The economic growth and environment : evidence from Vietnamese cities

Pham Thi Ha
Graduate School of Economics, Kyushu University : Doctoral Program

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Pham Thi Ha[†]

Abstract

In this paper, we investigate the relationship between economic growth and industrial pollution emissions in Vietnam by using panel data for 63 provinces in Vietnam between 2000 and 2013. We examine three industrial pollution indicators including gaseous, solid waste and liquid waste. Our results suggest that all emissions rise with increases in economic growth at current income levels in Vietnam.

Key words: economic growth, gaseous, solid waste and liquid waste.

1. Introduction

Over the past three decades since "Doi Moi" (innovation) in late 1980s, Vietnam has strongly promoted policies towards socio-economic development and poverty alleviation through increased industrialization. The rapid industrialization from the early 1990s until now has been one of the key drivers that transformed Vietnam from a poor to middle-income country (Appendix 1). However, besides the gained marvelous achievements in socio-economic developments, Vietnam also has to pay a dear price and face a series of environmental challenges.

According to Vietnam Environment State Report published by Ministry of Natural Resources and Environment (MONRE) in 2010, it is estimated that the total economic loss resulting from environmental pollution in Vietnam accounts at least 1.5% to 3% of gross domestic product (GDP). Consequently, environmental problems must be identified and solutions put forward for environmental protection in the coming years in order to mobilize all resources necessary to fulfill the goals set in the ***"National strategy on environmental protection to 2020 and vision to 2030"***. Accordingly, the general objectives to 2020 are to control and minimize the increase of

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environment pollution, resource deterioration and biodiversity degradation; to further improve quality of the habitat; to raise the capability of responding climate change, striving for sustainable national development. With the visions to 2030 are to prevent and push back environment pollution, resource deterioration and biodiversity degradation; to improve quality of the habitat; to actively respond to climate change; to create fundamental conditions for a green economy, with low waste and low carbon, for the sake of the country's prosperity and sustainable development.

In this paper, we examine the relationship between economic growth and the environment in Vietnam. We make two specific contributions to the growth - environment literature. First, we focus on Vietnam given the undeniable strain such a large and rapidly growing economy is placing on the natural environment. Studies investigating these issues in Vietnam are relatively scarce. Second, we concentrate our analysis on Vietnamese cities and examine the city-level characteristics that influence industrial emissions. We believe the use of city-level variables provides more potential explanatory power than the use of highly aggregated variables reported at the national level.

The remainder of this paper is organized as follows. Section 2 provides literature review of economic growth and pollution. Section 3 provides the model specification and a description of data. Section 4 presents the empirical results, and the final section concludes.

2. Literature review

The interaction between environment and economic growth has been a subject of different approaches. Environmental Kuznets Curve (EKC) approach analyzes the effects of economic growth on different dimensions of environmental quality. Initiated by Grossman and Krueger (1991), studies in the EKC literature hypothesize that the negative scale effect tend to prevail in the initial states of economic growth, but after a threshold level of development it should be outweighed by the positive structural and technological effects. Following the paper in 1991, Grossman and Krueger (1995) used a cross country data set covering 58 countries in the 1980s and found the support of an inverse U-shape relationship between the income and pollution, i.e. pollution increases with income at low levels of income and decreases at high levels of income, with the turning point for most of the pollutants coming before a country reaches a per capita income of US$8,000 (Grossman and Kruger, 1995, p.370).

Different studies in the EKC literature employs different indicators such as carbon dioxide (CO_2), sulfur dioxide emissions (SO_2) (Boulatoff and Jenkins, 2010); urban air quality (Esty and Porter, 2005); deforestation (Ehrhardt-Martinez et al., 2002), and waste (Mazzanti et al., 2009). The empirical result is mixed, however. It is not possible to talk about unique curve for all types of environmental degradation, which raises doubts about the generalizability of the EKC hypothesis (Ozler and Obach, 2009).

Grossman and Krueger (1991) described three possible sources of environmental impact from economic growth: A scale effect, a technique effect, and composition effect; and, some studies have done in order to break down these effects. Panayotou (1997) argued that the determinants of environmental quality include: (1) the scale of economic activity (scale effects); (2) the composition of economic activity (composition effects), and (3) the effect of income on the demand and supply of pollution abatement efforts (pure income effects). The scale effect is expected to be a monotonically decreasing function of income while the income effect is monotonically decreasing function of income, all else being equal. The composition effect is likely to be a non-monotonic (inverted -U) function of income. Panayotou (1997) specified a cubic function form for all decomposition effects, with other variables including population density, the rate of economic growth and the quality of institutions. The results on ambient SO_2 levels confirmed the expectation of the three effects, and also suggested that policies and institutions can help flatten the EKC and reduce the environmental price of economic growth. De Bruyn et al. (1998) adopted a dynamic model and estimated for three types of emissions (CO_2, NO_X, and SO_2) in four developed countries (Netherlands, UK, US, and Western Germany). They found that these emissions may decline over time, probably due to structural and technological changes.

For individual countries, Vincent et al. (1997) found that suspended particulate matter (SPM) and chemical oxygen demand (COD) increase with income, while biochemical oxygen demand (BOD) decreases with income in Malaysia; whereas Carson et al (1997) found that all major air pollutants declined with increasing levels of income across 50 US states. In China, Shen (2006) used a simultaneous equations model to examine the existence of the EKC relationship between per capita income and per capita pollution emissions. Shen (2006) tested two air pollutants (SO_2 and dust fall) and three water pollutants (COD, arsenic, and cadmium) from 1993 to 2002 in 31 Chinese provinces and municipalities. The results suggested an EKC relationship for all water pollutants, while SO_2 showed a U-shaped relationship with income levels and dust fall has no significant relationship with income levels. In addition, government expenditure on pollution abatement had a significant, and negative, effect on pollution; while the net effect of secondary industries on pollution emissions were all positive and significant. In a related paper, Zhang (2013) used a panel of 112 Chinese cities over four years from 2001 to 2004 to examine the income-pollution nexus for several water and air pollution indicators. The majority of pollutant emissions confirmed that at current income levels in China, economic development will induce more industrial pollution emissions; whereas EKC was found to exist for wastewater and petroleum-like matter with the estimated turning point is US$ 3,605 and US$ 4,992 (at 1990 prices), respectively. Therefore, environmental policy and industrial structure both play important roles in determining water and air pollution levels in China.

Literature review on Vietnam

As Vietnam has become another successful Asian transition economy in terms of growth performance, the consequences of economic development on the environment has examined accordingly. To our knowledge, there are quite a few researches that investigate EKC hypothesis in Vietnam basing on time series data and CO_2 emissions variables for pollution have done with mixed results. Pham (2017) examined the relationship between foreign direct investment economic growth, and CO_2 emissions basing on time series data from 1988 to 2015, and revealed that pollution haven hypothesis does not exist in Vietnam; it is consistent with the outcomes of Al-Mulali et al (2015) and Dinh et al (2012). However, Tang and Tan (2015) confirmed the existence of EKC hypothesis and assumed an inverted U-shaped relationship between CO_2 emissions and economic growth.

For panel data study, there is only one study of Ramstetter (2011) that investigated the ownership and pollution in Vietnam's manufacturing firms in 2002 and 2004; due to the absence of previous studies examining the city-level characteristics that influence a city's pollution emissions; this paper therefore aims to at least partially fill this gap in the literature by examining the extent to which economic growth influences industrial pollution emissions in Vietnam using data for 63 cities between 2000 and 2013. We examine three industrial pollution indicators including gaseous, solid waste and liquid waste.

3. Data and methodology

The panel data for 63 provinces in Vietnam from 2000 to 2013 are extracted from the statistical yearbooks of General Statistics Office of Vietnam will be used in this research. All the values of per capita GDP are adjusted to 2010 prices using GDP deflator. Emissions data are reported in terms of total emissions for a large selection of key enterprises in each city; however the number of selected enterprises and the proportion of enterprises vary across cities. Such data cannot provide the information of total industrial pollution emissions at city-level; therefore General Statistics Office of Vietnam had to convert available pollution emissions of selected enterprises to the emissions of all the enterprises in the city. In this study, we assumed that the emissions per unit of industrial product are the same among cities. Total emissions are then scaled by population to form per capita emissions. Although, some limitations exist in the emissions data; but it is only available source to arrive at the total industrial pollution emissions in each city in Vietnam. Appendix table 1.2 and 1.3 provide summary statistics and a correlation matrix of variables, respectively.

In order to investigate the relationship between economic growth and environment, we start by estimating the following reduced-form equation for the emission of industrial pollutants:

$$\ln Epc_{it} = \gamma_i + \theta_t + \beta_1 \ln GDP_{it} + \varepsilon \quad (1)$$

$$\ln Epc_{it} = \gamma_i + \theta_t + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{it}^2 + \varepsilon \quad (2)$$

$$\ln Epc_{it} = \gamma_i + \theta_t + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{it}^2 + \beta_3 \ln GDP_{it}^3 + \varepsilon \quad (3)$$

Where Epc denotes per capita emissions including liquid waste, gaseous waste, and solid waste; γ is city - specific intercepts, θ_t is time - specific intercepts, GDP presents per capita income, ε is the error term. Subscripts i and t represent city and year, respectively.

We include per capita income (GDP), and then add its quadratic term (GDP^2) and finally the cubic term (GDP^3). If a linear regression is considered, we expect a positive relationship between income and pollution at current economic development levels in Vietnam. If a quadratic function is estimated, we expect a standard EKC relationship (inverted-U) between income and pollution, that is $\beta_1 > 0$ and $\beta_2 < 0$. Following Grossman and Krueger (1995), we expect negative β_1 and β_3 and a positive β_2 in the cubic functions.

In order to avoid the problem that the model is whether the unobserved individual-specific effects and time effects, we estimate two-way fixed effects and random effects error component models. For our fixed effects models we initially use the within regression estimator, which is a pooled OLS estimator based on time - demeaned variables, or uses the time variation in both dependent and independent variables within each cross-sectional observation (Wooldridge, 2000). For the random effects models, we choose the generalized least square (GLS) estimator, which produces a matrix-weighted average of the between and within estimator results.

The equations are estimated using two alternative functional forms in logs so as to reduce the positive skewness of all the dependent and independent variables. We estimated both fixed and random effects models. Hausman specification tests were performed to discover whether the random effects model was appropriate and suggest that the random effects estimator was not efficient and therefore we focused on the fixed effect results. Time dummy variables are included for all estimations.

We tested for heteroskedasticity and cross-sectional correlation across panels, and the results rejected the null hypothesis of homoscedasticity and cross-sectional correlation; therefore we employed Feasible Generalised Least Square (FGLS) in order to correct them as well as the presence of AR(1) autocorrelation within panels. The FGLS estimation results are reported in Table 1.

4. Empirical results

In the Table 1, columns 1, 4, 7 and 2, 5, 8 provide linear and quadratic specifications of the simple relationship between income and emissions with no further controls. The quadratic specification (columns 2, 5, and 8) provides a direct test of the EKC hypothesis. Columns 3, 6 and

9 illustrate the results of cubic function.

Gaseous waste

Column 1 for gaseous waste shows a statistically significant and positive relationship between income and emissions of gaseous. It confirms our expectation that economic growth induces more gaseous waste pollution at current income levels for all cities in Vietnam. The income elasticity is approximately 0.364, indicating that a 1 per cent increase in per capita income will increase per capita emissions of gaseous by 3.64 per cent. It is consistent with the findings in Shen (2006) and Zhang (2013).

When a quadratic specification is considered, we could not find an inverted - U shaped relationship between income and per capita emissions. The relationship between quadratic income and gaseous waste per capita is significant at 1 per cent but it is positive, indicating that economic growth is increasing environmental pollution levels in Vietnam, and most Vietnamese cities are on the up sloping part of the curve; however there is a decrease slightly when a 1 per cent increase in per capita income only results in going up of gaseous waste by 2.3 per cent approximately.

Column 3 shows the result of cubic relationship, the sign of income elastic is positive (0.223) and significant at 1 per cent; it confirms that the increase in income still induces more gaseous waste in Vietnam.

Solid waste

The result of solid waste in column 4 is almost the same result of gaseous waste in column 1 when a 1 per cent increase in per capita income will increase per capita of solid waste by 3.47 per cent. Thus, economic growth causes the rise of gaseous and solid waste at the same rate in provincial level in Vietnam. For the consideration of quadratic specification, the income elastic is negative (-0.294) but it is insignificant; therefore it could not provide evidence of an inverted -U EKC relationship.

Column 6 provides the results to support the conclusion of economic development which leads to the growth of gaseous and solid waste at the same level, around 22 per cent.

Liquid waste

In respect to liquid waste, the coefficient of linear specification indicates that economic growth induces more liquid waste than gaseous and solid waste, a 1 per cent in per capita income causes approximate 4 per cent in liquid waste (3.64, and 3.47 per cent for gaseous and solid waste, respectively). It is supported the results of Zhang (2013).

An inverted - U shaped relationship between income and per capita emissions is not exist here when the elastic of quadratic function is significant but it is positive (0.203). The coefficients of per capita income and quadratic per capita income are around 20 per cent; indicating that at higher income levels, the increase of pollution emissions is still the same.

The result of cubic function is positive and significant at 1 per cent level. It is 0.159 and smaller than the coefficients of linear and quadratic function (0.397, and 0.203 respectively); hence the increase in income level will decrease liquid waste significantly.

Table 1 FGLS results

	Gaseous waste			Solid waste			Liquid waste		
Variables	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
GDP	0.364	0.159	0.078	0.347	0.374	0.294	0.397	0.217	0.160
	(11.61)***	(2.38)**	(1.15)	(7.19)***	(3.62)***	(2.78)***	(3.432)***	(3.31)***	(2.38)**
GDP^2		0.2327	0.143		-0.294	-1.118		0.203	0.1397
		(3.5)***	(2.10)**		(0.29)	(1.11)		(3.10)***	(2.06)**
GDP^3			0.223			0.221			0.159
			(4.89)***			(3.09)***			(3.51)***
Constant	3.621	3.467	3.164	3.324	3.343	3.044	3.432	3.299	3.082
	(19.85)***	(18.59)***	(16.30)***	(11.81)***	(11.55)***	(10.02)***	(19.10)***	(17.93)***	(15.99)***
EKC		No			No			No	
Observations	869	869	869	818	818	818	869	869	869

Notes: Absolute value of z-statistics in parentheses. All variables are in logs. *, **, and *** indicate significant at 10%, 5%, and 1%, respectively.

5. Conclusion

In this paper, we used a panel of 63 Vietnamese cities over 14 years to examine the income – pollution nexus for gaseous, solid and liquid waste. The evidence from the majority of pollutant emissions confirms that at current income levels in Vietnam, economic development will induce more industrial pollution emissions, that is, the net effect of economic growth on environment quality is negative. Notably, the increase in income induces more liquid waste than gaseous and solid waste due to large amount of waste water discharged from industrial zones, and manufacturing establishments without properly treatment as well as the subsectors significantly contributed in water pollution[1]. In addition, the environmental Kuznets curve is not found to exist in Vietnam at provincial level, indicating that Vietnamese economy is still at the initial stages of development. It is consistent with the finding of Pham (2017), Al-Mulali et al (2015), and Dinh et al (2012) for the studies of Vietnam; and Mattew et al (2011) for the case of China.

The largely positive relationship between income and emissions suggests that the increased stringency and enforcement of environmental regulations are crucial to alleviate pressure on the

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natural environment in Vietnam. For further research, it should be possible to explore panel estimates across regions in Vietnam by adding other variables such as energy consumption (Tang et el. 2015, Al-Mulali et al 2015), factor demand, and technology intensity (Ramstetter et el. 2013) as well as other waste emissions and ownership data to gain more understanding of the issues.

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Appendix Table 1.1

Economic growth and social welfare gain

Year	GDP growth (%)	GDP per capita (US$)	Year	GDP growth (%)	GDP per capita (US$)
1986	2.3	202	2001	6.9	416
1987	3.6	205	2002	7.1	441
1988	6	211	2003	7.3	492
1989	4.7	220	2004	7.8	558
1990	5.1	227	2005	8.4	642
1991	6	235	2006	7	797
1992	8.7	251	2007	7.1	919
1993	8.1	266	2008	5.7	1,165
1994	8.8	285	2009	5.3	1,232
1995	9.5	301	2010	6.4	1,334
1996	9.3	337	2011	6.2	1,543
1997	8.2	261	2012	5.3	1,755
1998	5.8	365	2013	5.4	1,909
1999	4.8	374	2014	5.9	2,357
2000	6.8	402	2015	6.2	2,520

Source: Vietnam, General Statistics Office yearbook 1994-2015

Appendix Table 1.2

Descriptive statistics of variables

Variable	Obs.	Mean	Std.Dev.	Min	Max
Gas waste (m3 per 1000 persons)	869	3029.7323	9370.5901	18.7030	56242.2441
Liquid waste (m3 per 1000 persons)	869	1208.9977	10316.0699	2.2639	61898.6837
Solid waste (tons per 1000 persons)	818	21253.0463	71439.7039	1.4917	428639.7153
GDP (billion VND per 1000 persons)	882	18.4747	37.3072	1.9494	225.7928

Appendix Table 1.3

Correlations of the variables

	Gas waste	Liquid waste	Solid waste	GDP	GDP^2	GDP^3
Gas waste	1.0000					
Liquid waste	-0.0515	1.0000				
Solid waste	0.1786	-0.1393	1.0000			
GDP	0.0805	-0.0792	0.1470	1.0000		
GDP^2	0.0970	-0.0545	0.1127	0.8663	1.0000	
GDP^3	0.0616	0.0289	0.0334	0.6151	0.5867	1.0000