Is there a Race to the Bottom in Environmental Policies?

The Effects of NAFTA

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Abstract

We address the question whether NAFTA altered the nature of strategic environmental policymaking across US states. Specifically, we extend previous research - that has documented a race to the top between US states in environmental policymaking - by examining interstate environmental relationships in the time leading up to and beyond the ratification of NAFTA. By focusing on states which border Mexico or Canada, we test the hypothesis that if NAFTA is contributing to a race to the bottom in terms of environmental quality and protection then states which border the NAFTA neighbors should be less responsive to changes in environmental policies in neighboring US states. For sulfur dioxide emissions, we find some evidence that states bordering Mexico give less weight to their US neighbors, indicating a concern for firm flight to Mexico. However, around the time of the NAFTA negotiations, it appears that this concern declined. For other measures of environmental quality, and for states bordering Canada, no significant effects are detected.

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EXECUTIVE SUMMARY

We explore the effect of NAFTA on the determinants of environmental quality and policy in US states by differentiating interior states from those bordering Mexico and Canada. We seek to answer whether US states that border either of these countries act differently than interior states and if their behavior changed during times surrounding the ratification of NAFTA. The idea is to test the existence of strategic interaction among states in the determination of environmental policy, and in particular if this interaction differs in border and interior states. In other words, to what extent do state policymakers maintain an eye on environmental policy in neighboring states? Policymakers in US border states may have a stronger concern with capital flight. If this fear plays a role, environmental policy in US border states should be less responsive to changes in neighboring US states. In addition, if NAFTA increased fears of capital flight, then states along the border should be even less responsive to its US neighbors immediately before and after its ratification.

Using three different measures of environmental quality and policy - per capita sulfur dioxide emissions, Levinson's (1999) index of relative state compliance costs, and per capita toxic chemical releases - we reach three important conclusions. First, all three measures indicate that environmental quality and protection improved for all US states leading up to the ratification of NAFTA and continued to improve beyond ratification for toxic releases as well. Second, we find some evidence that US states along the Mexican and Canadian borders respond differentially to environmental changes in neighboring US states in terms of sulfur dioxide emissions and environmental compliance costs, but not toxic releases. States bordering Mexico are less responsive to changes in neighboring sulfur dioxide levels, while states on the Canadian border are more responsive to changes in neighboring states.

In terms of compliance costs, states on either border are less responsive to changes in neighboring US states than interior states. This finding may indicate a fear by border states of capital flight to Canada or Mexico. However, around the time of the NAFTA negotiations, this concern may have actually declined. For toxic releases (the only measure of environmental quality available beyond 1994) there was no change in the determination of pollution levels during the 1990s. Finally, we fail to find any evidence of a change in the manner in which environmental quality and protection was determined around the time of NAFTA's ratification. When this is combined with the fact that our three measures of environmental quality improved during the 1990s, we conclude from this analysis that NAFTA has not had a detrimental impact on the environment in the US.

I. Introduction

In connection with the NAFTA negotiations and ratification in the early 1990s, capital flight became an important issue of debate.[1] The hypothesis we test in this paper is whether US states bordering either Mexico or Canada altered the manner in which they decided upon their environmental policies during the 1990s. If such states were more or less concerned with the possible loss of firms to Mexico or Canada after the ratification of NAFTA, then one might expect the determinants of environmental policy in border states to have changed. Specifically, whereas prior to NAFTA negotiations and ultimate ratification, US environmental policies were determined at the state level with a watchful eye on the policies enacted by neighboring states, in the NAFTA era US states now must (may) be more cognizant of the environmental policies of Mexico and Canada. In addition, if any US state governments are to be fearful of losing jobs to either border country, it should be those on the border. Within such border states, firms incur lower costs from moving over the border, there may be fewer cultural barriers impeding relocation, and firms may possess better information about the business conditions in the neighboring country. Thus, one method of testing for an adverse effect of NAFTA on environmental protection in the US is to examine if the environmental policies of bordering states became less responsive to the policies of neighboring US states during the 1990s. If so, this would provide some evidence that NAFTA may have a detrimental impact on the US environment.

It should be noted that the above hypothesis relies on the mindset of policymakers, as well as voters and political pressure groups, in US states bordering Mexico or Canada. In other words, if policymakers and others *believe* firms may move from the US to Mexico or Canada, then they may be less responsive to changes in environmental policies in neighboring US states. However, this belief may

[1] A survey by Jaffe *et al*. (1995) turns up weak evidence that firm location has been affected by environmental regulations in the US. However, List and Co (2000) do find some evidence of this sort.

or may not be accurate. Thus, we may detect an adverse effect of NAFTA on US environmental policy even though the policy response is misguided. Alternatively, if policymakers naively believe that firms will not move to either Mexico or Canada, when in fact they will, we will detect no adverse environmental effects of NAFTA. One must be cautious, therefore, in that the results presented do not provide support either for or against claims of capital flight as a result of the free trade agreement.

Using three different measures of environmental quality (per capita sulfur dioxide emissions per capita toxic chemical releases, and Levinson's (1999) index of relative state compliance costs), we find no evidence that border states altered the manner in which they determined their levels of environmental protection during the early 1990s. When this is combined with the fact that our three measures of environmental quality improved during the 1990s, we conclude that NAFTA has not had a detrimental impact on the environment. However, we find some evidence that US states bordering Mexico have historically paid less attention to their US neighbors; thus, indicating a concern for policy activities in Mexico. However, this effect appears to have disappeared *before* the arrival of NAFTA.

There is some previous empirical evidence on the relationship between economic integration, the stringency of environmental protection, and environmental quality. Fredriksson and Gaston (1999, 2000) investigate empirically the “regulatory chill” hypothesis, i.e. whether openness to trade affects the propensity for governments to undertake environmental policy. They find no evidence that more open countries were less prone to cooperate on the global climate change issue. Damania *et al*. (2000) find that countries with more open trade set stricter levels for the amount of lead allowed in gasoline, and that this effect of openness is more pronounced in countries with highly corrupt governments (where environmental policy tends to be particularly distorted). Dean (1999) finds that in China, increased openness to trade has induced greater environmental damage due to China’s comparative advantage in polluting sectors. However, increased income levels (due to more open trade) have in turn had a

negative effect on emissions growth, reducing pollution levels. Hettige *et al*. (1992) and Grossman and Krueger (1993) find evidence that more open countries tend to have lower pollution levels.

The remainder of the paper is organized as follows: section 2 presents the basic empirical model, the data, as well as extensions to the basic model; section 3 discusses our findings; and section 4 provides some concluding remarks.

II. Empirical Analysis

II.A. *Specifications*

The econometric models used to test the impact of NAFTA interstate interaction in the determination of environmental quality build on Fredriksson and Millimet (2000). The basic regression equation is

$$E_{it} = \alpha_i + \gamma_t + (\delta_o + \delta_m D_{1i} + \delta_c D_{2i}) \sum_{j=1}^{48} \omega_{ijt} E_{jt} + x_{it}\beta + \varepsilon_{it}, \quad i = 1,\ldots,48, \tag{1}$$

where E_{it} is a measure of environmental quality in state i at time t, α_i are state fixed effects, γ_t are time fixed effects, ω_{ijt} is the weight assigned to state j by state i at time t ($j \neq i$), where some of the weights may be zero, E_{jt} is the measure of environmental quality in state j at time t, δ_k ($k = o, m, c$) are the parameters of interest, D_{1i} (D_{2i}) is an indicator variable equal to one if the state borders Mexico (Canada) and zero otherwise, x_{it} is a vector of state characteristics, and ε_{it} represents idiosyncratic shocks uncorrelated across states and over time.[2] Thus, the impact of environmental quality in neighboring states on own environmental quality is δ_o if the state does not border either Canada or

[2] There are only 48 states as Alaska and Hawaii are excluded (discussed below).

Mexico, $\delta_o + \delta_m$ if it borders Mexico, and $\delta_o + \delta_c$ if it borders Canada. The measures of environmental quality, E (discussed below), include: per capita sulfur dioxide emissions, Levinson's (1999) industry-adjusted measure of relative state environmental compliance costs, and total toxic chemical releases.

In (1), δ_k, where $k = c, m$, represents the *average* annual deviation in strategic environmental policymaking of bordering states from interior states over the span of the data. To assess the impact of NAFTA, however, we must ascertain if the behavior of bordering states differed (from their historical norm) during the 1990s. Thus, we estimate several variants of (1). First, we estimate (1) separately for each year of data - rather than pooling all years together - to obtain a unique estimate of δ for each time period. Plotting the resulting estimates over time allows examination for structural breaks in the way in which environmental information is used strategically by bordering and interior states. Note, however, since we no longer have a panel, state and time fixed effects cannot be included in the cross-sectional regressions.

Second, we explicitly incorporate a structural break into (1) and estimate the following specification:

$$E_{it} = \alpha_i + \gamma_t + \left[(\delta_o^{pre} + \delta_m^{pre} D_{1i} + \delta_c^{pre} D_{2i}) * I_t + (\delta_o^{post} + \delta_m^{post} D_{1i} + \delta_c^{post} D_{2i}) * (1 - I_t)\right] \sum_{j=1}^{48} \omega_{ijt} E_{jt} + x_{it}\beta + \varepsilon_{it},$$

$$i = 1,\ldots,48, \qquad (2)$$

where I_t is an indicator variable which takes the value one if the year is 1993 or earlier ("pre-NAFTA") and zero otherwise ("post-NAFTA"). Thus, comparison of δ_k^{post} and δ_k^{pre}, $k = c, m$, provides insight into changes which occurred after the ratification of NAFTA. The benefit of the structural break model in (2) is that we may still include the state and time fixed effects, whereas the fixed effects are not identified in (1) estimated separately by year. The drawback is that we must specify the year of the structural break.

Because states may have altered their behavior while negotiations were still ongoing, we estimate several versions of (2) using different years for the structural break (e.g., 1993 and 1992).

There are two econometric issues to be addressed when estimating equations such as (1) and (2). The first issue is the choice of weights, w. The simplest weighting scheme is to assign a weight of zero to non-contiguous states and then assign equal weights to all contiguous states. In other words, $\sum_j w_{ijt} E_{jt}$ simplifies to the mean of environmental quality in neighboring states. In this case, the weights for each state are time invariant. An alternative weighting scheme also assigns a weight of zero to non-contiguous states, but weights each contiguous state by its per capita income. Specifically, $w_{ijt} = y_{jt} / \sum_{j \in J_i} y_{jt}$, where y is per capita income and J_i is the set of states neighboring state i. This scheme assigns a weight to each state equal to its share of total per capita income of all neighboring states. Unlike the previous weighting scheme that simply averaged over neighboring states, the weights assigned by this scheme will vary by year.

The second issue of concern in the estimation of (1) pertains to the potential endogeneity of the environmental quality of other states. If there is strategic interaction among the states, then states are choosing their environmental policies simultaneously and incorporating their expectations about the decisions of other states into their own decision-making process. This may give rise to concerns about the direction of causation. In addition, there may be unobservable regional or national shocks that may be correlated with the decisions of multiple states.

To address these concerns, we include state and time fixed effects (α_i and γ_t, respectively) when identified. As a result, even if there exist time invariant unobservable state or regional attributes that

affect environmental quality in several or more states, we still obtain consistent estimates of the parameters of interest, δ_k , $k = o, c, m$.[3]

However, the inclusion of state and time fixed effects will not circumvent the reverse causation story alluded to earlier. One solution is to instrument for the measure of neighboring environmental quality. The instruments used are the attributes included in x_{it} in (1) and (2) for neighboring states, employing the same weighting scheme for the instruments as we do for environmental quality. State characteristics such as per capita income, population, population density, and the degree of urbanization are assumed to affect own environmental quality, but not environmental decisions in neighboring states *conditional* on the environmental quality in neighboring states. In other words, once a given state either knows or forms an expectation about the environmental quality in a neighboring state, that is the only information used to decide its environmental response; other characteristics of the neighboring state are ignored. Thus, these attributes represent valid exclusion restrictions.

II.B. ***Data***

Multiple measures of environmental quality across US states are used to test for the effects of NAFTA. The first measure is per capita sulfur dioxide emissions. The data come from the US Environmental Protection Agency's (EPA) *National Air Pollutant Emission Trends, 1900 - 1994* and span 1929 - 1994. The second measure of environmental quality is an index capturing the stringency of environmental regulation within each state. The index is developed in Levinson (1999) and spans the years 1977 -

[3] Such region-specific unobservables may include religious attitudes or the degree of political activism, for example. The time fixed effects will control for national events which occur in a given period and may impact all states through a reshaping of attitudes. Well known environmental disasters such as the Exxon Valdez or the nuclear disaster at Chernobyl are prime examples. The time fixed effects will also capture changes in federal environmental regulations such as the Clean Air Act and the later passage of its Amendments.

1994, except 1987. The measure accounts for differences in state industrial composition and is defined as

$$S_{it}^{*} = \frac{S_{it}}{\hat{S}_{it}}, \tag{3}$$

where S_{it} is the actual pollution abatement cost, $PACE_{it}$, per dollar of output, Y_{it}, produced in state i at time t and is given by

$$S_{it} = \frac{PACE_{it}}{Y_{it}}, \tag{4}$$

and $\hat{S}_{it}$ is the predicted pollution abatement cost per dollar of output and is calculated as

$$\hat{S}_{it} = \frac{1}{Y_{it}} \sum_{m=20}^{39} \left(\frac{Y_{imt}}{Y_{mt}} \right) PACE_{mt}, \tag{5}$$

where m = 20,...,39 indexes the two-digit SIC manufacturing sectors, Y_{imt} is total output in state i at time t from sector m, Y_{mt} is total national output (GDP) from sector m, and $PACE_{mt}$ is total national pollution abatement costs spent by industries in sector m.

Equation (5) gives the average pollution abatement costs per dollar of state output that would exist in state i at time t if each firm conformed to the national average for its industry. Consequently, the index (3) expresses the ratio of *actual* pollution costs per dollar of output to *predicted* pollution costs per dollar of output. A value greater than one indicates that industries in the state spent relatively more per dollar of output on pollution abatement than identical industries located in other states. If S_{it} is less than one, industries in the state spent relatively less on pollution abatement. The reader is referred to Levinson (1999) for further details.

Because the first two measures of environmental quality are only available through 1994, they do not allow us to examine changes after ratification of NAFTA. Thus, we turn to the third measure of environmental quality, releases of toxic chemicals, available through the US EPA's Toxic Release

Inventory (TRI). With the passage of the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986, all manufacturing facilities are required to release information on the emission of over 650 toxic chemicals.[4] Any facility that produces or processes more than 25,000 pounds or uses more than 10,000 pounds of any of the listed toxic chemicals must submit a TRI report (US EPA (1992). While data are available at the chemical level, for the present purpose the data are aggregated together. Although the aggregation gives equal weight to each chemical, as reported by the EPA, most of the widely used chemicals do not vary significantly in their toxicity and many of the less toxic chemicals have not been assigned risk scores by the EPA (Arora and Cason (1999); US EPA (1989)). The data is currently available from 1988 - 1997.

State level data on income as well as other attributes are obtained from the US Census Bureau. Summary statistics are given in Table 1. In addition, Figure 1 plots the values (weighted by state population) for the three measures of environmental quality, along with PACE per unit of manufacturing output, over time for interior states as well as for states bordering Canada or Mexico. According to the top two panels in Figure 1, not only have per capita sulfur dioxide emissions been decreasing since the 1970s and toxic chemical releases declining over from 1988 - 1997, but emissions of both types are significantly higher in interior states relative to states bordering Mexico or Canada. In addition, the downward trend in per capita toxic chemical releases in all three types of states remains unaltered in the post-NAFTA world.[5]

The bottom two panels of Figure 1, displaying the average value of the Levinson index and PACE per unit of manufacturing output, yield a slightly different picture, however, at least with regard to states bordering Canada. Specifically, while the value of the Levinson index is highest (indicating greater environmental stringency) in states along the Mexican border over the entire range of the data

[4] Manufacturing facilities are defined as those falling under Standard Industrial Classification (SIC) 20 - 39.
[5] This could of course also depend on significant firm relocation away from the US, however there is little evidence that this has taken place.

(1977 - 1994), states bordering Canada have the lowest level of all US states in terms of relative compliance costs since the early 1980s. Since the Levinson index is a relative measure, it has an overall mean of roughly one in each year. To examine the historical trend of abatement expenditures by states, the final panel examines PACE per unit of manufacturing output. Consistent with the ranking of states using the Levinson index, states bordering Canada have the lowest expenditure on pollution abatement per unit of manufacturing output; states bordering Mexico have the highest. Nonetheless, expenditures on abatement have increased in all three types of states since the mid-1980s and display no signs of slowing down as the ratification of NAFTA approached.

It is interesting to note that while states bordering Canada have the lowest level of abatement expenditure per unit of manufacturing output, they have the lowest level of per capita releases of toxic chemicals. One possible explanation is that northern states utilize more efficient types of abatement technology.

III. Results

The econometric results are presented in Tables 2 - 6 along with Figure 2. The estimates of the parameters of interest (i.e., δ_o, δ_c, and δ_m from equation (2)) are presented after taking the log transformation of own and neighboring environmental quality. Thus, the coefficients are the elasticities of own environmental quality with respect to neighboring environmental quality. In other words, given a 10% increase (decrease) in neighboring environmental quality, own environmental quality will increase (decrease), on average, by $(10*\delta_k)$%, $k = o, c, m$. We report the estimates obtained by ordinary least squares (OLS) as well as two-staged least squares (denoted IV).

In all regressions, state and time fixed effects are included in addition to controls for per capita income (and higher order terms), population, population density, and the share of the population living

in urban areas (although the results are not presented). The coefficients on the other control variables are of the expected sign and magnitude, particularly for per capita income where we observe the typical inverted U-shaped relationship between emissions and income associated with the environmental Kuznets curve. The full set of results is available from the authors upon request.

Before discussing the specific results, we note two things. First, the point estimates throughout are qualitatively similar regardless if neighboring states are weighted equally or by income. Second, while the OLS-FE results (OLS including state and time fixed effects) are presented for completeness, only the IV-FE (IV including state and time fixed effects) provide statistically consistent estimates of the strategic interaction effects (to the extent that the instruments represent valid exclusion restrictions). Thus, in the interests of brevity, we focus the remaining discussion on the IV-FE results weighting neighboring states by income.

III.A. *Sulfur Dioxide*

Table 2 presents the results using the full data set without allowing for any type of structural break during the time of the NAFTA ratification or negotiations. For per capita sulfur dioxide emissions, weighting neighboring states by income, and using the IV-FE results, the elasticity for interior states is 0.988, but falls to 0.644 for states bordering Mexico and increases to 1.199 for states on the Canadian border. Therefore, a 10% decline in per capita sulfur dioxide emissions in a state's neighbors leads to, on average, a 9.6% decline in interior states, a 6.4% decline in states bordering Mexico, and a 12.0% decline in states bordering Canada. These results indicate that improvements in per capita levels of sulfur dioxide emissions by one's neighbors are matched nearly one-for-one in interior states and greater than one-for-one in states bordering Canada. However, states bordering Mexico are less likely to match reductions in sulfur dioxide emissions by their neighbors.

While per capita sulfur dioxide levels in states bordering Mexico are historically less responsive to changes in emission levels in neighboring states, we are mainly interested in whether this relationship changed as NAFTA approached. To do so, equation (1) is estimated separately for each year, weighting neighboring states by income and using the IV-FE estimation method. Panel A in Figure 2 plots the parameter estimates for interior states along with the *total* coefficients for states bordering Mexico or Canada by year (i.e., $\delta_o + \delta_m$ and $\delta_o + \delta_d$) from the equation for sulfur dioxide. While the data for sulfur dioxide emissions does not, unfortunately, extend post-NAFTA, we are able to look for changes preceding actual ratification.

Two interesting results emerge. First, in every year the elasticity is largest for states bordering Canada and smallest for states bordering Mexico. While the differences may not be statistically significant in any one year, taken cumulatively the results point to a significant fear of firms leaving the country on the part of states bordering Mexico but not Canada. Second, there has been a sharp increase in the degree of strategic interaction for all three types of states in since 1960; however, there has been little change since the early 1980s. Thus, there is no change in the level of interaction conditional on type of state during NAFTA negotiations and ratification.

The final set of results, presented in Tables 3 - 6, allow for a structural break at different points in time. In other words, the models allow for the elasticity to change at some set point in time. However, unlike in the model presented in Figure 2, the elasticity is restricted to be the same each year prior to the break and the same again after the break, yet possibly at a different value. If NAFTA did cause a structural break in the manner in which states interact with one another, the break may have occurred at the time of ratification, or it could have occurred during the negotiation period assuming that states are not overly myopic. Thus, Table 3 tests for a break in 1994, Table 4 in 1993, and Table 5 in 1992. Table 6 then presents the results from statistical tests of the equality of the elasticity before and after the break.

If the elasticities do not differ before and after the break, this provides some indication that NAFTA had little effect on the determinants of environmental quality in the US.

Using the IV-FE results weighting neighboring states by income, Table 3 reveals that the elasticity of per capita sulfur dioxide emissions in interior states with respect to neighboring levels is 0.974 on average from 1929 - 1993 and 0.816 in 1994, although this difference is not statistically significant. For states bordering Canada (Mexico), the elasticity prior to 1994 is 1.168 (0.635). This is consistent with the findings from Table 2 and Figure 2; namely, the elasticity is highest for states bordering Canada and lowest for states bordering Mexico. In 1994, the elasticity is 1.028 (0.506), neither of which is statistically different from the pre-break elasticity. From Table 6, we see that p-values associated with the test that elasticities are equal across the break are well above the range used to determine statistical significance. For Canada (Mexico), the p-value is 0.43 (0.48).

One possible explanation for the lack of a break in 1994 may be that the break occurred during the negotiation period, prior to 1994. According to Table 4, the elasticity for interior states prior to 1993 is 0.958; 0.843 in 1993 - 1994. Again, this difference is not statistically significant. For states bordering Canada (Mexico), the elasticity for sulfur dioxide emissions is 1.136 (0.623) prior to 1993 and 1.040 (0.534) after 1993. While the elasticities decreased slightly after the structural break, the differences are again statistically insignificant (p-values of 0.45 (0.50) in Table 6). Thus, we reject the idea that a structural break occurred in 1993 as well.

Lastly, we test for a possible break in 1992. The results are no different. For interior states, the elasticity for per capita sulfur dioxide emissions is 0.942 prior to 1992 and 0.830 from 1992 - 1994; the difference not being statistically significant. For states bordering Canada (Mexico), the elasticities are 1.101 (0.609) before the break and 1.016 (0.529) afterwards. The p-values associated with the hypothesis that the elasticities are equal before and after the break are 0.42 for states bordering Canada and 0.47 for states bordering Mexico. Thus, we cannot reject the hypothesis of no structural

break at conventional levels of statistical significance. In the end, then, while states behave differently depending on whether they are located in the interior of the US or on the Mexican or Canadian border, there is no indication that the behavior of states with respect to sulfur dioxide levels changed during critical times during the ratification process.

III.B. *Compliance Costs*

We next turn our focus to a measure of environmental compliance costs within each state. Compliance costs may be a better indicator of the effect of NAFTA since compliance costs are directly affected by state legislation and/or enforcement activity, whereas pollution levels are only indirectly controlled by policymakers.

Table 2 presents the results without allowing for any structural breaks. Using the IV-FE results weighting neighbors by income, the elasticity for interior states is 1.924. The elasticity falls, however, to 0.550 (1.081) for states on the Canadian (Mexican) border. Both of these differences are statistically significant (Mexico only at the 10% level of significance). In fact, one cannot even reject the hypothesis that the elasticity for states bordering Canada is zero at conventional levels of significance (the p-value is 0.16). Thus, a 10% increase in regulatory compliance costs in neighboring states implies a 19.2% increase in interior states, but only a 10.8% increase in states bordering Mexico and a 5.5% increase in states bordering Canada (although it is not statistically significant). It is interesting to note the dichotomy for states along the Canadian border; they are the most responsive states with respect to neighboring pollution levels, but least responsive states with respect to neighboring compliance costs.

Figure 2 examines the elasticities by year in order to determine if there were any changes prior to NAFTA. For interior states, the elasticity remained fairly constant from 1977 - 1994. The elasticities are more volatile for states bordering Canada and particularly Mexico. For states on the Canadian border,

the elasticity was very stable from 1977 - 1992, but then increased fairly dramatically in 1993 and 1994. For states bordering Mexico, the elasticity is roughly U-shaped; peaking in 1977 and 1992 and reaching a low in 1984. However, the elasticity declined in 1993 and 1994, prior to the ratification of NAFTA. While the results may indicate a change in the determination of environmental compliance costs, particularly for states on the Canadian border, as 1994 approached, one must be cautious. Because the elasticities are based on cross-sections of data, the sample size is small for each year. Thus, large swings in the point estimates of the elasticities are not necessarily indicative of a statistically significant change.

To determine whether there is an actual structural break, we turn to Tables 3 - 6. First, we present the results testing for a break in 1994 in Table 3. Using the IV-FE results and weighting neighbors by income, we find the elasticity for interior states to be 1.739 for the period 1977 - 1993 and 1.639 in 1994. The difference is not statistically significant at conventional levels. For states bordering Canada (Mexico), the elasticity is 0.565 (0.937) before the break and 0.738 (1.687) afterwards. While the difference is large in magnitude for states bordering Mexico, it is not statistically significant (the p-value is 0.39); neither is the difference significant for states on the Canadian border (the p-value 0.78). However, even if the difference was significant, the fact that the elasticities increased after the break is contrary to the hypothesis of NAFTA having a detrimental effect on environmental protection in the US. If US border states were concerned about capital flight to Canada or Mexico post-NAFTA, one should expect the elasticities to be smaller after the break as states were less concerned with changes in neighboring US states and more concerned with changes across the border. This is clearly not the case.

To examine the possibility of a structural break while negotiations were still underway, we allow for the possibility of a structural break in 1993 (Table 4) and 1992 (Table 5). According to Table 4, the elasticity for interior states is 1.682 prior to 1993 and 1.493 thereafter, and the difference is not statistically significant. Along the Canadian (Mexican) border, the elasticity is 0.582 (0.812) on average from 1977 - 1992 and 0.444 (1.768) from 1993 on. While the difference is even larger than above in

magnitude for states bordering Mexico, it is still not statistically significant (the p-value is 0.15) and neither is the difference for states bordering Canada (the p-value 0.74). Again, note that while the difference is not significant, the point estimate of the elasticity is greater after the break than prior.

Finally, we test for a break in 1992. For interior states and states bordering Canada, the conclusions from Tables 3 and 4 are unaltered. Specifically, the elasticity for interior states is 1.734 on average over the period 1977 - 1991 and 1.641 thereafter, with the difference not being statistically significant at conventional levels. For states bordering Canada, the pre-break elasticity is 0.316 and -0.041 from 1992 - 1994. However, we cannot reject the hypothesis that the elasticities are equal before and after the break (the p-value is 0.21). In addition, we cannot reject the hypothesis that both the pre-break and post-break elasticities are both zero. For states bordering Mexico, on the other hand, the elasticity prior to 1992 is 0.740 and 1.753 from 1992 - 1994. In addition, we do reject the hypothesis that the two elasticities are equal at the 10% level of significance. Thus, there is mild evidence of a structural break in 992 with regards to compliance costs. However, the fact that the elasticity is larger after the break is, as stated previously, contrary to the notion of NAFTA lowering environmental protection in states on the US-Mexico border. Combining this fact with the plots in Figure 1 which document an increase in pollution abatement expenditures in the early 1990s in states bordering Mexico provides further evidence that environmental protection did not erode during this time.

III.C. *Toxic Releases*

Our last measure of environmental quality is the release of toxic chemicals. The benefit of this measure is that the data is available through 1997 and, unlike sulfur dioxide emissions, the data is for releases of all types of pollutants (e.g., air, water, land, and underground injections). In addition, the fact the data is

collected from self-reports by firms rather than monitoring stations means that there is no issue of spillover effects driving our results.

Table 2 presents the first set of results from the model pooling all years of data together. Using the IV-FE results weighting neighbors by income, the elasticity for interior states is 0.860. The elasticity declines to 0.847 (0.821) for states on the Canadian (Mexican) border; however, neither of the differences are statistically significant. Relative to the results discussed previously for per capita sulfur dioxide levels, the elasticities for toxic releases are lower for states in the interior of the US and on the Canadian border. The elasticity is higher for states along the Mexican border. The fact that one would expect lower elasticities for toxic releases since the data is based on self-reporting by firms (as opposed to EPA monitoring of local air quality conditions) makes it all the more surprising that elasticity is higher for states on the Mexican border. Nonetheless, a 10% decrease in per capita toxic releases in neighboring states implies approximately an 8.6% decrease in all US states, regardless of proximity to either border.

Figure 2 examines the elasticities by year. Two observations emerge. First, the elasticities for all three state types are fairly similar in each year. Second, the elasticities increased beginning in 1990 and, after peaking in 1993, have been slightly increasing each year from 1994 through 1997. Thus, during and after the NAFTA negotiations, states become increasingly responsive to toxic release levels in neighboring states. At the time of ratification, the elasticity fell for all states; however, the drop lasted only the single year. Thus, the data is conceivably consistent with the idea that states were concerned about the possible adverse effects of NAFTA at the time of implementation. However, after a year of states realizing that such fears were not coming to fruition, policymaking returned to usual and states have slowly begun to turn their attention away from Mexico and Canada and back to their US neighbors.

For completeness, we test for a structural break and report the results in Tables 3 - 6. Table 3 contains the results looking for a break in 1994. Using the IV-FE results and weighting neighbors by

income, the elasticity for interior states is 0.737 for the period 1988 - 1993 and 0.771 from 1994 - 1997. The difference is not statistically significant at conventional levels. For states bordering Canada (Mexico), the elasticity is 0.639 (0.834) before the break and 0.657 (0.902) afterwards. As shown in Table 6, the differences are not statistically significant for either states bordering Canada (the p-value is 0.75) or Canada (the p-value 0.37). In addition, as found previously with regard to the elasticity for compliance costs, the elasticity for states bordering Mexico is higher (although the change is not statistically significant) after the break, contrary to the notion of NAFTA adversely impacting toxic releases in border states.

To examine the possibility of a structural break during the negotiation period, we test for a structural break in 1993 (Table 4) and 1992 (Table 5). According to Table 4, the elasticity for interior states is 0.776 prior to 1993 and 0.720 thereafter, and the difference is not statistically significant. Along the Canadian (Mexican) border, the elasticity is 0.634 (0.331) during the pre-NAFTA period and 0.654 (0.250) from 1993 on. The differences are still not statistically significant (the p-value is 0.75 for Canada; 0.27 for Mexico). Moreover, the elasticities for states bordering Mexico are not significantly different from zero statistically either before or after the break.

Finally, we test for a break in 1992. The conclusions from Tables 3 and 4 are for the most part unaltered. Specifically, the elasticity for interior states is 0.836 on average over pre-NAFTA period and 0.791 thereafter, with the difference not being statistically significant at conventional levels. For states bordering Canada (Mexico), the elasticity is 0.701 (0.585) and 0.706 (0.535) from 1992 - 1997. We cannot reject the hypothesis that the elasticities are equal before and after the break (the p-value is 0.95 for Canada; 0.48 for Mexico). However, the elasticity for states bordering Mexico is now significant both before and after the break (though only at the 10% level of significance in the post-break period).

IV. Conclusion

In this paper we explore the effect of NAFTA on the determinants of environmental quality in US states, differentiating interior states from those bordering Mexico and Canada. We seek to answer if states that border either of these countries act differently than interior states and if their behavior changed during critical times surrounding the ratification of NAFTA? The idea we have in mind relies on the notion of strategic interaction among states in the determination of environmental policy. In other words, state policymakers maintain an eye on environmental policy in neighboring states for political (e.g., voters may form opinions on a government's effectiveness by making comparisons to neighboring states) and economic (e.g., firms may move to neighboring states if environmental regulations are more lax) reasons. However, for states bordering Canada or Mexico, policymakers may have an additional (or stronger) concern: international capital flight. If this fear plays a role in the mind of policymakers, environmental policy in border states should be less responsive to changes in neighboring US states. In addition, if NAFTA increased fears of capital flight, then states along the border should be even less responsive immediately before as well as after its ratification. This hypothesis forms the basis of our empirical tests.

Using three different measures of environmental quality - per capita sulfur dioxide emissions, Levinson's (1999) index of relative state compliance costs, and per capita toxic chemical releases - we reach three important conclusions. First, all three measures indicate that environmental quality and protection improved for all US states leading up to the ratification of NAFTA and continued to improve beyond ratification for toxic releases as well. Second, we find some evidence that states along the Mexican and Canadian borders respond differentially to environmental changes in neighboring US states in terms of sulfur dioxide emissions and environmental compliance costs, but not toxic releases. Specifically, states bordering Mexico are less responsive to changes in neighboring sulfur dioxide levels, while states on the Canadian border are more responsive to changes in neighboring states. In

terms of compliance costs, states on either border are less responsive to changes in neighboring states than interior US states. This finding in particular may indicate a fear by border states of capital flight to Canada or Mexico. However, around the time of the NAFTA negotiations, this concern may have actually declined. For toxic releases - the only measure of environmental quality available beyond 1994 - there was no change in the determination of pollution levels during the 1990s. Finally, we fail to find any evidence of a structural break in the determination of environmental quality and protection around the time of NAFTA's ratification. When this is combined with the fact that our three measures of environmental quality improved during the 1990s, we conclude (at least from this analysis) that NAFTA has not had a detrimental impact on the environment in the US.

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TABLE 1. SUMMARY STATISTICS

VARIABLE	YEARS	MEAN	STD DEV	MINIMUM	MAXIMUM
Per Capita Sulfur Dioxide Emissions	1929-1994	0.16	0.21	0.00	1.62
Levinson Index of Environmental Compliance Costs	1977-1994 (except ‘87)	1.02	0.37	0.23	2.59
Per Capita Pollution Abatement & Control (PACE) Expenditures ($1000s)	1973-1994 (except ’87)	0.02	0.02	0.00	0.25
Per Capita Toxic Chemical Releases	1988-1997	15.57	19.60	0.69	220.93
Per Capita State Income ($1000s)	1929-1994	9.09	4.24	1.16	22.46
Population (1,000,000s)	1929-1994	3.79	4.06	0.09	31.40
Population Density (per sq. Km)	1929-1994	50.96	76.30	0.32	411.72
Urban Population, Percent	1929-1994	0.59	0.18	0.16	0.93

TABLE 2. STRATEGIC INTERACTION ELASTICITIES BY TYPE OF STATE*

DEPENDENT VARIABLE	ESTIMATION METHOD	WEIGHTING SCHEME: CONTIGUOUS STATES					
		EQUAL WEIGHT			INCOME WEIGHT		
		Coefficient (δ_b)	Mexico Effect (δ_m)	Canada Effect (δ_c)	Coefficient (δ_b)	Mexico Effect (δ_m)	Canada Effect (δ_c)
SULFUR DIOXIDE	**OLS-FE**	0.613	-0.194	-0.563	0.600	-0.180	-0.543
		(25.646)	(-4.007)	(-11.615)	(24.813)	(-3.787)	(-11.290)
			[p=0.00]	[p=0.28]		[p=0.00]	[p=0.21]
	IV-FE	0.964	-0.320	0.199	0.988	-0.344	0.211
		(20.828)	(-4.937)	(2.236)	(20.669)	(-5.366)	(2.427)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]
LEVINSON INDEX	**OLS-FE**	0.382	-0.125	-0.671	0.380	-0.183	-0.685
		(4.009)	(-0.544)	(-4.167)	(3.950)	(-0.800)	(-4.226)
			[p=0.23]	[p=0.03]		[p=0.35]	[p=0.02]
	IV-FE	1.913	-0.711	-1.300	1.924	-0.843	-1.374
		(6.153)	(-1.514)	(-2.651)	(6.097)	(-1.750)	(-2.801)
			[p=0.01]	[p=0.12]		[p=0.02]	[p=0.16]
TOXIC RELEASES	**OLS-FE**	0.260	0.029	-0.009	0.266	0.020	-0.015
		(3.173)	(0.219)	(-0.128)	(3.181)	(0.150)	(-0.211)
			[p=0.04]	[p=0.00]		[p=0.04]	[p=0.00]
	IV-FE	0.830	-0.010	-0.025	0.860	-0.013	-0.039
		(6.203)	(-0.065)	(-0.286)	(6.283)	(-0.082)	(-0.455)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]

* NOTES: t-statistics in parentheses. p-values associated with the test that $\delta_b + \delta_k = 0$ ($k = c, m$) in brackets. Each regression also includes state and time fixed effects, per capita state income (along with higher order terms), population, population density, and percentage of state population living in urban areas. IV results use per capita state income (along with higher order terms), population, population density, and percentage of state population living in urban areas from neighboring states as instruments along with these same variables interacted with the dummy variables for bordering Mexico or Canada.

TABLE 3. STRATEGIC INTERACTION ELASTICITIES BY TYPE OF STATE: STRUCTURAL BREAK, 1994*

DEPENDENT VARIABLE	WEIGHTING SCHEME	ESTIMATION METHOD: IV-FE					
		PRE-BREAK			POST BREAK		
		Coefficient (δ_O^{pre})	Mexico Effect (δ_m^{pre})	Canada Effect (δ_c^{pre})	Coefficient (δ_O^{post})	Mexico Effect (δ_m^{post})	Canada Effect (δ_c^{post})
SULFUR DIOXIDE	**EQUAL**	0.953	-0.316	0.183	-0.177	0.028	0.025
		(21.240)	(-4.876)	(2.034)	(-0.934)	(0.285)	(0.346)
			[p=0.00]	[p=0.00]		[p=0.01]	[p=0.00]
	INCOME	0.974	-0.339	0.194	-0.158	0.029	0.018
		(21.072)	(-5.293)	(2.203)	(-0.835)	(0.295)	(0.255)
			[p=0.00]	[p=0.00]		[p=0.01]	[p=0.00]
LEVINSON INDEX	**EQUAL**	1.730	-0.690	-1.114	-0.072	0.892	0.267
		(6.150)	(-1.582)	(-2.481)	(-0.184)	(0.873)	(0.360)
			[p=0.01]	[p=0.08]		[p=0.04]	[p=0.29]
	INCOME	1.739	-0.802	-1.174	-0.100	0.850	0.273
		(6.116)	(-1.811)	(-2.616)	(-0.260)	(0.913)	(0.370)
			[p=0.02]	[p=0.11]		[p=0.04]	[p=0.34]
TOXIC RELEASES	**EQUAL**	0.716	0.038	-0.087	0.027	0.012	-0.017
		(4.464)	(0.170)	(-0.810)	(0.582)	(0.208)	(-0.446)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]
	INCOME	0.737	0.097	-0.098	0.034	0.034	-0.016
		(4.550)	(0.411)	(-0.909)	(0.738)	(0.553)	(-0.406)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]

* NOTES: p-values associated with the test that $\delta_o^{pre} + \delta_k^{pre} = 0$ and $\delta_o^{pre} + \delta_k^{pre} + \delta_o^{post} + \delta_k^{post} = 0$ ($k = c, m$) in brackets. For other explanations, refer to the notes beneath Table 2.

TABLE 4. STRATEGIC INTERACTION ELASTICITIES BY TYPE OF STATE: STRUCTURAL BREAK, 1993*

DEPENDENT VARIABLE	WEIGHTING SCHEME	ESTIMATION METHOD: IV-FE					
		PRE-BREAK			POST BREAK		
		Coefficient (d_O^{pre})	Mexico Effect (d_m^{pre})	Canada Effect (d_c^{pre})	Coefficient (d_O^{post})	Mexico Effect (d_m^{post})	Canada Effect (d_c^{post})
SULFUR DIOXIDE	**EQUAL**	0.939	-0.313	0.170	-0.136	0.025	0.025
		(21.477)	(-4.816)	(1.869)	(-1.004)	(0.339)	(0.470)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]
	INCOME	0.958	-0.335	0.178	-0.115	0.026	0.019
		(21.302)	(-5.222)	(2.003)	(-0.846)	(0.353)	(0.369)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]
LEVINSON INDEX	**EQUAL**	1.672	-0.693	-1.034	-0.182	1.045	0.060
		(6.291)	(-1.651)	(-2.333)	(-0.729)	(1.361)	(0.124)
			[p=0.01]	[p=0.08]		[p=0.01]	[p=0.77]
	INCOME	1.682	-0.870	-1.100	-0.189	1.145	0.051
		(6.263)	(-2.061)	(-2.490)	(-0.759)	(1.615)	(0.106)
			[p=0.04]	[p=0.10]		[p=0.01]	[p=0.46]
TOXIC RELEASES	**EQUAL**	0.764	-0.461	-0.131	0.046	-0.144	-0.037
		(4.587)	(-1.882)	(-1.174)	(0.980)	(-2.423)	(-0.957)
			[p=0.24]	[p=0.00]		[p=0.49]	[p=0.00]
	INCOME	0.776	-0.445	-0.142	0.056	-0.137	-0.036
		(4.637)	(-1.764)	(-1.272)	(1.193)	(-2.217)	(-0.914)
			[p=0.21]	[p=0.00]		[p=0.42]	[p=0.00]

* NOTES: Refer to the notes beneath Table 3.

TABLE 5. STRATEGIC INTERACTION ELASTICITIES BY TYPE OF STATE: STRUCTURAL BREAK, 1992*

DEPENDENT VARIABLE	WEIGHTING SCHEME	ESTIMATION METHOD: IV-FE					
		PRE-BREAK			POST BREAK		
		Coefficient (d_O^{pre})	Mexico Effect (d_m^{pre})	Canada Effect (d_c^{pre})	Coefficient (d_O^{post})	Mexico Effect (d_m^{post})	Canada Effect (d_c^{post})
SULFUR DIOXIDE	**EQUAL**	0.925	-0.313	0.154	-0.133	0.031	0.031
		(21.527)	(-4.774)	(1.688)	(-1.174)	(0.493)	(0.708)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]
	INCOME	0.942	-0.333	0.159	-0.112	0.032	0.027
		(21.341)	(-5.163)	(1.782)	(-0.989)	(0.513)	(0.617)
			[p=0.00]	[p=0.00]		[p=0.00]	[p=0.00]
LEVINSON INDEX	**EQUAL**	1.716	-0.766	-1.349	-0.094	0.913	-0.263
		(6.780)	(-1.886)	(-3.224)	(-0.451)	(1.316)	(-0.732)
			[p=0.01]	[p=0.27]		[p=0.01]	[p=0.98]
	INCOME	1.734	-0.994	-1.418	-0.093	1.106	-0.264
		(6.727)	(-2.454)	(-3.391)	(-0.444)	(1.706)	(-0.734)
			[p=0.05]	[p=0.34]		[p=0.00]	[p=0.92]
TOXIC RELEASES	**EQUAL**	0.815	-0.277	-0.124	0.038	-0.103	0.041
		(5.078)	(-1.197)	(-1.131)	(0.751)	(-1.867)	(-1.097)
			[p=0.03]	[p=0.00]		[p=0.09]	[p=0.00]
	INCOME	0.836	-0.251	-0.135	0.045	-0.095	-0.040
		(5.165)	(-1.054)	(-1.235)	(0.899)	(-1.646)	(-1.056)
			[p=0.02]	[p=0.00]		[p=0.07]	[p=0.00]

* NOTES: Refer to the notes beneath Table 3.

TABLE 6. TESTS FOR EQUALITY OF ELASTICITIES PRE- & POST-NAFTA *

DEPENDENT VARIABLE	WEIGHTING SCHEME	YEAR OF STRUCTURAL BREAK					
		1992		1993		1994	
		Mexico	Canada	Mexico	Canada	Mexico	Canada
SULFUR DIOXIDE	EQUAL	p=0.35	p=0.33	p=0.40	p=0.38	p=0.42	p=0.38
	INCOME	p=0.47	p=0.42	p=0.50	p=0.45	p=0.48	p=0.43
LEVINSON INDEX	EQUAL	p=0.22	p=0.21	p=0.24	p=0.77	p=0.39	p=0.75
	INCOME	p=0.10	p=0.21	p=0.15	p=0.74	p=0.39	p=0.78
TOXIC RELEASES	EQUAL	p=0.34	p=0.96	p=0.18	p=0.88	p=0.58	p=0.87
	INCOME	p=0.48	p=0.95	p=0.27	p=0.75	p=0.37	p=0.75

* NOTES: p-values reported for the test that the elasticities are equal for states bordering Mexico and Canada before and after the structural break, i.e., the null hypothesis is H_o: $\delta_o^{pre} + \delta_k^{pre} = \delta_o^{pre} + \delta_k^{pre} + \delta_o^{post} + \delta_k^{post}$, or $\delta_o^{post} + \delta_k^{post} = 0$ (k = c, m).