2018

Examining the Relationship between Environmental Regulations and Foreign Direct Investment Level: Evidence from China

Hadia Fakhreldin
The British University in Egypt, hadia.fakhreldin@bue.edu.eg

Yomna Elsawy

Recommended Citation

Fakhreldin, H. & Elsawy, Y. (2018). Examining the relationship between environmental regulations and foreign direct investment levl- Evidence from China. International Journal of Business and Globalisation. Inderscience Publishing, 20 (4), 519-536 (Scopus Indexed)

Examining the relationship between environmental regulations and foreign direct investment level: evidence from China

Hadia FakhrEldin* and Yomna Elsawy

The British University in Egypt,
Elsherouk Road,
Elsherouk 11837 Cairo, Egypt
Email: Hadia.fakhreldin@bue.edu.eg
Email: yomna.elsawy93@gmail.com
*Corresponding author

Abstract: This study examines the relationship between the environmental regulations and the FDI levels in China. The environmental regulation stringency is measured using emissions and other energy consumption data. The study is based on the pollution haven hypothesis and additionally applies direction of causality tests. The main objectives of the study are: to measure the environmental regulatory stringency and to identify the relationship between the application of the environmental restrictions and the level of FDI in China in the period from 1979–2013. The study adopts a quantitative approach; a correlation matrix, a multiple regression model, and granger causality are used first; then a time series multiple regression model is conducted; afterwards the granger causality is applied. The results of the statistical analysis show a negative relationship between environmental regulations and FDI levels and a negative bidirectional causal relationship between the emissions and energy consumption variables and the FDI levels. Thus, countries aiming at increasing their FDI levels need to consider their environmental regulations. In addition, the study provides useful information to other developing countries which are still in less developed stages, as it can have policy implications on increasing the FDI levels and on the environmental regulations.

Keywords: foreign direct investment; FDI; environmental regulations; China; international business.

Reference to this paper should be made as follows: FakhrEldin, H. and Elsawy, Y. (xxxx) 'Examining the relationship between environmental regulations and foreign direct investment level: evidence from China', *Int. J. Business and Globalisation*, Vol. X, No. Y, pp.xxx–xxx.

Biographical notes: Hadia Fakhreldin is an Associate Professor of International Business at the British University in Egypt. She is an Acting Vice-Dean for Teaching and Learning since 2013. She teaches international business and comparative international management and conducts research on cross-cultural management and SME development and internationalisation. She participated in several international conferences and published in various international journals.

Yomna Elsawy has graduated from the British University in Egypt, majoring in international Business, class of 2015. During her university years, she has participated in trainings and several extracurricular activities. She has been working as a human resource business partner for two years now.

This paper is a revised and expanded version of a paper entitled 'Impact of the environmental regulations on the FDI level: evidence from China' presented at Business in a Dynamic World International Conference, Limassol, Cyprus, 15–17 January 2016.

1 Introduction

Researchers have long been concerned with whether environmental regulations hinder or alter patterns of international trade (Brunel and Levinson, 2013). Various studies have been conducted to identify the relationship between environmental regulations and foreign direct investment (FDI). Researchers have tackled this issue from several perspectives; mostly they focused on examining and testing the pollution haven hypothesis (PHH).

China is considered one of the host countries with the largest share of FDI and environmental stringency fluctuates among its provinces (Dean et al., 2009). Kearney (2014) identifies China as ranking the second highest when it comes to FDI inflow, it also has one of the world's largest GDPs. China's economic growth for the past decade has affected its environmental state and public health, which has led to the need for environmental regulations to protect its environment from degradation and to preserve its economic growth (Xu, 2014).

Since 1750, China accounted for 1/3 of world industrial output, this early modern wealth and power was based on the exploitation of China's environmental resources [Marks, (2011), p.204]. Since 1978, China started its road to liberalisation with an open-door policy, and private enterprises – including foreign participation – were permitted [Dana, (2002), p.41]. However, there was an environmental crisis in China before the Communist party took over in 1949 [Marks, (2011), p.236]. Local and foreign entrepreneurs are currently playing an important role in the economic and social development of China, with heavy investment pouring in from overseas (Dana, 2002). Evidence shows that the Chinese are still willing to take risks with the environment and global climate to achieve rapid economic growth [Marks, (2011), p.297].

The literature has a significant amount of research on developed countries but less on developing countries. The paper is structured as follows: Section 2 presents the literature review, Section 3 discusses the research framework derived from the literature, Section 4 discusses the data and the methodology adopted. Section 5 is devoted to the results and analysis; the final section presents conclusions and recommendations.

2 Literature review

2.1 Environmental regulations

There are several official definitions which are used in the literature to describe environmental regulations, and they mostly involve government intervention to sustain the environment (EPA, 2010; OECD, 2002b; GOV.UK, 2014). According to the Organisation for Economic Co-operation and Development (OECD), environmental regulations refer to the imposition of rules by the government, which are supported by penalties that are enforced to adjust the economic behaviour of individuals and firms in the private sector (OECD, 2002a; 2002b). Thus, they are laws and regulations set by governments to take care of the environment and make it more sustainable.

2.2 Foreign direct investment

FDI is a type of foreign ownership of a domestic productive asset; tangible or intangible (Mehra, 2013). FDI is often perceived as a driver for economic development, since it brings capital, transfer of knowledge, technology, jobs, and finally, access to new markets. The FDI level is identified through net inward FDI. Net flows of FDI are the capital earned from an investing enterprise by a foreign direct investor or is provided by a foreign direct investor to an enterprise either directly or through other related enterprises (UNCTAD, 2007).[1]

2.3 Environmental regulations and FDI

Major concerns have been voiced over the adoption of stringent environmental regulations and its impact on the international competitiveness of domestic firms (Asghari, 2013). Khouli et al. (2014) affirm that environmental degradation will be accelerated with the increase of FDI (PHH) unless the environment is preserved by taking essential measure sat both national and international levels.

The PHH is supported by opponents of the application of environmental policies who argue there is a negative relationship between environmental stringency and FDI. This implies that multinational companies are likely to expand their corporations geographically into other areas and will relocate themselves in countries where environmental regulations are less stringent (Zhang et al., 2014). Empirical studies show that the PHH is most valid in emerging economies (Kheder and Zugravu, 2008). Empirical evidence confirms that environmental regulation plays a significant role in the relocation of foreign enterprises; particularly the augmented migration of pollution intensive industries to developing countries (List and Co, 2000; Smarzynska and Wei, 2001; Xing and Kolstad, 2001; Keller and Levinson, 2002; Eskeland and Harrison, 2003; Cole and Elliott, 2005; Waldkirch and Gophinat, 2008; Wagner and Timmins, 2009; MacDermott, 2009 as cited in Asghari, 2013; Bazillier et al., 2013).

Other researchers claim the relationship between environmental regulations and FDI is positive and significant (Dean et al., 2009; Hanna, 2010; Leiter et al., 2011 as cited in Khouli et al., 2014). Some suggest that, environmental improvement and competitiveness can be achieved, and that the application of pollution regulations is likely to increase productivity (Linde et al., 1995). Linde et al. (1995) suggested that environmental regulations encourage innovation, which eventually reflects on the environmental performance, the business performance and competitiveness. However, the literature indicates that this is the case in developed countries (Rivera and Oh, 2013). Kheder and Zugravu (2012) (as cited in Khouli et al., 2014) suggest that the relationship between both variables is positive and significant, but only for developed countries. Moreover, democratic countries are more likely to be less resistant to the restrictiveness of environmental regulations than in authoritarian ones (Rivera, 2010 cited in Rivera and Oh, 2013).

Thus, research in developed countries supports the PHH, which proclaims that multinational companies adopt the most advanced technology and therefore preserve the environment from deteriorating. Therefore, FDI will bring cleaner, advanced technology and will adopt good environmental-practice management in developing countries, resulting in less pollution. Thus, FDI is the driver for transfer of technology from developed to developing countries. This means, adopting a more stringent environmental regulation is one of the advantages for foreign investment (Asghari, 2013). To confirm this, a study on French firms discovered that laxer environmental regulations are more likely to discourage foreign investments (Kheder and Zugravu, 2008).[2]

This means that companies with high environmental standards tend to locate in less dirty countries (Dam and Scholtens 2008 as cited in Bazillier et al., 2013). Still, this theory does not have empirical support in the developing countries.

A clearer explanation is provided by the environmental Kuznets curve (EKC) hypothesis. As concluded by Narayanan (2013), the increase in the economic activity tends to increase and preserve environmental quality. This theory, which was formally introduced by Grossman and Krueger (1991), suggests that that there is a relationship between several indicators of economic growth, environmental degradation, and pollution escalation. However, other indicators affect its variability, which results in reaching a certain level when it reverses, which infers that 'the environmental impact indicator is modelled as a quadratic function of the logarithm of income'. This implies that at first economic growth will lead to a negative impact on the environment, however, over time it will reach a point where economic growth will have positive impact on the environment and its quality (Stern, 2004; Lieb, 2002; Asghari, 2013).

Critics of the PHH believe that not all companies are likely to locate in countries with laxer environmental regulations. This depends on the environmental standard of the firm itself; as stated by Dam and Scholtens (2012), firms that have high environmental responsibility are likely to locate in countries where high environmental standards are applied (Dean et al., 2004). Mabey and McNally (1999), indicated that environmental destruction has been on the increase due to increased economic activity, and some researchers claimed that FDI has become a significantly high contributor to this. Monteiro (2009) showed – using a panel granger causality test – there is 'bidirectional causality' between environmental stringency and FDI.

It was only Asghari who tested both hypotheses on developing countries. She examined the PHH and the halo hypothesis by determining the correlation between the carbon emissions and FDI inflows in the MENA region during 1980–2011. Her empirical analysis showed a negative and weak relationship between the two variables. She argued that FDI inflows may be the vehicle that provides cleaner technology, which supports the Pollution Halo Hypothesis. But it also provides weak evidence for the PHH (Asghari, 2013).

2.4 The relationship between environmental regulations and FDI levels in China

The OECD (2013) announced in 2013, that China has the second largest share of FDI after the USA (Williams and Zhang, 2015). Also, China has the highest share of FDI in the developing world (Dean et al., 2009). In addition, China is the most stringent country when it comes to FDI regulatory restrictiveness (OECD, 2014a, 2014b, 2014c).

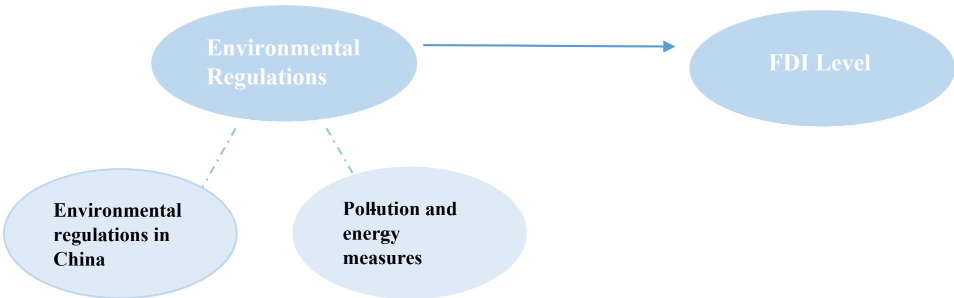
In a study on China by Dean et al. (2004), it was indicated that less restricted regulations were the main attractiveness of Chinese provinces for joint ventures with partners from Hong Kong, Taiwan and other countries in South Asia. Another study on China by Bu et al. (2013), showed how multinational companies in China are more attracted to laxer environmental regulations. However, he stated that corporate social responsibility can counteract the increased attraction to laxer environmental regulations. Moreover, as China's environmental stringency varies among its provinces; it is considered as an "excellent setting for the pollution haven effect" (Dean et al., 2009).

Thus, China is the first destination of FDI globally and is one of the countries with the highest level of pollution. Therefore, China can be considered as a perfect setting to examine the relationship between environmental regulation stringency and the FDI level.

3 Research framework

The below framework demonstrates the relationship between environmental regulations and the FDI level. This shows how environmental regulation stringency will be measured by using two integrated approaches.

Figure 1 The relation between environmental regulations and FDI level (see online version for colours)



The research aim is to determine the impact of environmental regulations on the level of FDI in China using two integrated approaches; direct assessment of environmental regulations, composite indexes and measures on pollution and energy consumption in measuring the level of environmental stringency in China over a period of time and then comparing it with the trend of the FDI level (Brunel and Levinson, 2013).

Research objectives:

1 To measure environmental regulatory stringency in China.

2 To identify the relationship between the application of environmental restrictions and the level of FDI from 1979–2013.

The study will test the following two hypotheses:

H1 There is a negative relationship between environmental regulations and FDI levels in China.

H2 There is a bidirectional relationship between environmental regulations and FDI levels in China.

The associated null hypothesis for H1 and H2 is that there is no relationship between environmental regulations and the FDI level in China.

4 Data and methodology

This study is a longitudinal study and adopts a quantitative approach. It uses data from the WTO based on a list of indicators published by the World Bank (http://data.worldbank.org), based on 35 observations over the period 1979 to 2013; where the missing data is filled using linear interpolation.

The quantitative analysis measures environmental regulation stringency using emissions and energy use data. The emissions considered are carbon dioxide (CO_2), nitrous dioxide (NO_x), methane, other greenhouse gases, HFC, PFC and SF6. As for energy use, there is one variable measuring the energy use from 1979 to 2013.

The study adopts a deductive research approach, where specific theories are tested (Brunel and Levinson, 2013). It utilises a combination of techniques including correlation matrix, time series multiple regression model, and finally a granger causality test. The analysis starts with descriptive statistics followed by inferential statistics with correlation matrix. The aim of the correlation matrix is to identify the degree or strength of the relationship between the FDI and gross domestic product (GDP), CO_2, NO_x, methane, other greenhouse gases, HFC, PFC and SF6 and energy use. The correlation matrix is conducted with the assumption of normality along all the six independent variables.

The ADF fisher unit root test, proposed by Maddala and Wu in 1999, is one to determine the stationarity of the variables though testing if they have unit root as the variables entered in the multiple regression model should be stationary (Ramirez, 2006). A time series multiple regression model is conducted to determine the nature of the relationship and the variability of each independent variable with the dependent variable (Gujarati, 2004). The granger causality test is administered to determine 'the directed functional (causal) interactions' using time series and to identify the direction of the relationship whether it is unidirectional causality, bidirectional causality, or dependence (Gujarati, 2004).

The software used is the 'Eviews' package, it is specialised in time series concerned with econometric analysis (Bossche, 2011).

5 Results and analysis

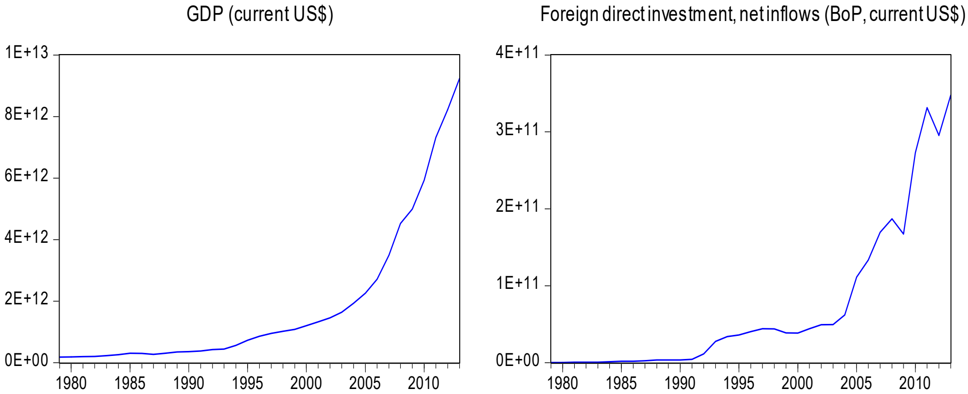
The descriptive statistics summary in Table 1 shows that China has an FDI mean of approximately \$73.1 billion and a standard deviation of \$101.5 billion. As for the minimum and maximum value, China's FDI has a maximum value of \$347.8 billion. On the other hand, the minimum value is a quarter billion \$.

Despite the introduction of environmental regulations in China over the years from 1979 till 2013, as shown in Table 1, emission levels, and energy use are still increasing. Moreover, as shown in Figure 2, there is a positive trend in the graphs for the FDI and the GDP values, both variables have been on the increase. This indicates the growth of China's economy through the duration from 1979 to 2013.

Table 1 Summary statistics (1979–2013, observations = 35)

Variable	*Mean*	*Std. Dev.*	*Maximum*	*Minimum*
FDI	73,085,691,242	1.01E + 11	3.48E + 11	249,750,000
GDP	1.88E + 12	2.46E + 12	9.24E + 12	1.77E + 11
CO_2	4,054,640.98	2,502,686.17	10,070,935.12	1,451,501.28
Energy use	1,300,529.62	727,313.92	3,149,720.54	593,862.21
Methane	1,179,708.71	257,191.43	1,799,784.60	987,789.29
NO_2	383,869.93	106,716.90	617,799.65	237,039.99
GHG	88,443.66	98,077.85	306,566.30	7902.49

Figure 2 Line graphs for GDP in US$ and FDI, net inflows in US$ in China (1997–2013, observations = 35) (see online version for colours)



From 1997–2013, the independent variables including CO_2 emission, nitrous oxide emissions, methane emissions, energy use, and other greenhouse gases also have a positive trend, which implies there is growth in values over the years. Moreover, China's environmental stringency has been decreasing over time, as the level of emissions have been increasing by time not decreasing or constant. It may be stringency has increased but not as fast as GDP hence emissions could have been growing even faster IF stringency has not been increased over the years.

Table 2 shows the correlation matrix for FDI, GDP, CO_2, NO_x, GHG, methane and energy use. The results of the correlation conducted are displayed in Table 2 and show there is a strong relation between FDI and GDP, and a strong relation between FDI and all the independent variables including Carbon dioxide emissions (CO_2), nitrous oxide emissions (N_2O), This is also true for Methane emissions, Energy use, and other Greenhouse gas emissions, HFC, PFC and SF6 (GHG) as their values in the table are approximately 1 indicating a strong relation between the variables being tested. All the values of 'r' are around 0.98 which indicates the strong relationship between FDI, GDP, CO_2, NO_x, methane, and other green gases, HFC, PFC and SF6. All the p-values are of value 0.0000, which means that all the correlations are significant.

Table 2 Correlation matrix for FDI, GDP, CO_2, NO_x, GHG, methane and energy use

Correlation/ probability	*CO_2*	*Energy use*	*FDI*	*GDP*	*Methane*	*NO_x*	*GHG*
CO_2	1						
Energy use	0.99833	1					
	0						
FDI	0.96819	0.97451	1				
	0	0					
GDP	0.96205	0.97231	0.98653	1			
	0	0	0				
Methane	0.98264	0.98516	0.97289	0.97319	1		
	0	0	0	0			
NO_x	0.98062	0.9782	0.92414	0.91778	0.93966	1	
	0	0	0	0	0		
GHG	0.98471	0.98584	0.94666	0.9415	0.98351	0.96744	1
	0	0	0	0	0	0	

A natural logarithm is taken followed by a unit root test to determine whether the time series variables are stationary or not.

Table 3 Unit root test for the lagged original variables

Null hypothesis: unit root (individual unit root process)				
Series: $LNCO_2$, LNENERGY, LNFDI, LNGDP, LNGHG, LNMETHANE, LNNITROUS				
Sample: 1979 2013				
Exogenous variables: individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0 to 2				
Total number of observations: 232				
Cross-sections included: 7				
Method			*Statistic*	*Prob.***
ADF – Fisher Chi-square			2.44430	0.9997
ADF – Choi Z-stat			6.13471	1.0000
Intermediate ADF test results Untitled				
Series	*Prob.*	*Lag*	*Max Lag*	*Obs*
$LNCO_2$	0.9489	1	8	33
LNENERGY	1.0000	0	8	34

Notes: **Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 3 is the unit root test for the lagged original variables, which conducts the unit root test with the natural logarithm. However, the p-values for all the variables were all above the alpha, expected for the FDI. This implies that all variables expect for FDI have a unit root indicating they are all non-stationary. The second trial is to apply the first difference of the same variables as shown in Table 4. The results of the test show stationarity of the following variables; CO_2, GDP, energy use, other green gases, HFC, PFC and SF6. This conclusion is justified through the p-value of all the mentioned variables, where they are all less than 0.05, except for methane and NO_x; (their p-values are greater than 0.05) indicating a unit root. Finally, after taking second differences for the remaining variables; methane and NO_x, the results displayed a significance level of stationarity.

Table 4 shows the estimation of the multiple regression model for FDI and GDP, CO_2, NO_x, GHG, methane and energy use.

Table 4 Unit root test for first differenced logged variables

Null hypothesis: unit root (*individual unit root process*)				
Series: $LNCO_2$, LNENERGY, LNFDI, LNGDP, LNGHG, LNMETHANE, LNNITROUS				
Sample: 1979 2013				
Exogenous variables: individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0 to 1				
Total number of observations: 230				
Cross-sections included: 7				
Method			*Statistic*	*Prob.***
ADF – Fisher Chi-square			41.4255	0.0002
ADF – Choi Z-stat			–3.634	0.0001
Intermediate ADF test results D (*untitled*)				
Series	*Prob.*	*Lag*	*Max Lag*	*Obs*
D($LNCO_2$)	0.0289	0	7	33
D(LNENERGY)	0.0214	0	7	33
D(LNFDI)	0.0021	1	7	32
D(LNGDP)	0.0142	0	7	33
D(LNGHG)	0.1813	0	7	33
D(LNMETHANE)	0.5917	0	7	33
D(LNNITROUS)	0.5182	0	7	33

Notes: **Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

As shown in Table 5, the p-values of the dummy variables for years represented are considered significant.

Using time series (1997–2013) and 35 observations, an estimation of the multiple regression model is conducted where Y is FDI and the environmental regulations' stringency indicators are the X's. In the Table 11 is GDP, X2 is CO_2, X3 represents the other green gases including emissions of hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride (GHG). X4 is NO_x, X5 is methane, lastly, X6 represents the energy use.

Table 5 Unit root test for second differenced logged variables

Null hypothesis: unit root (*individual unit root process*)				
Series: $LNCO_2$, LNENERGY, LNFDI, LNGDP, LNGHG, LNMETHANE, LNNITROUS				
Sample: 1979 2013				
Exogenous variables: individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 0 to 1				
Total number of observations: 222				
Cross-sections included: 7				
Method			*Statistic*	*Prob.***
ADF – Fisher Chi-square			162.293	0.0000
ADF – Choi Z-stat			–11.3	0.0000
Intermediate ADF test results D (*untitled*, *2*)				
Series	*Prob.*	*Lag*	*Max lag*	*Obs*
D($LNCO_2$, 2)	0.0000	0	7	32
D(LNENERGY, 2)	0.0000	0	7	32
D(LNFDI, 2)	0.0000	1	7	31
D(LNGDP, 2)	0.0000	1	7	31
D(LNGHG, 2)	0.0000	0	7	32
D(LNMETHANE, 2)	0.0000	0	7	32
D(LNNITROUS, 2)	0.0000	0	7	32

Notes: ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 6 Estimation of the multiple regression model for FDI (dependent variable) and GDP, CO_2, NO_x, GHG, methane, and energy use

Dependent variable: FDI				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant	–0.032	0.1063	–0.305	0.7642
D2LNMETHANE	0.2186	0.7709	0.2835	0.78
D2LNNITROUS	4.3591	1.9362	2.2514	0.0371
$DLNCO_2$	1.848	0.6267	2.9486	0.0086
DLNENERGY	–1.428	0.7201	–1.983	0.0628
DLNGDP	0.3032	0.2045	1.4823	0.1556
DLNGHG	–0.085	0.0952	–0.892	0.3841

Note: Using time series (1997–2013), observations = 35.

All independent variables are significant, given that all the p-values are less than 0.05 except for the methane where its p-value is 0.78. This infers that methane does not affect the FDI, resulting in excluding the methane variable. As shown in Table 6, all the signs of the coefficients are positive which indicates that Y and X vary in the same direction.

Furthermore, an increase in GDP is likely to lead to an increase in FDI by approximately 0.75%, while an increase in the GHG's is likely to cause an increase in FDI by approximately 0.78%. Moreover, an increase in energy use is likely to lead to an increase in FDI by approximately 1.15%, while an increase in NO_x will result in an increase in FDI by approximately 6.87%.

The residuals are 'white noise'. Dummy variables were created for the following seven years; 1984, 1992, 1993, 2003, 2005, 2009 and 2012.

In Table 7, the estimation of the model for FDI (dependent variable), trend variable and dummy variables for years 1984, 1992, 1993, 2003, 2005, 2009, 2012 is conducted using time series (1997–2013) and the 35 observations.

Table 7 Estimation of multiple regression model for FDI (dependent variable), trend variable and dummy variables for years 1984, 1992, 1993, 2003, 2005, 2009, 2012

Dependent variable: FDI				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
T	–0.006	0.0029	–2.001	0.0607
DU9293	0.8254	0.0603	13.686	0
DU84	0.3981	0.0772	5.1548	0.0001
DU05	0.4062	0.076	5.3462	0
DUM10	0.2872	0.0903	3.1814	0.0052
DU03	–0.317	0.0963	–3.293	0.004
DU09	–0.303	0.0805	–3.768	0.0014
DU012	–0.275	0.0865	–3.177	0.0052

Note: Using time series (1997–2013), observations = 35.

As shown in Table 7, the p-values of the dummy variables for the years represented are considered significant.

Table 8 demonstrates the results of the R^2, adjusted R^2, F-statistic, and probability of the F-statistics from the multiple regression model. The multiple regression model shows that the R^2 is of value 0.957580; this implies that 96% of the variation in the FDI is explained through the GDP, CO_2, NO_x, energy use, and GHG. As for the adjusted R2 it is 0.924587, i.e., after taking the number of variables into account, the model explains approximately 92.5% of the variation in the FDI.

These values are very high for this type of study. I suspect they are the result of extreme multiple correlation (see the correlation matrix). This means the model is either mis-specified or over-specified e.g., many of the dependent variables (extreme r values) are actually measuring the same thing.

Table 8 Results of the R^2, adjusted R^2, F-statistic, and probability of the F-statistics from the multiple regression model

Dependant variable: FDI			
Independent variables: GDP, CO_2, No_x, GHG, ,methane, and energy use			
R-squared	*Adjusted R-squared*	*F-statistic*	*Prob (F-statistic)*
0.9576	0.9246	29.023	0

The aim of the Granger causality test is to find out the nature of causality between the FDI and the environmental regulations stringency indicators including CO_2, NO_x, GHG, energy use, and methane in China for a specific period from 1979 till 2013. Gujarati (2004) affirms that the direction of the relationship is highly sensitive to the number of lags selected in conducting the Granger causality test; stating that the test 'depends critically on the number of lagged terms introduced in the model'. Therefore, each independent variable's relationship with the FDI will be explained alone.

The causality between FDI (dependent variable) and GDP (independent variable) is examined as shown in Table 9. Up to six lags show a bidirectional causality between CO_2 and FDI. However, at eight lags, the results shown in Table 9 suggests that there is a directional causality from GDP to FDI, as the p-value is greater than alpha and therefore the null hypothesis is rejected. However, there is no 'reverse causation' from FDI to GDP, as the p-value is 0.0317.

Table 9 Causality between FDI (dependent variable) and GDP (independent variable)

Variable: GDP				
Null hypothesis	*Lags*	*F-statistic*	*Prob.*	*Decision*
DLNGDP does not Granger cause DLNFDI	2	0.4195	0.7928	Reject
DLNFDI does not Granger cause DLNGDP	2	0.651	0.6325	Reject
DLNGDP does not Granger cause DLNFDI	4	0.4195	0.7928	Reject
DLNFDI does not Granger cause DLNGDP	4	0.651	0.6325	Reject
DLNGDP does not Granger cause DLNFDI	6	1.6467	0.2024	Reject
DLNFDI does not Granger cause DLNGDP	6	0.5676	0.7499	Reject
DLNGDP does not Granger cause DLNFDI	8	2.152	0.1374	Reject
DLNFDI does not Granger cause DLNGDP	8	3.7898	0.0317	Do not reject

Table 10 Causality between FDI (dependent variable) and CO_2 (independent variable)

Variable: Carbon dioxide (CO_2)				
Null hypothesis	*Lags*	*F-statistic*	*Prob.*	*Decision*
DLNFDI does not Granger cause DLNCO_2	2	0.56969	0.6875	Reject
DLNCO_2 does not Granger cause DLNFDI	2	1.53069	0.2296	Reject
DLNFDI does not Granger cause DLNCO_2	4	0.56969	0.6875	Reject
DLNCO_2 does not Granger cause DLNFDI	4	1.53069	0.2296	Reject
DLNFDI does not Granger cause DLNCO_2	6	1.44391	0.2625	Reject
DLNCO_2 does not Granger cause DLNFDI	6	0.82021	0.5713	Reject
DLNFDI does not Granger cause DLNCO_2	8	2.11059	0.1434	Reject
DLNCO_2 does not Granger cause DLNFDI	8	0.56205	0.7855	Reject
DLNFDI does not Granger cause DLNCO_2	10	3.79895	0.1497	Reject
DLNCO_2 does not Granger cause DLNFDI	10	0.62509	0.7493	Reject

With reference to the causality between FDI (dependent variable) and CO_2 (independent variable) in Table 10, the P-values of all the lags are greater than the alpha (0.05), this means that we reject the null hypothesis that (CO_2 does not granger cause FDI) and that

(FDI does not granger cause CO_2). Hence, up to ten lags, there is bilateral causality between CO_2 and FDI.

In Table 11, the goal is to examine the causality between FDI (dependent variable) and GHG (independent variable), there is a bidirectional relationship between the GHG and the FDI. This indicates that there is a bidirectional relationship between energy use and FDI, up to ten lags. The P-vales of all the lags are greater than the alpha, this means that we reject the null hypothesis that (GHG does not granger cause FDI) and that (FDI does not granger cause GHG). Hence, up to ten lags, there is bilateral causality between GHG and FDI.

Table 11 Causality between FDI (dependent variable) and GHG (independent variable)

Variable : GHG				
Null hypothesis	*Lags*	*F-statistic*	*Prob.*	*Decision*
DLNGHG does not Granger cause DLNFDI	2	1.27616	0.3124	Reject
DLNFDI does not Granger cause DLNGHG	2	0.78221	0.55	Reject
DLNGHG does not Granger cause DLNFDI	4	1.27616	0.3124	Reject
DLNFDI does not Granger cause DLNGHG	4	0.78221	0.55	Reject
DLNGHG does not Granger cause DLNFDI	6	1.05714	0.4317	Reject
DLNFDI does not Granger cause DLNGHG	6	0.23663	0.9571	Reject
DLNGHG does not Granger cause DLNFDI	8	0.41472	0.8827	Reject
DLNFDI does not Granger cause DLNGHG	8	0.50659	0.8222	Reject
DLNGHG does not Granger cause DLNFDI	10	4.0091	0.2161	Reject
DLNFDI does not Granger cause DLNGHG	10	6.30007	0.1447	Reject

Table 12 Causality between FDI (dependent variable) and energy use (independent variable)

Variable: Energy use				
Null hypothesis	*Lags*	*F-statistic*	*Prob.*	*Decision*
DLNFDI does not Granger cause DLNENERGY	2	0.9528	0.4535	Reject
DLNENERGY does not Granger cause DLNFDI	2	0.08453	0.9863	Reject
DLNFDI does not Granger cause DLNENERGY	4	0.9528	0.4535	Reject
DLNENERGY does not Granger cause DLNFDI	4	0.08453	0.9863	Reject
DLNFDI does not Granger cause DLNENERGY	6	0.71798	0.6414	Reject
DLNENERGY does not Granger cause DLNFDI	6	0.27413	0.9405	Reject
DLNFDI does not Granger cause DLNENERGY	8	1.07116	0.4559	Reject
DLNENERGY does not Granger cause DLNFDI	8	0.1004	0.9982	Reject
DLNFDI does not Granger cause DLNENERGY	10	16.4037	0.0208	Do not reject
DLNENERGY does not Granger cause DLNFDI	10	0.08552	0.9987	Reject

The causality between FDI (dependent variable) and energy use (independent variable) shown in Table 12 shows that the P-vales are greater than the alpha, this means that we reject the null hypothesis that energy use does not granger cause FDI and that FDI does not granger cause energy use. Hence, up to eight lags, there is bilateral causality between energy use and FDI. However, at ten lags, the results suggest there is a directional causality from energy use to FDI as the p-value is greater than alpha and therefore the null hypothesis is rejected. On the other hand, there is no 'reverse causation' from the FDI to energy use, as the p-value is 0.0208.

Looking at the causality between FDI (dependent variable) and NO_x (independent variable) in Table 13, the P-vales of all the lags are greater than the alpha, this means that we reject the null hypothesis that (NO_x does not granger cause FDI) and that (FDI does not granger cause NO_x). Hence, up to ten lags, there is bilateral causality between NO_x and FDI.

Table 13 Causality between FDI (dependent variable) and NO_x (independent variable)

Variable: NO_x				
Null hypothesis	*Lags*	*F-statistic*	*Prob.*	*Decision*
DLNFDI does not Granger cause DLNENERGY	2	1.14971	0.3622	Reject
DLNENERGY does not Granger cause DLNFDI	2	0.87924	0.4939	Reject
DLNFDI does not Granger cause DLNENERGY	4	1.14971	0.3622	Reject
DLNENERGY does not Granger cause DLNFDI	4	0.87924	0.4939	Reject
DLNFDI does not Granger cause DLNENERGY	6	1.65168	0.2055	Reject
DLNENERGY does not Granger cause DLNFDI	6	0.61401	0.716	Reject
DLNFDI does not Granger cause DLNENERGY	8	0.93627	0.536	Reject
DLNENERGY does not Granger cause DLNFDI	8	0.77963	0.6334	Reject
DLNFDI does not Granger cause DLNENERGY	10	2.39551	0.3303	Reject
DLNENERGY does not Granger cause DLNFDI	10	3.8406	0.2242	Reject

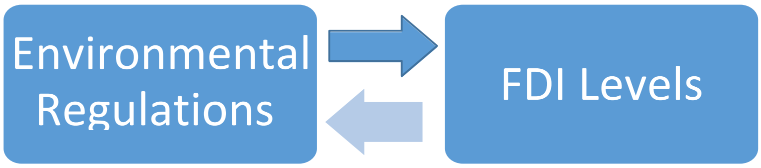
It can be concluded that there is a strong positive relationship between the FDI and GDP, CO_2, NO_x, GHG's, methane, and energy use. This implies the significant negative relationship between the FDI and environmental regulations' stringency.

Moreover, the multiple regression results suggest a positive relation between FDI and the variables of the emissions except for methane and energy use. The high levels of emissions and energy use might be indicators of less stringent environmental regulations. This means that there is a negative relationship between the FDI and the environmental regulations in China. As the environmental regulations stringency gets laxer, the FDI increases. This supports the PHH, i.e., multinational companies tend to be attracted to laxer environmental regulations. Hence H1 is accepted.

Furthermore, the granger causality tests show that GDP and FDI have a bidirectional causality. There is also a bidirectional causality between the emissions and energy use, and the FDI, which means that there is a bidirectional relationship between environmental regulations and FDI, as confirmed previously in Monteiro (2009). Hence H2 is accepted.

It is clear, that the environmental regulations have been growing over the years from 1970 to 2013, but not to the extent to be able to control the levels of emissions. This supports the literature, where there is a negative relationship between environmental regulations and FDI (List and Co, 2000; Smarzynska and Wei, 2001; Xing and Kolstad, 2001; Keller and Levinson, 2002; Eskeland and Harrison, 2003; Cole and Elliott, 2005; Khedr and Zugravu, 2008; Waldkirch and Gophinat, 2008; Wagner and Timmins, 2009; MacDermott, 2009 as cited in Asghari, 2013; Bazillier et al., 2013). Taking into consideration the movement of environmental regulations and how it has been declining in practice in the past years and how the FDI has only been increasing as shown in Figure 1 supports the PHH and shows the negative bidirectional relationship (Monteiro, 2009), which could mean a 'turnaround' after some time, as predicted by the pollution halo hypothesis and the EKC as identified in the previous literature (Stern, 2004; Lieb, 2002; Asghari, 2013).

Figure 3 Nature and direction of the relation between environmental regulation and FDI level (see online version for colours)



6 Conclusions

Countries aiming at increasing their FDI levels need to consider their environmental regulations with caution. This entails developing and institutionalising policies and processes that would result in decreasing the level of their emissions, as well as their energy consumption relative to GDP growth? Developed countries are already doing that (Asghari, 2013) and are achieving higher FDI levels. This should also be the case for developing countries; they can attract FDI without sacrificing their environment and deteriorating their standards. As a matter of fact, countries with low FDI levels can attract and develop more FDI opportunities through adopting and following tighter environmental policies. These policies lead to more innovative technologies, especially emission abatement technology and solutions which, in turn, increase FDI levels without harming the environment. This requires more dexterous government interventions that can further support and develop FDI.

The role of governments is therefore crucial and necessary. Evidence shows that the Chinese are still willing to take risks with the environment and global climate to achieve rapid economic growth [Marks, (2011), p.297]. This confirms that it is essential that its government should determine the appropriate degree of regulation to enact and to enforce, such that the benefits to society exceed the costs of compliance [Dana, (2002), p.258]. Eventually, – as predicted by the pollution halo hypothesis – the tight environmental regulations will attract more FDI (Lieb, 2002).

One of the limitations of this study is the limited number of observations, more accurate results would have been conducted if the time series was greater than 35 observations. Also, there were some figures missing in the data that was adopted from the WTO, which was filled using linear interpolation. The results of the statistical analysis would have been more accurate if the data was complete. Furthermore, it is important to verify – without any doubt - that the Pollution Halo Hypothesis is supported over time by the more stringent regulations in China. Therefore, research should be conducted to cover the last two years and another 2–3 years to be able to draw more concrete and confirmed conclusions. Examining the years from 2014–2018 will give a clear indication to confirm or reject the s hypothesis in the Chinese case.

This study focused on China at the national level; future studies should examine the different industries within China, as well as the various nationalities of the FDI activities – to evaluate if developed countries seek to invest in countries with less stringent environmental policies. It would also be useful to identify differences among industries worldwide and differences between countries. Another aspect that should be investigated, would be to compare the results of the study with other countries with similar conditions such as the BRICS; it would be interesting to conduct a cross sectional study to bring more generalisable results. In addition, research in this area can be conducted with more sophisticated models using panel data to be able to examine more than one relationship. There is a need to put other external factors into consideration and to examine their effect when conducting this study in the future. The next step is to test the EKC especially; with the amendment of the environmental protection law in 2014 and the expectation of FDI into China declining in the future raising the question – will the situation change? (Economist, 2014).

References

Appleton, A.E. (1999) 'Environmental labelling schemes: WTO law and developing country implications', *Trade, Environment and the Millenium*.

Asghari, M. (2013) 'Does FDI promote MENA region's environment quality? Pollution halo or pollution haven hypothesis', *International Journal of Scientific Research in Environmental Sciences* (*IJSRES*), Vol. 1, No. 6, pp.92–100.

Bazillier, R., Hatte, S. and Vauday, A.J. (2013) *Environmental Responsibility and FDI: Do Firms Relocate their Irresponsibilities Abroad?*, Paris.

BBC (2015) 'China overtakes US for foreign direct investment', *BBC News*, 30 January [online] http://www.bbc.com/news/business-31052566 (accessed 22 May 2015).

Bossche, F.A. (2011) 'Fitting state space models with EViews', *Journal of Statistical Software*, May, Vol. 41, No. 8, pp.25–38, pp.1–16.

Brunel, C. and Levinson, A.A. (2013) *Measuring Environmental Regulatory Stringency*, OECD Trade and Environment Working Papers, No. 5.

Bu, M., Liu, Z., Wagner, M., and Yu, A.X. (2013) 'Corporate social responsibility and the pollution haven hypothesis: evidence from multinationals' investment decision in China', *Asia Pacific Journal of Accounting & Economics*, Vol. 20, No. 1, pp.85–99.

Corporations, T. (2007) *Extractive Industries and Development*, UNCTAD, NY, Geneva.

Dam, L. and Scholtens, A.B. (2012) 'The curse of the haven: the impact of multinational enterprise on environmental regulation', *Ecological Economics*, June, Vol. 78, pp.148–156.

Dana, L.P. (2002) *When Economies Change Paths: Models of Transition in China, the Central Asian Republics, Myanmar and the Nations of Former Indochine Francaise*, World Scientific Publishing Company, Singapore.

Dean, J.M., Lovely, A.M. and Wang, H. (2009) 'Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China', *Journal of Development Economics*, September, Vol. 90, No. 1, pp.1–13.

Dean, J.M., Lovely, M.E. and Wang, A.H. (2004) *Foreign Direct Investment and Pollution Havens: Evaluating the Evidence from China*, Office of Economics, US International Trade Commission.

EPA (2010) *Regulations*, 1 April [online] http://www2.epa.gov/ (accessed 1 April 2015).

GOV.UK (2014) *Environmental Regulations*, 9 May [online] https://www.gov.uk (accessed 9 May 2015).

Grossman, G.M. and Krueger, A.B. (1991) *Environmental Impacts of a North American Free Trade Agreement*, No. w3914, National Bureau of Economic Research.

Gujarati, D.N. (2004) *Basic Econometrics*, The McGraw Hill, New York.

Jeck, T. (2007) *UNCTAD: World Investment Report 2007*, Transnational Corporations, Extractive Industries and Development – Tomáš Jeck. Ekonomický časopis, Vol. 10, pp.1025–1027, May 2015.

Kearney, A. (2014) *The 2014 A.T. Kearney Foreign Direct Investment Confidence Index*, June [online] http://www.atkearney.com/; http://www.atkearney.com/researchstudies/foreign-direct-investment-confidenceindex/full-report (accessed May 2015).

Kheder, S.B. and Zugravu, A.N. (2008) *The Pollution Haven Hypothesis: A Geographic Economy Model in a Comparative Study*.

Khouli, B., Omri, A. and Chaibi, A.A. (2014) *Environmental Regulations, Trade, Foreign Direct Investment: Evidence from Gravity Equations*, Working Papers 2014-189, Department of Research, Ipag Business School.

Leino, T. and Ali-Yrkkö, A.J. (2014) *How Does Foreign Direct Investment Measure Real Investment by Foreign-Owned Companies?*, 14 May [online] http://www.etla.fi/ (accessed May 2015).

Lieb, C.M. (2002) 'The environmental Kuznets curve and satiation: a simple static model', *Environment and Development Economics*, Vol. 7, No. 03, pp.429–448.

Linde, Porter, M.E. and Der, A.C. (1995) *Green and Competitive*, September–October [online] http://www.uvm.edu/ (accessed May 2015).

Mabey, N. and McNally, A.R. (1999) *Foreign Direct Investment and the Environment: From Pollution Havens to Sustainable Development*, Research Paper, WWF-UK, London.

Marks, R. (2011) *China: Its Environment and History*, Rowman and Littlefield Publishers, Lanham.

Mehra, N. (2013) 'Impact of foriegn direct investment on employment and growth', *Int. J. Eco. Res.*, pp.29–38.

Monteiro, J.A. (2009) *Pollution Havens: a Spatial Panel VAR Approach*.

Narayanan, B. (2013) *Trade and Environment*, Theory and evidence. Princeton University Press.

OECD (2008) *The Impact of Foreign Direct Investment on Corporate Social Responsibility*, 23–24 June [online] http://www.oecd.org/.

OECD (2011a) *China's Emergence as a Market Economy: Achievements and Challenges*, OECD Contribution to the China Development Forum, accessed April 2015.

OECD (2011b) *Towards Green Growth: Monitoring Progress* [online] http://www.oecd-ilibrary.org/ (accessed April 2015).

OECD (2013) *Foreign Direct Investment* [online] http://www.oecd-ilibrary.org/.

OECD (2014a) *Economic Outlook for Southeast Asia, China and India 2014* [online] http://www.oecd.org/.

OECD (2014b) *FDI Regulatory Restrictiveness Index* [online] http://www.oecdilibrary.org/; http://www.oecd.org/investment/fdiindex.htm (accessed April 2015).

OECD (2014c) *General Assessment of the Macroeconomic Situation*, OECD Economic Outlook, 2011, p.1.

Ramirez, M.D. (2006) 'A panel unit root and panel cointegration test of the complementarity hypothesis in the Mexican case: 1960–2001', *Atlantic Economic Journal*, Vol. 35, No. 3, pp.343–356.

Ridgeway, A. (2004) *Definition of Foreign Direct Investment* (*FDI*) *Terms*, Issues paper, p.20 [online] http://www.imf.org/.

Rivera, J. and Oh, A.C. (2013) 'Environmental regulations and multinational corporations' foreign market entry investments', *Policy Studies Journal*, 1 May, Vol. 41, No. 1, pp.243–272.

Stern, D.I. (2004) 'The rise and fall of the environmental Kuznets curve', *World Development*, Vol. 32, No 8, pp.1419–1439.

Williams, J. and Zhang, X. (2015) 'Explorations of inward foreign direct investment: US and China comparative analysis', *Journal of Finance and Accountancy*, March, Vol. 19, pp.52–56.

Xu, B. (2014) 'China's environmental crisis', *Council on Foreign Relations*, 25 April, p.5 [online] http://www.cfr.org/: http://www.cfr.org/china/chinas-environmental-crisis/p12608.

Zhang, Y-B., Yang, L., Wang, Z-S., Liu, Y. and Qu, A.H-M. (2014) 'Study on environmental effects and regulation of FDI in China', *Environmental Engineering and Management Journal*, May, Vol. 13, No. 5, pp.1–9.

Notes

1 FDI net flows are divided into two elements; the net inflow and the net outflow. The net inflow is the money earned by a country from the investment of a non-resident foreign investor in the reporting economy and containing reinvested earnings. The net outflow refers to the outward value of investments made by a resident of a country in another country, which benefits other countries' economies (UN, n.d.; Leino and Ali-Yrkkö, 2014).

2 For example Exxon-Mobil has publicly questioned the wisdom of the US in scrapping President Obama's 'clean energy' policy and expressed a strong wish to abide by the Paris agreement of 2016 (CNN International, Wednesday 29th March, 7 AM Report).