

## **Working Paper**

### **NAFTA, Environmental Kuznets Curves, and Mexico's Progress**

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#### Abstract

The North American Free Trade Agreement generated much debate about the effects of freer and more open trade on the environment. Many environmentalists believed increased trade would lead to environmental degradation, while many economists argued that increased trade would enrich countries, leading to environmental improvement. Substantial empirical work supported an Environmental Kuznets Curve in which rising income increases pollution until a certain threshold is reached, after which pollution diminishes. In this paper we examine Mexico's environmental record in the pre- and post-NAFTA periods. The evidence shows that although Mexico's environmental quality has improved by some measures, by most measures it has deteriorated. We conclude that economic growth has been insufficient to bring widespread environmental improvement.

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## 1. Introduction

Environmental Kuznets Curves (EKC) emerged on the scene in 1991 when Eugene Grossman and Alen Kreuger, two Princeton economists, produced a path-breaking working paper that reported a strong statistical relationship between some commonly used measures of environmental quality and per capita income for a cross section of countries.<sup>2</sup> The Grossman-Kreuger innovation brought important focus to debates surrounding the relative merits of the North American Free Trade Agreement (NAFTA) and spawned a cottage industry. Literally hundreds of EKC studies have been published.<sup>3</sup> Innocent enough when viewed in a diagram or on a chalkboard, EKCs shed some important light on the possibility of having more income and more environmental quality.

So what is an EKC? An EKC is a simple graphical device that shows a mapping of a specific measure of environmental quality, let us say the concentration of SO<sub>2</sub>, into per capita income or GDP for a sample of countries, or for a specific geographic location, for example, Mexico, across time. A generic EKC for SO<sub>2</sub> is shown in Figure One.<sup>4</sup>

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<sup>2</sup> Gene M. Grossman and Alan B. Krueger, *Environmental Impact of a North American Free Trade Agreement*, Working Paper 3914, Cambridge, MA: National Bureau of Economic Research (1991).

<sup>3</sup> See Bruce Yandle, Bhattarai Madhusudan, and Maya Vijayaraghavan, *Environmental Kuznets Curves: A Review of Findings, Methods, and Policy Implications*, RS-01-1a, Bozeman, MT: Property and Environmental Research Center (2004).

<sup>4</sup> See Xiang Dong Qin, *Economic Development and Environmental Quality: A Closer Look at Environmental Kuznets Curves*, Dissertation, Clemson University, Clemson, SC (1998). Qin's estimate

The neat inverted U-shaped curve shown here is for a sample of 14 countries with data points for six years for each country. The EKC indicates that SO<sub>2</sub> concentration increases as per capita GDP rises from very low to intermediate levels. Then, a point is reached where SO<sub>2</sub> concentration diminishes with further per capita GDP improvements. Notice that there are two EKCs in Figure One. When the quadratic form was estimated, an index for property rights enforcement was included. The lower EKC is for those countries in the sample with stricter property rights enforcement. One can infer that property rights matter.<sup>5</sup>

Grossman's and Krueger's EKC discovery was born out of the 1990s' debate regarding the North American Free Trade Agreement (NAFTA), which was ratified in 1994. Opponents for opening the door wider for trade between the United States and Mexico raised a number of objections. Some were predictable: With NAFTA U.S. manufacturers would relocate industrial plants and jobs to Mexico. As 1992 presidential candidate Ross Perot put it, "NAFTA will cause a giant sucking sound as jobs go south."<sup>6</sup> Put differently, the United States would succumb to a dramatic race to the

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used SO<sub>2</sub> World Bank data for a balanced panel of 14 countries for the years 1981-86. He introduced a property rights enforcement indicator variable from Business Environmental Risk data.

<sup>5</sup> SO<sub>2</sub> EKCs like this one have been estimated many times for different country samples. Invariably, the estimates look a lot like this one. But not all EKC relationships turn out to be so optimistically shaped. Each pollutant is a case unto itself; different country groups may have different preferences for environmental quality and income.

<sup>6</sup> Ross Perot, *Save Your Job, Save Our Country*, New York: Hyperion, [http://www.ontheissues.org/Archive/Save\\_Your\\_Job\\_Ross\\_Perot.htm](http://www.ontheissues.org/Archive/Save_Your_Job_Ross_Perot.htm), visited March 1, 2009 (1992).

bottom. Industrial firms would pull up stakes and move to avoid stricter U.S. environmental regulation.<sup>7</sup> There was also concern that Mexico would not enforce safety and health regulations for protecting workers. But the environment became the galvanizing issue when Public Citizen, Friends of the Earth and the Sierra Club brought suit against the Office of the U.S. Trade Negotiator complaining that NAFTA should be subject to an environmental impact statement,<sup>8</sup> a suit that was ultimately decided in favor of the Office of the U.S. Trade Negotiator by the D.C. Court of Appeals.<sup>9</sup>

The opposing voices staked out a logical position. Yes, hungry people in developing communities are more apt to be concerned about filling their stomachs and warding off disease than clearing the air to observe beautiful landscapes. Logic was joined by emotion; America was in the midst of an environmental saga that was assigning high value to enhanced environmental quality, but environmental leaders were convinced that economic growth was the cause of environmental degradation. As seen in the eyes of some, free markets and environmental quality were mortal enemies. The Sierra Club and other environmental organizations were riding high. NAFTA, it seemed, might be scuttled to avoid an unfortunate environmental catastrophe.

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<sup>7</sup> A review of this debate is provided in Bruce Yandle, *Is Free Trade the Enemy of Environmental Quality*, Terry L. Anderson, editor, NAFTA and the Environment, San Francisco: Pacific Public Policy Institute, 1-11 (1993).

<sup>8</sup> Public Citizen v. USTR, 782 F.Supp. 139, 140 D.D.C. (1992)

<sup>9</sup> 970 F.2d 916,297 U.S.App.D.C.287.

As the debate roared on, Grossman and Krueger, decided to “count the teeth.” Since no one really knew the relationship between income growth, which was a fundamental basis for NAFTA support, and environmental quality, though many people thought they did, the two economists decided to get their hands in some data. They saw the environmental arguments opposing NAFTA as a refutable hypothesis that could be tested with data. To do this, they assembled panels of World Bank data on air quality and per capita GDP data for a sample of 42 countries for SO<sub>2</sub> emissions and 19 for smoke. They then built and estimated statistical models to find the relationship between GDP and environmental quality.

Their 1991 report supported the notion that lower income countries did accept higher levels of air pollution. The results also indicated that higher income countries were associated with lower, not higher, levels of air pollution. The trick, of course, was how to get lower income countries locked into a path of economic growth. They called the inverted bowl-shaped relationship an Environmental Kuznets Curve. And they identified the turning point, the range of per capita GDP where the race to the bottom ended, and the race to top begins. The range of per capita GDP at the turning point was roughly \$7,800 to \$9,800 in 2008 dollars for sulfur dioxide and smoke.<sup>10</sup> (No turning point was found for suspended particulates, which they also estimated.<sup>11</sup>)

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<sup>10</sup> Grossman and Krueger, 1991. The initial 1991 value has been adjusted by applying the CPI.

<sup>11</sup> Later researchers obtained similar results to Grossman-Krueger, but sometimes with significantly higher income turning points. See Thomas M. Seldon and Daqing Song, *Development and the Environment: Is there a Kuznets Curve for Air Pollution?* 27 *Journal of Environmental Economics and Management*, 147-162 (1994) and generally the review provided by Yandle, Bhattarai, and Vijayaraghavan.

Interestingly enough, Mexico's per capita GDP at the time fell within the EKC turning point range. One could infer that if NAFTA generated higher GDP for Mexico, then the people of Mexico would demand improved air quality. Now the EKC estimates didn't tell us how all this would happen. They just suggested that environmental quality would improve with NAFTA-generated income, not deteriorate, at least for SO<sub>2</sub> and smoke.

We argue that each point on an EKC is associated with different institutions for protecting environmental quality.<sup>12</sup> We note that such protection is costly. Income growth is necessary to support the use of low-polluting machinery and for the operation of the institutions that protect environmental quality. Movement beyond the turning point requires income growth.

During the 2008 presidential campaign, the NAFTA debate reemerged. On April 20, 2009, Ronald Kirk, the U.S. Trade Negotiator, indicated that President Obama would not, as promised, reopen the North American Free Trade Agreement (NAFTA) in an effort to strengthen the labor and environmental protection provisions contained in the agreement.<sup>13</sup> Mr. Kirk's comments were newsworthy for one principle reason: Candidate

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<sup>12</sup> On this, see Indur M. Goklany, *Clearing the Air: The Real Story about the War on Air Pollution*, Washington: Cato Institute (1999) and Andrew H. Morriss and Bruce Yandle, *The Technologies of Property Rights: Choice Among Alternative Solutions to Tragedies of the Commons*, 28 *Ecology Law Quarterly* 123-168 (2001).

<sup>13</sup> Brian Knowlton, *Obama Doesn't Plan to Reopen NAFTA Talks*. *The New York Times*, April 20. [http://www.nytimes.com/2009/04/21/business/21nafta.html?\\_r=1](http://www.nytimes.com/2009/04/21/business/21nafta.html?_r=1). Visited May 4, 2009 (2009).

Obama had been sharply critical of NAFTA and indicated that, if elected, he would reopen the agreement in order to add teeth to the provisions that protected American jobs and the environment. Candidate Obama's position was strongly supported by organized labor and the environmental community. Both groups expressed concern about the relationship between economic growth fostered by NAFTA and environmental quality. This concern and Mr. Obama's response seemed to suggest that Mexico's post-NAFTA economy had prospered somewhat and that Mexico's environment had simultaneously deteriorated.

While Grossman and Kreuger's path-breaking work established a basis for assessing the outlook for environmental quality in the context of income growth and focused specifically on the prospects for Mexico, there has been little in the way of before and after EKC statistical assessment of environmental data to determine what happened. Making that assessment is the fundamental purpose of this paper.

Our paper is organized in the following way: Section 2 reviews NAFTA, some of its key elements, and assessments that have been made of its environmental effects. Section 3 provides our statistical examination of important environmental variables in Mexico. We summarize our finding in Section 3 and offer final thoughts in the paper's last section. Our findings suggest that Mexico's income growth since NAFTA has not been large enough to push the country beyond the EKC turning point range. Said differently, we find no evidence of a race to the bottom or a race to the top. Mexico apparently remains at the turning point. The race to the top is yet to occur.

## 2. NAFTA: Background and Outcomes

The NAFTA treaty is unique among trade agreements for its environmental awareness and concerns. As stated in the preamble, the founding governments resolved to “strengthen the development and enforcement of environmental laws and regulations.”<sup>14</sup>

This lofty tribute to environmental quality is backed by an extensive institutional structure. The centerpiece is the environmental side agreement, known as the North American Agreement on Environmental Cooperation. Some argue this agreement is tarnished because it was “more the product of the US legislative battle over the NAFTA than the result of an acute environmental conscience in the governments of Canada, Mexico, and the United States.”<sup>15</sup> Whatever the impetus for the Agreement, its stated objectives include environmental protection and improvement, sustainable development, pollution prevention, and cooperation among the member states in these and other objectives.<sup>16</sup> To achieve these ends, countries are to set and enforce their own environmental standards and respect each other’s autonomy.<sup>17</sup> Each government is also

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<sup>14</sup> NAFTA Treaty Preamble, available at <http://tech.mit.edu/Bulletins/nafta.html>.

<sup>15</sup> Gary Clyde Hufbauer; Daniel C. Esty; Diana Orejas; Luis Ribio; and Jeffrey J. Schott, *NAFTA and the Environment: Seven Years Later*. Institute for International Economics, Washington, DC (2000), 17.

<sup>16</sup> North American Agreement on Environmental Cooperation, Article 1, available at at [www.worldtradelaw.net/nafta/naaec.pdf](http://www.worldtradelaw.net/nafta/naaec.pdf).

<sup>17</sup> North American Agreement on Environmental Cooperation, Articles 3 and 5, available at [www.worldtradelaw.net/nafta/naaec.pdf](http://www.worldtradelaw.net/nafta/naaec.pdf).

expected to recognize the rights of private parties to seek redress if such a party finds its country's environmental laws and regulations violated.<sup>18</sup>

### **The Institutional Framework**

To implement its objectives, the NAAEC established the Commission for Environmental Cooperation. This governing body is charged with encouraging cooperation among member countries, ensuring the implementation of appropriate environmental legislation, and resolving environmental disputes.<sup>19</sup>

A special concern is pollution along the U.S.-Mexican border. To address this concern, these countries agreed in 1993 to establish the Border Environment Cooperation Commission and the North American Development Bank, under the auspices of the U.S.-Mexico Border Environmental Cooperation Agreement. These agencies have the authority to “evaluate, certify, and help fund environmental projects.”<sup>20</sup> The BECC certifies infrastructure projects for the NADB, which provides management assistance, grants, loans, and loan guarantees.<sup>21</sup> Recognizing the dramatic population growth and economic development in the region, and the accompanying environmental impacts, the countries agreed in 1996 to the Border XXI Program. Building on the 1983 Agreement

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<sup>18</sup> North American Agreement on Environmental Cooperation, Article 6, available at [www.worldtradelaw.net/nafta/naaec.pdf](http://www.worldtradelaw.net/nafta/naaec.pdf).

<sup>19</sup> North American Agreement on Environmental Cooperation, Article 10, available at [www.worldtradelaw.net/nafta/naaec.pdf](http://www.worldtradelaw.net/nafta/naaec.pdf) and Gary Clyde Hufbauer and Jeffrey J. Schott, *NAFTA Revisited: Achievements and Challenges*. Institute for International Economics, Washington, DC (2005).

<sup>20</sup> Hufbauer and Schott, 157.

<sup>21</sup> Hufbauer, Esty, Orejas, Rubio, and Schott, 43-47.

for the Protection and Improvement of the Environment in the Border Area (La Paz Agreement), the Border XXI Program is designed to “achieve a clean environment, protect public health and natural resources, and encourage sustainable development.”<sup>22</sup> These goals are implemented through the efforts of nine workgroups that address water pollution, air pollution, hazardous and solid waste, pollution prevention, contingency planning and emergency response, cooperative enforcement and compliance, environmental information resources, natural resources, and environmental health.<sup>23</sup>

The presence of an institutional structure for environmental protection does not guarantee its achievement. Many critics of the NAFTA Treaty have called into question its effects on the environment and the validity of the EKC itself. To assess the effects of the NAFTA Treaty on the environment, in particular Mexico’s environment, we first examine a number of earlier studies.

### **Reported Evidence on Outcomes**

As explained earlier, the assumption that trade will improve environmental conditions is predicated on the assumption that trade raises incomes and that higher incomes, in turn, bring about improved environmental quality. This is the essence of the theory behind the EKC. But, how does this happen?

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<sup>22</sup> Border XXI Program Framework. Document available at [www.epa.gov/border2012/docs/borderXXIprogram-archieive.pdf](http://www.epa.gov/border2012/docs/borderXXIprogram-archieive.pdf).

<sup>23</sup> Border XXI Program Framework. Document available at [www.epa.gov/border2012/docs/borderXXIprogram-archieive.pdf](http://www.epa.gov/border2012/docs/borderXXIprogram-archieive.pdf).

Support for the EKC is based largely on the technique effect, the reduction in pollution resulting from the increased use of pollution abatement equipment and cleaner technologies.<sup>24</sup> However, counterarguments abound. By increasing economic output, total pollution may rise, despite the employment of pollution abatement equipment and cleaner technologies, an effect commonly known as the scale effect.<sup>25</sup> A further concern is that mobile firms will migrate to countries with the laxest environmental standards and enforcement, a location effect that results in pollution havens.<sup>26</sup> If increased competition leads to lower environmental standards (the competition effect or downward harmonization) or if environmental regulations are trumped by trade rules (the regulatory effect), the environment may suffer all the more.<sup>27</sup>

The evidence for Mexico is mixed. In a detailed study of U.S.-Mexican trade, Gamper-Rabindran examines U.S. imports from Mexico to see if their composition changed in the post-NAFTA years. If U.S. imports from Mexico became more pollution intensive, the data would support the hypothesis that NAFTA resulted in Mexico as a haven for pollution intensive industries. As the author puts it, the key question is whether

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<sup>24</sup> See Kevin P. Gallagher, *Free Trade and the Environment: Mexico, NAFTA, and Beyond*, Stanford University Press, Stanford (2004) and Shanti Gamper-Rabindran, *Nafta and the Environment: What Can the Data Tell Us?* 54 *Economics Development and Cultural Change*, 605-633 (2006).

<sup>25</sup> See Commission for Environmental Cooperation. *Free Trade and the Environment: The Picture Becomes Clearer*, Commission for Environmental Cooperation of North America, Montreal, (2002) and Gallagher and Gamper-Rabindran.

<sup>26</sup> See Commission for Environmental Cooperation and Gallagher.

<sup>27</sup> See Commission for Environmental Cooperation.

or not NAFTA caused “growth of U.S. import intensity in dirty industries relative to clean industries.”<sup>28</sup> The author examined industry data (SIC-4 level) for a variety of air pollutants (PM-10, CO, SO<sub>2</sub>, NO<sub>2</sub>, and VOCs) and toxic materials. The author’s results “do not support the claim that U.S. import intensity grew in the dirtier industries relative to cleaner industries during the NAFTA transition.”<sup>29</sup> Further, the author finds that Mexico’s imports of pollution abatement equipment increased.

Yet, other studies show increases in pollution. The Commission for Environmental Cooperation, in an effort to better assess NAFTA’s environmental impact, summarized a host of studies in a 2002 publication. The findings vary across the pollutants considered, but among the most important are these: air pollution is marginally greater; the threat of invasion by alien species is greater; freight transport has increased, resulting in a commensurate increase in air pollution, especially in the border area; fisheries and forest have been affected very little; and evidence of pollution havens is weak.<sup>30</sup>

Pollution havens are unlikely because abatement costs are generally too small to affect firm location, especially when compared to the costs of moving. Furthermore, many firms prefer to remain close to their product markets. Nevertheless, Mexico’s air pollution has worsened in the post-NAFTA era. If Mexico is not a pollution haven, why has air pollution worsened? The answer is simple: the scale effect. Moreover, Mexico’s

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<sup>28</sup> Gamper-Rabindran, 610.

<sup>29</sup> Gamper-Rabindran, 615 and 617.

<sup>30</sup> See Commission for Environmental Cooperation.

production techniques are generally more pollution intensive than those in the U.S., though there are important exceptions, such as Mexico's cement and iron and steel industries, which are cleaner than their U.S. counterparts because of greater energy efficiency and a cleaner fuel mix.<sup>31</sup>

In the border region environmental conditions are often poor and deteriorating, especially with respect to water pollution, inadequate sewage treatment, and inadequate and inappropriate disposal of hazardous and solid waste, even though Mexico has not become a pollution haven, and the U.S. and Mexico have not competed to lower environmental standards.<sup>32</sup>

Nevertheless, blame on NAFTA may be blame misplaced. While assessing the counterfactual is admittedly problematic, all parties, those who favor NAFTA and those who oppose it, must acknowledge that the border region would have experienced strong economic and population growth, leading to greater pollution, even without NAFTA. Indeed, environmental degradation may have been worse without NAFTA. Mexico's program of voluntary compliance has had good results, especially for large firms, and NAFTA's institutional structure encourages pro-environmental legislation and enforcement, even if it is underfunded.<sup>33</sup>

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<sup>31</sup> Gallagher.

<sup>32</sup> Hufbauer, Esty, Orejas, Rubio, and Schott and Hufbauer and Schott.

<sup>33</sup> Hufbauer, Esty, Orejas, Rubio, and Schott and Hufbauer and Schott.

Much of the blame lies with inadequate Mexican infrastructure and a lack of institutions for protecting environmental quality. Mexican municipalities depend almost exclusively on the national government for funding. They have little fiscal authority and lack a civil service tradition that, in the U.S., leads to better infrastructure for border localities. Starved for tax revenues, Mexican municipal governments are ill-equipped to deal with the environmental problems they face.<sup>34</sup>

In an effort to further assess NAFTA's impact, we examine a number of important pollutants in Mexico. We now turn to these findings.

### **3. Taking a Closer Look at a Sample of Key Environmental Indicators**

To better determine what has happened to Mexico's environment, we examine some key water and air pollutants.<sup>35</sup> On the whole, the results show that Mexico's environment has worsened in the post-NAFTA period, though there are some important exceptions.

#### **What about Water Emissions?**

Two exceptions are the share of population with access to improved water and sanitation. From 1990 to 2004 the share of Mexico's population with access to improved water rose from 82 to 97 percent, and the share of Mexico's population with access to improved sanitation rose from 58 to 79 percent. Over this period, Mexico's RGDP per capita

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<sup>34</sup> Hufbauer, Esty, Orejas, Rubio, and Schott and Hufbauer and Schott.

<sup>35</sup> All pollution data in this paper are taken from the World Resources Institute available at [www.wri.org](http://www.wri.org). Per capita real GDP (RGDP) data are taken from the Penn World Tables available at [www.pwt.econ.upenn.edu](http://www.pwt.econ.upenn.edu). The per capita RGDP are chained 2000 dollars adjusted for purchasing power parity.

increased from \$8,582 to \$10,208 (2008 dollars) for an annualized rate of increase of 1.25 percent, a finding consistent with the EKC hypothesis.

On the other hand, an examination of other pollutants reveals demonstrably poorer outcomes. For example, organic water pollution emissions (biochemical oxygen demands) have risen significantly from 1980 to 2000, whether measured in total or per capita terms. In total, BOD emissions rose from 130,933 kilograms per day to 296,093 kilograms per day. In per capita terms, BOD emissions rose from 0.00193 kilograms per day to 0.00296 kilograms per day. We note that in a 1995 study, Grossman and Krueger replicated their earlier finds and extended their EKC analysis to other pollutants. The estimated turning point for BOD emissions was \$14,977 in 2008 dollars.<sup>36</sup> Apparently, Mexico's income growth fell short of the turning point for this pollutant.

What is particularly telling, as shown in Figures 2 and 3, is the reversal of trends from the pre- to post-NAFTA periods. (Post-NAFTA is defined as 1994 and later years.) While the number of years is small, it is clear that BOD emissions, in total and per capita, were declining in the pre-NAFTA years, but have risen in the post-NAFTA years.<sup>37</sup> Tests of structural stability indicate that regressions of the pre- and post-NAFTA periods are

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<sup>36</sup> See Gene M. Grossman and Alan B. Krueger, *Economic Growth and the Environment*, 110 *Economic Journal*, 353-377 (1995) discussed in Yandle, Bhattarai, and Vijayaraghavan.

<sup>37</sup> Both regressions of total BOD emissions are statistically significant, with F-values of 7.38 for the pre-NAFTA period and 84.55 for the post-NAFTA period. For the regressions of per capita BOD emissions, neither regression is significant, with F-values of 2.03 for the pre-NAFTA period and 0.43 for the post-NAFTA period.

significantly different.<sup>38</sup> Although Mexico's per capita RGDP over this period rose from \$9,090 to \$10,104 in 2008 dollars, it falls short of the expected turning point level for these emissions. Perhaps it is worth pointing out that the annualized growth rate of per capita RGDP was only 0.53 percent over this period, which was marked by severe recessions in 1982-83, 1986-88, and 1995.<sup>39</sup> Very likely, it is unreasonable to expect environmental improvement in a country that has yet to reach or barely reached expected turning points, and in which the likelihood of deep and lengthy recessions weighs heavy in the minds of politicians and citizens alike. Economic crises may simply take precedence over environmental quality.<sup>40</sup>

### **What about Air Emissions?**

Turning to air pollution, we find similar results for carbon monoxide, nitrogen oxide, and sulfur dioxide emissions. In each case, at least in per capita terms, emission levels fell from 1990 to 1995 during the early NAFTA years only to rise significantly from 1995 to 2000.<sup>41</sup> Perhaps Mexico has yet to reach the required per capita income level to yield

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<sup>38</sup> The F-statistic for the test of structural stability for the totals regressions is 180.8, and the F-statistic for the test of structural stability for the per capita regressions is 62.2.

<sup>39</sup> Per capita RGDP fell 10.4 percent during the 1982-83 recession, 7.9 percent in the 1986-88 recession, and 7.9 percent in the 1995 recession.

<sup>40</sup> Gallagher.

<sup>41</sup> In per capita terms, carbon monoxide emissions fell from 0.154066 thousand metric tons in 1990 to 0.1434 thousand metric tons in 1995, but then rose to 0.20577 thousand metric tons in 2000. For per capita nitrogen oxide and sulfur dioxide emissions the pattern is similar: in thousands of metric tons, nitrogen

widespread environmental improvement. Or, if it has, the periodic macroeconomic crises the country has faced may have diverted political attention from environmental concerns. Either way, Mexico does not appear to be the poster child for EKC turning points.

Of particular contemporary concern are greenhouse gases that are often considered an exception to the EKC hypothesis, or perhaps more realistically, the turning points for these emissions are there but at much higher income levels.<sup>42</sup> For example, Dutt estimated a turning point for per capita carbon dioxide emissions that falls in a range centered on \$36,800 in 2008 dollars.<sup>43</sup>

As expected of a developing country and shown in Figures 4 and 5, Mexico's carbon dioxide emissions have risen steadily in total and per capita terms over the last half of the 20<sup>th</sup> century and the first few years of the 21<sup>st</sup>. Regression estimates of these equations are highly significant in statistical terms.<sup>44</sup> But, did NAFTA make a difference? For total emissions, the evidence is not supportive. As shown in Figure 6, the slope on

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oxide emissions fell from 0.017529 to 0.01712 from 1990 to 1995, only to rise to 0.022545 in 2000 while sulfur dioxide emissions fell from 0.024988 in 1990 to 0.024324 in 1995, only to rise to 0.029316 in 2000.

<sup>42</sup> Yandle, Bhattacharai, and Vijayaraghavan.

<sup>43</sup> See Kuheli Dutt, *Governance, Institutions and the Environment-Income Relationship: a Cross-Country Study*, Environment, Development and Sustainability, published on line January 25, 2008 <http://www.springerlink.com/content/661x3u658wk81507/> Visited March 1, 2009 (2007).

<sup>44</sup> F-values for the total CO<sub>2</sub> emissions regression and the per capita CO<sub>2</sub> emissions regression are 492.5 and 1,038.0, respectively.

carbon dioxide emissions differs little between the pre- and post-NAFTA periods.<sup>45</sup> In regression tests for differences in intercept and slope terms, the slopes of the pre- and post-NAFTA regressions are not statistically different.<sup>46</sup>

When estimated in per capita terms, as shown in Figure 7, carbon dioxide emissions, while still growing, are growing at a slower rate in the post-NAFTA period.<sup>47</sup> Again, using regression analysis, we can test for differences in intercepts and slopes. In this case, slope differences are significantly different.<sup>48</sup> Our finding is weakly supportive of the Dutt result discussed earlier. While carbon dioxide emissions are still rising, the rate of increase, at least for per capita emissions, has slowed since the implementation of the NAFTA treaty. Still, there is no sign of an EKC turning point as indicated by the strong fit of the linear model.

### **Seeking an Explanation**

To summarize, Mexico's environmental record shows little improvement in the post-NAFTA period. While a larger share of the population has access to improved water and sanitation, emissions of every other measure of pollution considered in this paper have increased. Of particular note, emissions of headlines-grabbing greenhouse gases continue

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<sup>45</sup> Both regressions are highly significant with F-values of 333.8 for the pre-NAFTA period and 60.5 for the post-NAFTA period.

<sup>46</sup> The t-statistic on the interaction term is -0.35.

<sup>47</sup> These regressions too are highly significant with F-values of 655.2 for the pre-NAFTA period and 21.9 for the post-NAFTA period.

<sup>48</sup> The t-statistic on the interaction term is -2.43.

to increase in total and per capita terms, though the rate of increase has diminished in per capita terms in the post-NAFTA period.

If EKC's have predictive power, they should provide insight into why Mexico's environment has failed to improve as optimists hoped and predicted. The key factor in EKC analysis is income, and it is here that we find a plausible explanation for Mexico's often disappointing environmental performance. From 1994 to 2004, Mexico's per capita real GDP rose at an annualized growth rate of only 1.1 percent. Further, this slow growth was marred by recessions in 1995 and 2001-2002, in which real GDP per capita fell by 7.9 and 1.9 percent, respectively. Simply put, while NAFTA's institutional framework alone may have reduced pollution below levels that would have otherwise prevailed, the treaty has not resulted in the rapid economic growth necessary for Mexico to reach and surpass turning points for pollutants other than those that most directly affect human health and welfare (water and sanitation). Mexico will have to wait for further income growth before progress begins on other pollutants and Mexico begins its race to the top.

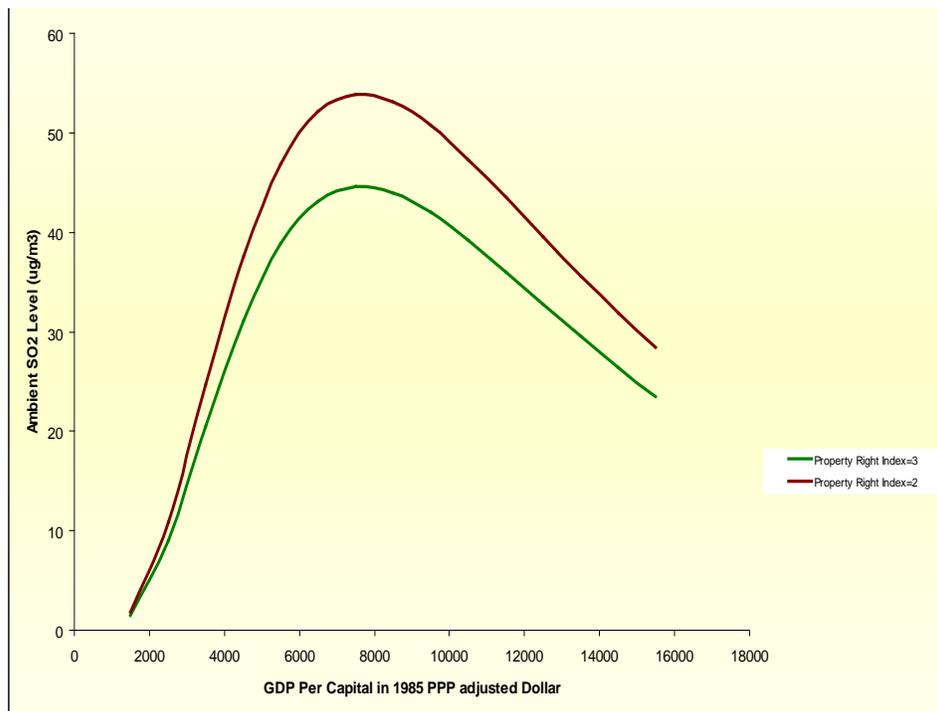
#### **4. Final Thoughts**

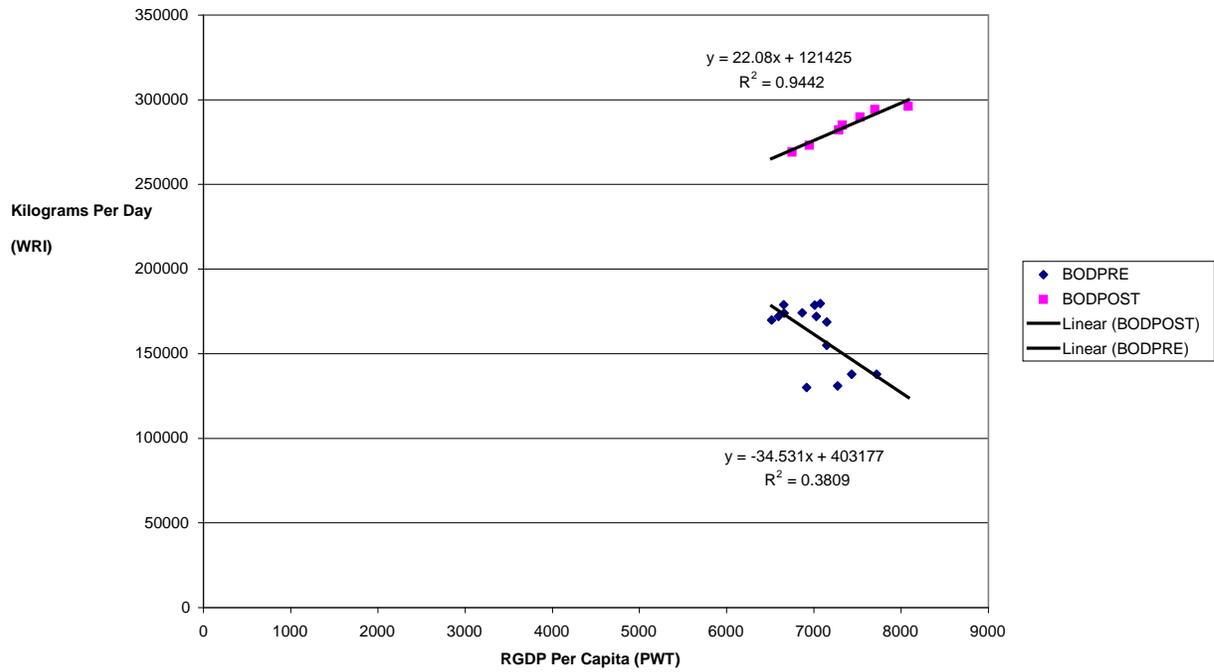
Canada, the United States, and Mexico ratified the NAFTA in 1994. Since then, Mexico's per capita GDP growth has been modest. Indeed, by most EKC estimates, Mexico seems caught in the turning point range. As might be expected, given the weak income growth, emissions for many pollutants have increased, though improvements have been made in water and sanitation.

What else can we infer about EKC's from the Mexican experience? EKC's can be a helpful guide in predicting longer-term environmental outcomes. As statistical artifacts, EKC estimates enable policy makers to consider the risk associated with decisions that

favor or disfavor economic growth. Because of the accumulated evidence, we know more about the sensitivity of environmental progress to income growth, but our knowledge is far from complete. And what about Mr. Obama's decision to leave NAFTA alone? Our examination of income data suggests that post-NAFTA Mexico has not experienced rapid economic development, which implies that NAFTA did not produce a great sucking sound of jobs heading south of the border. There has been little gain in environmental quality and little loss. In short, the evidence suggests Mr. Obama's decision to leave NAFTA alone is consistent with solid empirical evidence supported by EKC analysis.

Figure 1. An Environmental Kuznets Curve



**Figure 2. Industrial Water Pollution: Organic Water Pollution Emissions (BOD), 1980-2000**

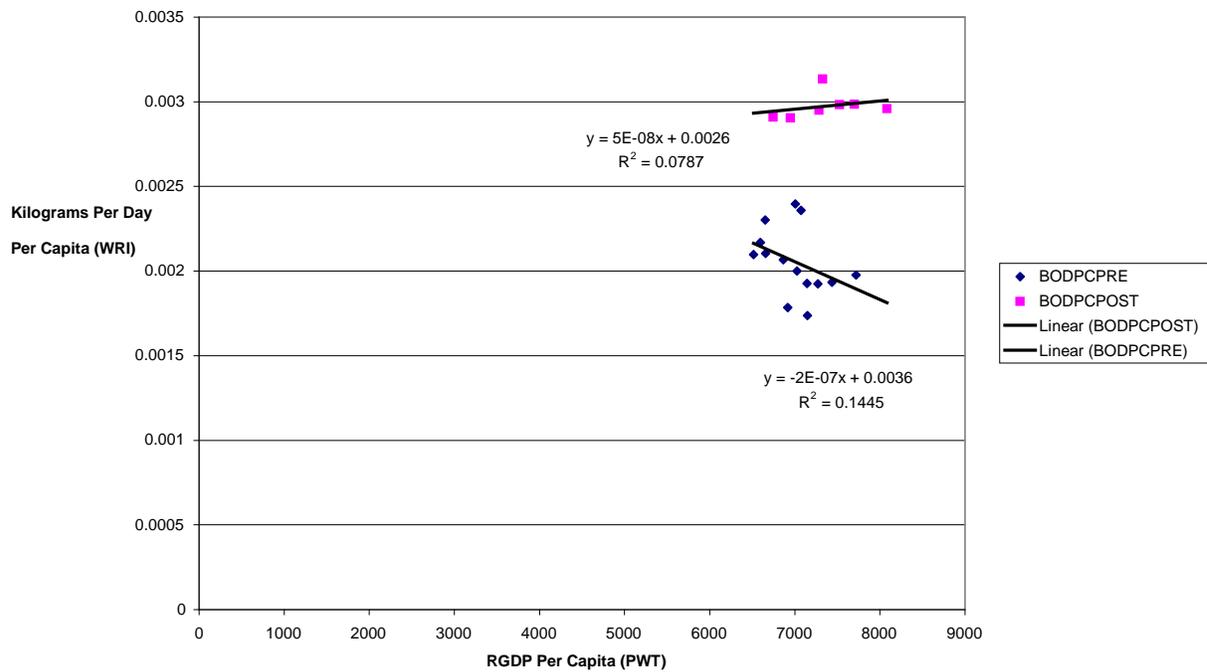
**Figure 3. Industrial Water Pollution: Organic Water Pollution Emissions (BOD) Per Capita, 1980-2000**

Figure 4. Mexico CO2 Emissions, 1950-2004

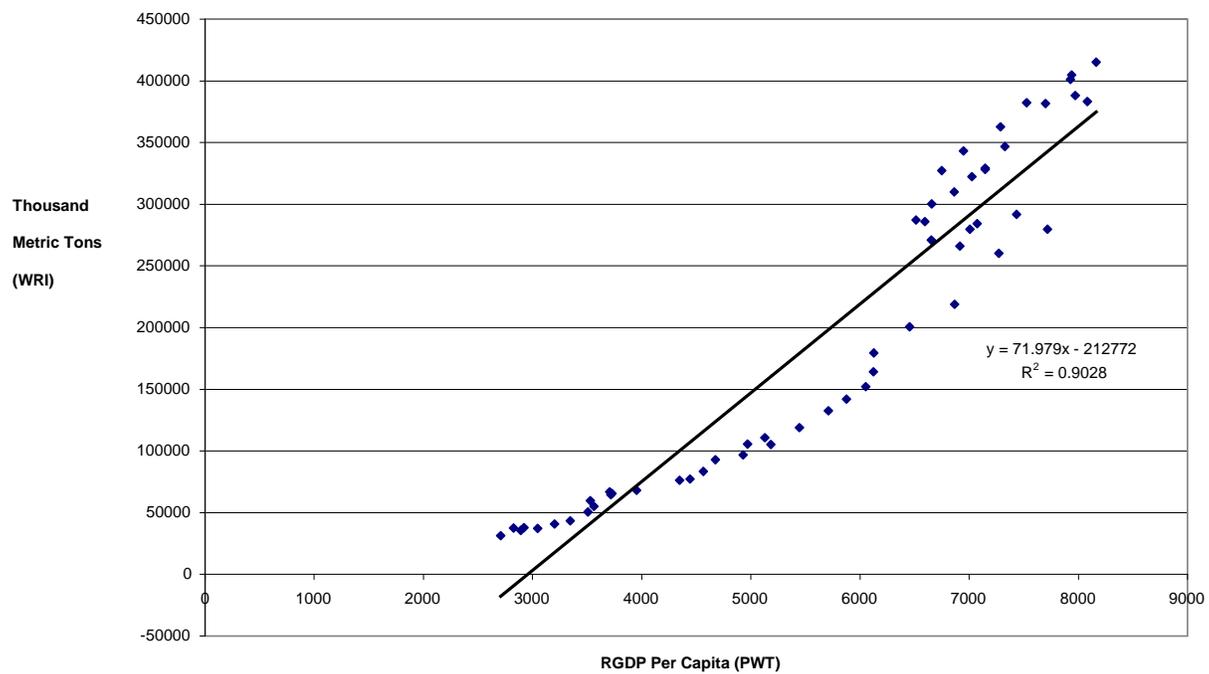


Figure 5. Mexico CO2 Emissions Per Capita, 1950-2004

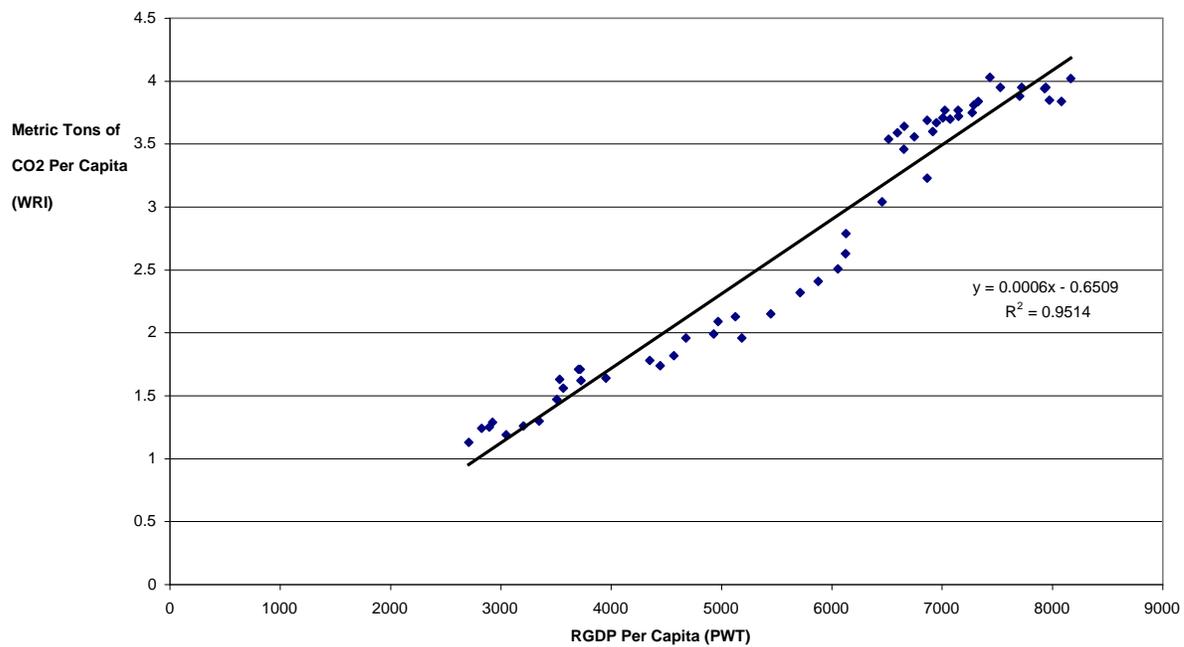


Figure 6. Mexico CO2 Emissions, 1950-2004: Pre and Post NAFTA

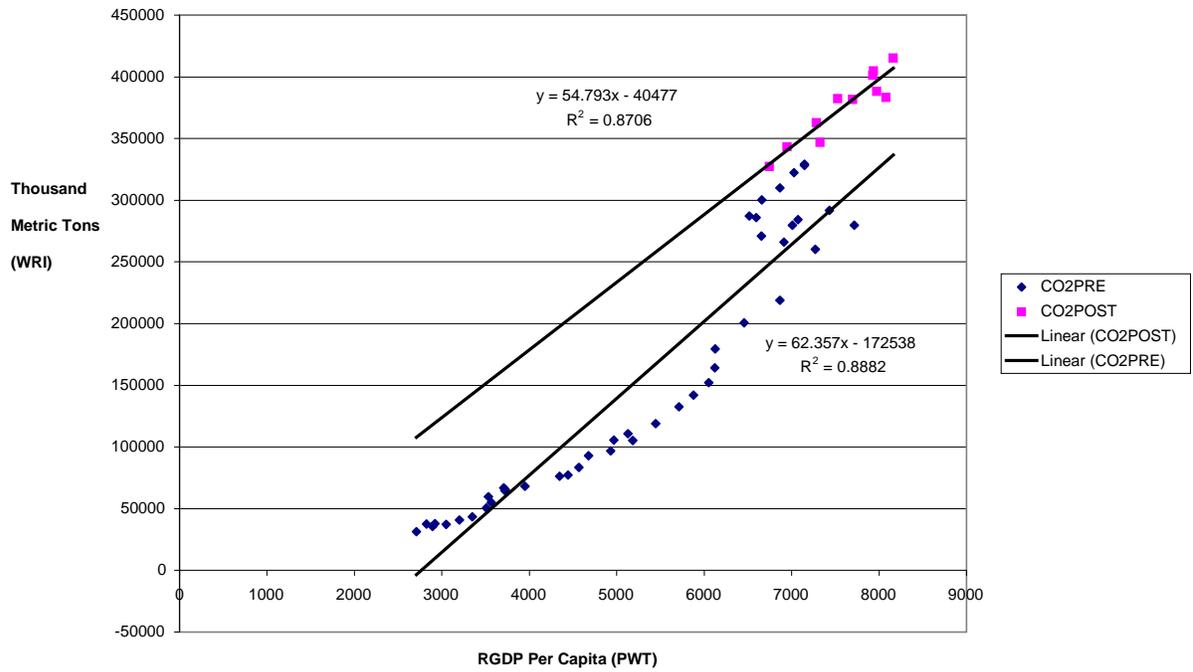


Figure 7. Mexico CO2 Emissions Per Capita, 1950-2004: Pre and Post NAFTA

