi, 1999. The interface between foreign direct investment and the environment: The case of China. China: Copenhagen Business School.

Hakimipour, N. and M. Damakeshideh, 2013. The impact of Fdi on environmental resources in selected countries (Non- OECD). International Journal of Research and Reviews in Applied Sciences, 17(November): 111-0115.

He, J., 2011. Environmental impacts of international trade: The case of industrial emission of Sulfur Dioxide (SO2) in Chinese Provinces Jie He. Université d'Auvergne. Retrived from https://hal.inria.fr/file/index/docid/564699/filename/2005.06.pdf.

Hornberger, K., J. Battat and P. Kusek, 2011. Attracting FDI: How much does investment climate matter? View point a publication of the world bank group. Washington, DC: The World Bank Group.

Jinjin, T. and X. Qing, 2003. An empirical study on the effect of FDI inflows on China's environmental quality. Shandong University of Finance.

Kheder, B.S., 2006. Foreign direct investment and environmental regulation: A panel-data comparative analysis. Paris Cedex: Université of Paris.

Lan, J., M. Kakinaka and X. Huang, 2012. Foreign direct investment, human capital and environmental pollution in China. Environmental and Resource Economics, 51(2): 255–275. *View at Google Scholar* | *View at Publisher*

Liang, F.H., 2006. Does foreign direct investment harm the host country's environment ? Evidence from China. Berkeley: Haas School of Business.

Morrison, W.M., 2014. China's economic rise: History, trends, challenges, and implications for the United States China's economicrise: History,trends,challenges,and implications for the United States. Retrived from http://www.eldis.org/go/home&id=69029&type=Document#.WEJoErn3Njg.

Rivera, J. and C.H. Oh, 2013. Environmental regulations and multinational corporations' foreign market entry investments. Policy Studies Journal, 41(2): 243–272. *View at Google Scholar* | *View at Publisher*

Romančíková, E. and J. Mikócziová, 2011. Environmental aspects of the globalization process. Copyright© 2011 Pro Global Science Association: 142. *View at Google Scholar*

Shen, J., 2008. Trade liberalization and environmental degradation in China. Applied Economics, 40(8): 997−1004. *View at Google Scholar* | *View at Publisher*

Shujing, Y., 2014. The comprehensive influence of FDI considering environmental regulation. School of Economic &Management, Southeast University. Retrived from https://www.rse.anu.edu.au/media/772511/Shujing-Yue.pdf.

Stern, D.I., 2004. The environmental Kuznets curve (EKC): A logistic curve? Applied Economics Letters, 11(7): 449–452. *View at Google Scholar* | *View at Publisher*

UNTCAD, 2015. World investment report: Reforming international investment governance. New York and Geneva. Retrived from http://unctad.org/en/PublicationsLibrary/wir2015_en.pdf.

Wan-Ping, Y., Y. Yang and X. Jie, 2008. The impact of foreign trade and FDI on environmental pollution. China-USA Business Review, 7(12): 1–11. *View at Google Scholar*

Wang, S.X., Y.B. Fu and Z.G. Zhang, 2015. Population growth and the environmental Kuznets curve. China Economic Review, 36: 146-16. *View at Publisher*

Wang, Y., 2010. The analysis on environmental effect of logistics industry FDI. iBusiness, 02(04): 300 – 304. *View at Publisher*

Yang, J. and Y. Wang, 2016. FDI and environmental pollution nexus in China. China: Lund University.

Zhang, J., 2008. Foreign direct investment, governance, and the environment in China: Regional dimension. University of Birmingham (P.hD Thesis).

Zilinske, A., 2010. Negative and postive effects of foreign direct investment. Economics and Management. *View at Google Scholar*

BIBLIOGRAPHY

Ali, S. and W. Guo, 2005. Determinants of Fdi in China. Journal of Global Business and Technology, 1(2): 21–33. *View at Google Scholar*

Aminu, M., 2005. Foreign direct investment and the environment: Pollution haven hypothesis revisited. Norwich. Available from https://www.gtap.agecon.purdue.edu/resources/download/2131.pdf.

Doytch, N. and M. Uctum, 2011. Globalization and the environmental spillovers of sectoral FDI Nadia Doytch. New York: University of New York.

Duce, M. and B.D. España, 2003. Definitions of foreign direct investment (FDI): A methodological note. Bank for international settlements. China: Bank for International Settlements.

Zhang, J., 2008a. Foreign direct investment, governance, and the environment in China: Regional dimensions. Birmingham: The University of Birmingham.

Appendix

Below presented table represents the Region wise regression analysis on both Sulphur emission and water waste emission.

East Region

Table-5. Impact of FDI on emission of sulphur dioxide in east region in China

Name of province	Ln FDI	Pop	Road	Unemp	Urbpop	Lit	Per capita
Beijing	-0.4733149 **	0.008615**	0.062894	0.606855*	0.000104	-0.010016	-0.0032065
Tianjin	-0.1813246***	-0.0002116	0.0106878	0.079759	0.000137	-0.004178	0.0012491
Hebei	0.487252	0.0025126	0.0247182	0.109147	4.27E-05	0.0005422	-0.1349839
Shanghai	2.041476*	-0.0127063**	1.172517	0.114617	0.014887	-0.015373	-0.0000788
Jiangsu	0.4104884**	-0.0004071	-0.003701	0.070919	0.00014***	0.0005749	-0.0867908
Zhejiang	-0.2498082***	-0.0000354	0.0207526	-0.02222	3.33E-05	0.0028841	-0.041443
Fujian	0.4348754	0.0027907***	0.0247978	0.184106	0.001624	0.0016363**	-0.2555249
Shandong	-0.2834841***	0.0000879	0.0037346	-0.02878	0.000152	0.0006771	-0.0363462
Guangdong	-2.799172	0.0018166	0.0030997**	-0.44422	-0.00078	0.00362	0.0634273
Hainan	0.0003693**	-0.035333	-0.089554***	-0.14059	-0.00269	0.0039945	0.3714684**

* Coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10

Table-6. Impact of FDI on emission of water waste in east region in China

Name of province	Ln FDI	Pop	Road	Unemp	Urbpop	Lit	Per capita
Beijing	0.1735861	0.0050667	-0.028495	0.204601	-0.00014	-0.007045	-0.0041761
Tianjin	0.3112742**	-0.0147703	0.3453031	0.195477	0.014592	0.0441488	0.0010055
Hebei	0.6878487***	0.0005202	-0.004164	0.158256	-0.00033	0.000035	-0.0070693***
Shanghai	0.5332596	-0.0096261	1.358578	0.040448	0.011048**	0.0053099	-0.0000331
Jiangsu	0.3912968	-0.0006373**	-0.01359	0.136264	0.000234	-0.000115	-0.0152046
Zhejiang	0.3913515	0.002433	-0.043133	-0.09143	-0.00137	0.0059755	-0.0126461
Fujian	-2.081193	0.005983	-0.060157***	-1.29304	-0.00701	-0.012745	0.4697075
Shandong	-1.149084	0.0010598	0.0019208	-0.08283	-2E-05	0.0002967	0.1205108
Guangdong	2.456205***	-0.0009529	-0.006401	-0.05369	0.000441	-0.001786***	-0.0999664
Hainan	-0.0016559**	0.0045955	0.0560323	0.039502	0.000448	-0.000411	-0.0328932**

Source: China Statistical Yearbook (n.d.), Researcher

Centre Region

Table-7. Impact of FDI on emission of sulphur dioxide in center region in China

Name of province	lnFDI	Pop	Road	Unemp	Urbpop	Lit	Per capita
Shanxi	0.2398209***	0.0000872	-0.157646	-0.01085	0.000862	0.0008272**	-0.048136
Anhui	0.0590606	-0.0002081	0.0024835	0.143144	0.000096	0.0009666	-0.0020323
Jiangxi	-0.0520055	-0.0011977	0.0736626***	-0.2211	-0.00057	-0.001982***	0.0277191***
Henan	0.2127684*	-0.001184	0.0008607	0.119324**	0.000514	-0.000354	-0.1278687**
Hubei	0.487252**	0.0025126	0.0247182	0.109147	4.27E-05***	0.0005422	-0.1349839
Hunan	1.08622	-0.0004271	-0.01711	-0.10044	-0.00281	-0.002572	0.1938574

*coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10

Table-8. Impact of FDI on water waste in center region in China

Name of province	lnFDI	Pop	Road	Unemp	Urbpop	Lit	Per capita
Shanxi	-0.0639	-0.0006	0.1214	-0.1113	0.00045	0.00189	0.04618
Anhui	0.6841396**	-0.0035	0.05179	1.50555	0.0036	0.01139	0.0364389**
Jiangxi	-0.0035	-0.0004	0.15	-0.4394	-0.0008	-0.0036	0.06832
Henan	-0.2850076**	0.0000434***	-0.002	0.02565	5.99E-07	0.0004749***	0.09418
Hubei	0.68785	0.00052	-0.0042	0.15826	-0.0003	3.5E-05	-0.0071
Hunan	0.0055069***	-0.0005	-0.018765**	0.62581	-0.0011	0.00013	0.21282

*coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10

Western Region

Table-9. Impact of FDI on emission of sulphur dioxide in west region in China

Name of province	lnFDI	Pop	Road	Unemp	Urbpop	Lit	Percapita
Inner Mongolia	0.0765544	-0.0035012	0.0136379	-0.12836	0.000382	-0.008543*	-0.0447975
Guangxi	-0.1745716***	0.0056759	1.446439	0.281477	-0.126	-0.011777	0.314231*
Chongqing	-0.1994948	-0.0080374	-0.007676	-0.02571**	-0.0008	0.000822	0.2266777
Sichuan	0.2979488	0.0004752	-0.026475	-0.09439	-0.00079	-0.001684	-0.011251
Guizhou	-0.5129571	0.0010109	0.029269	0.258429***	0.000202	-0.004506	-0.0011357**
Yunnan	1.894083***	-0.0097884***	0.0632942	-0.92234	-0.00086	-0.011488	0.0000106
Shaanxi	-0.330492	0.001589	-0.013819	-0.37762	0.001201	0.0074889**	-0.0113617
Gansu	0.4348754	0.0027907	0.0247978	0.184106	0.001624	0.0016363	-0.2555249
Qinghai	0.1065955***	0.0011424	-0.007483	0.020965	0.009176	0.0094779***	-0.060404
Ningxia	-0.6141001	0.0092661	1.678203	2.31435	0.053109	-0.152857	-1.039474
Xinjiang	0.0673924	-0.0055977**	0.0057215	0.229437	0.0018	-0.001853	0.1700807***

*coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10

Table-10. Impact of FDI on waste water in west region in China

Name of the province	lnFDI	Pop	Road	Unemp	Urbpop	Lit	Percapita
Inner Mongolia	0.0427111**	-0.0428	-0.00817	0.563243	0.017038	0.017332	-0.00814
Guangxi	0.731689	0.002858	0.461063	-0.22478	-0.00585	-0.00785	0.108852
Chongqing	0.233035	0.008027	0.066379	1.216836	0.017017	-0.00175	-1.20357
Sichuan	0.2157915***	8.39E-05	-0.01814	0.016219	0.000492	0.001285	0.008178
Guizhou	0.206803	-0.00061	-0.01676	0.082262	-0.00038	-0.0046	0.0032
Yunnan	1.878865	-0.00816	0.016823	-1.23592	4.01E-05	-0.00761	0.001818
Shaanxi	0.021916	0.010887	-0.076878**	0.044413	-0.00092	-0.00856	-0.02832
Gansu	-2.08119	0.005983	-0.06016	-1.29304	-0.00701	-0.01275	0.469708
Qinghai	-0.5978458**	0.115889	-0.063654***	0.392715	-0.03863	0.1145339*	0.090033
Ningxia	0.044314	-0.0208	-1.60023	-1.44167	-0.00478	0.148744	0.623859
Xinjiang	0.1377699***	0.001371	-0.04988	0.428708	0.004116	-0.006452***	-0.08706

*coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10

North East region

Table-11. Impact of FDI on Sulfur Dioxide emission in North east region in China

Name of province	lnFDI	Pop	Road	Unemp	Urbpop	Lit	Per capita
Liaoning	-1.036342**	0.0073598	0.0156748	-0.05756	-0.00208	0.0463496**	0.3774401
Jilin	0.0351603	-0.0244815	0.095304	-0.36625***	-0.01683	-0.002256	0.1583671
Heilongjiang	-0.6117653***	0.0039436	0.0141816	-0.16302	-0.00053	0.0017631**	0.0522923

*coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10

Table-12. Impact of FDI on Sulfur Dioxide emission in North east region in China

Name of the province	lnFDI	Pop	Road	Unemp	Urbpop	Lit	Percapita
Liaoning	-0.7769238***	0.007	-0.025	0.00972	-0.0037	0.04633	0.5269142**
Jilin	-0.1483	0.00629	-0.02945**	-0.0708	0.004367**	0.00594	-0.0009
Heilongjiang	-2.07127**	0.01645	0.02302	-0.0902	-2.00E-05	0.00839	0.23322

*coefficient significant at 0.01, ** coefficient significant at 0.05 and *** coefficient significant at 0.10