

Environmental Inspection Proclivity and State Manufacturing Growth: The US Experience from the 1990s

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Abstract

In this paper we construct a ranking of states based on their proclivity to inspect facilities for environmental compliance. Our measure utilizes state-level inspections data supplied by the US Environmental Protection Agency. After developing our ranking, we use it to predict state-level growth in manufacturing establishments. In doing so, we find support for the notion that enforcement intensity adversely impacts such growth. Our results offer insight into why existing studies that examine the impact of environmental regulation on location and growth produce inconsistent results.

Keywords: Monitoring and Enforcement, Environmental Regulations, Business Formation Growth

JEL Classifications: K32, Q28, R58

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Abstract

In this paper we construct a ranking of states based on their proclivity to inspect facilities for environmental compliance. Our measure utilizes state-level inspections data supplied by the US Environmental Protection Agency. After developing our ranking, we use it to predict state-level growth in manufacturing establishments. In doing so, we find support for the notion that enforcement intensity adversely impacts such growth. Our results offer insight into why existing studies that examine the impact of environmental regulation on location and growth produce inconsistent results.

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1. Introduction

Does the enforcement of environmental regulations help or hinder the growth of a state's manufacturing base? There are two opposing responses to this question. Of these, the most traditional response is that environmental regulations, and their enforcement, tend to hinder growth. Compliance with regulations can be burdensome and costly, thus, when firms choose a manufacturing location they will opt for locales in which they expect to face less regulation and enforcement. The opposing view suggests that states with strict regulations and strict regulatory enforcement should see positive growth in their manufacturing base. This view is based on two arguments. First, in comparison with labor and manufacturing costs, environmental compliance costs are relatively small. Second, valued employees care about quality of life issues, of which the local environment is an important component. This view suggests that the benefits of locating in states with stricter environmental enforcement might outweigh the costs.

In this paper we attempt to directly test these two contrasting predictions using state-level data on regulatory enforcement and the growth in manufacturing *establishments*.² An understanding of whether the level of environmental enforcement helps or hinders manufacturing growth is important to a number of constituencies. First, environmental economists are interested in answering this question because it can provide important insights into how corporations manage the costs and benefits of environmental compliance. Second, businesses, whether polluting or not, wish to know

² It is important to emphasize that we are focusing on the siting of new manufacturing establishments within states in our growth regression analysis as opposed to general manufacturing growth from the expansion of employment in both new as well as existing facilities. This is in deference to concerns that sufficiently strict environmental enforcement may cause plant closings and relocations to other states with more lax environmental enforcement (see, e.g., Gray, 1997). While this was the focus of the present study, a broader measure of growth would clearly be worth considering in subsequent research.

whether legislative and regulatory activities help or harm an area's manufacturing base since, in many instances, manufacturing is a basic (export-oriented) industry integral to the overall sustainability and growth of a region's economy. Finally, state regulators and legislators need to know whether, and to what extent, their efforts help or harm manufacturing growth in order to optimize regulatory enforcement.

In addition to offering insights into these public policy questions, this study also addresses a gap in the literature on economic growth and environmental regulation that is important to environmental economists and policy makers alike. Barro (1991) developed a model of economic growth that suggested an econometric procedure that could be used to explain differences in economic growth among nations. Several authors have used Barro's approach to attempt to explain differences in economic growth among states. A few papers have used measures of environmental quality and legislation, along with other economic variables, to explain economic growth (e.g., Goetz, Ready, and Stone, 1996; Polzin, 2001). Results have been mixed. These papers generally support the notion that environmental *quality* positively affects state economic growth, but there is less support for the notion that environmental *regulation* (enforcement) affects state economic growth.

These findings suggest that the literature has yet to adequately test the impact of an environmental (regulatory) regime. To see why, note that a *strict* environmental regime is most likely to affect manufacturers and is less likely to impact service industries. If all states' manufacturing sectors served as their economic base, that is as a basic (export-oriented) industry, then state-level measures of economic growth should reflect the impact of strict environmental regime.

However, the extent to which manufacturing serves as a basic industry to a regional economy varies widely in the US. To see this, we'll employ a common empirical measure to identify basic industries, the location quotient (LQ). Using states as our regional economic delineation, the location quotient (LQ) is essentially a ratio of state shares of a variable (commonly employment) to the corresponding national share of that same variable. In general, if an industry's LQ is in excess of one, indicating that a state's employment share of a given industry is larger than the national share, then that industry is classified, in economic base theory, as a basic industry whereby much of the production of that industry is exported outside the state's economy. As such, the industry generates external revenues that support the growth and development of other (non-basic) industries in that state.

For example, employment data from the Bureau of Economic Analysis reveal a LQ for motor vehicle manufacturing in Michigan in 1995 of 7.17, strongly suggesting, as one might suspect, that auto manufacturing is clearly a basic industry and, as such, is a significant contributor to Michigan's economic base.³ However, not all manufacturing industries are basic. In some economies, service industries are contributors to a state's economic base. For instance, with an LQ of 1.6, the finance and insurance industry serves as an important contributor to the economic base of New York, while, with an LQ of 2.7, a major basic industry in Nevada is gambling and recreation. If the strictness of a state's environmental regime has differing impacts on economic growth depending on the makeup of a state's economic base then one should use, as a dependent variable, the growth rate of each state's manufacturing base.

³ This data was obtained from <http://www.bea.gov/regional/spi/>. The year 1995 was chosen to reflect a reasonable LQ calculation for the period under consideration in this study.

Further, previous studies have used the number of state-level environmental policies to measure the strictness of a state's environmental regime. This measure is questionable for several reasons. First, it is possible that a number of state regulatory policies, such as those dealing with landfill sites or those dealing with drinking water standards, have little or no impact on a broad range of manufacturers. Second, although federal regulations apply to all states, their impact on the manufacturing base depends on the degree to which they are enforced, which varies widely across states. Finally, policies can and do change over time. Since companies are likely to care less about regulatory policy changes and more about the degree and rigor with which policies are enforced, a measure of enforcement is desirable. Our methodology addresses these concerns by using a measure of environmental *inspection* proclivity, at the state level, based on three major *federal* environmental acts.

In constructing this measure, we adopt a procedure employed by List and McHone (2000). This procedure uses econometric techniques to purge from a raw measure of inspection intensity (based on inspection counts) systematic cross-sectional and time-varying effects. In the end we obtain a time-invariant measure of inspection proclivities (that is, a measure of the intrinsic importance of environmental protection) unique to each state. Based on this measure, we construct a state ranking of inspection proclivity. Adopting the nomenclature of List and McHone (2000), we refer to this as a “conditional ranking”, as opposed to an “unconditional ranking” based solely on the raw inspections data.

Controlling for cross-sectional variation is beneficial since certain industries located in only a few states may simply require more inspection activity given the nature

of production. Some industries, for instance, are deemed “high priority” industries by the US EPA, demanding increased scrutiny. However, higher inspection activity due simply to industrial composition does not necessarily signal a greater proclivity to enforce regulations relative to other states with a different industrial composition. It simply may reflect, for instance, greater inspection activity required by federal authorities.

Likewise, controlling for time-varying patterns in inspection activity is useful in creating the conditional ranking. We know that industrial composition can change over time as plant closings and openings occur. If such changes happen in US EPA priority, or other high polluting industries, then inspection activity may fluctuate systematically over time. However, such changes in inspection rates do not necessarily reflect a change in a state’s attitude toward environmental enforcement. For instance, a state may experience plant closings in a high-polluting industry but still may be inclined to aggressively inspect plants in other industries, particularly if that state is inherently disposed towards maintaining and improving environmental quality.

To our knowledge, only two other papers constructed state-level environmental indexes by following econometric procedures similar to the one we use here. Henderson (1994) for instance, attempts to construct a ranking of state “attitudes” towards air quality regulation by employing US Census data on capital expenditure and operating costs data for pollution abatement.⁴ However, as an indicator of enforcement proclivity this construction is indirect at best and possibly inaccurate since there may be other reasons for firms to invest in pollution abatement other than compliance (see, e.g. Lyon and

⁴ This index was used in Henderson (1996) to test if such attitudes impact state ozone readings and did find that states with more progressive attitudes towards air quality realizes lower ozone readings, although this marginal effect is rather small. However, he did not test whether or not such attitudes impact business location decisions or establishment growth.

Maxwell, 2004, and Segerson and Li, 2000 for detailed discussions of “voluntary” or “strategic” motivations for pollution abatement).

As noted above, List and McHone (2000) also construct a state ranking of environmental *output* by state. As a measure of air quality the ranking is very useful. However, our interest is in measuring a state’s proclivity to enforce existing environmental regulations. Therefore, a different dataset is required. For instance, a state may have better air quality than others simply because the composition of the state’s economy is dominated by low-polluting industries, having very little to do with the relative importance the state places on environmental enforcement. Fortunately, data on inspections do exist. We can use this data to construct a direct measure of enforcement proclivity. As we will see, our ranking based on inspections data generates different rankings than both Henderson (1994) and List and McHone (2000).

The paper is organized as follows. In section 2 we discuss the raw, or unconditional, inspections data and its characteristics. In sections 3 and 4 we discuss the need and procedure for developing a conditional ranking in more detail and the resulting econometric results. In section 5 we apply our conditional ranking to an analysis of determinants of manufacturing establishment growth. In section 6 we conclude.

2. An Unconditional Ranking of Inspections

The primary goal in this study is to ascertain, through as direct a measure as possible, a state’s proclivity toward enforcement of environmental regulations. To this end we focus principally on inspection behavior.⁵ We obtained data on inspections

⁵ Clearly, this is not the only measure of enforcement. One could focus attention on enforcement actions or penalties as a measure of enforcement intensity. Our contention is that inspections are a broader measure of enforcement. They indicate a state enforcement authorities’ proclivity to enforce regulations on all potential violators.

conducted by states for the Clean Air Act (CAA), the Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA) compliance between 1992 and 1998, from the US EPA's Office of Environmental Compliance and Assistance (OECA).⁶ To measure the intensity of inspection activity, we borrowed a concept from the economic geography and regional science literatures, and constructed a "location quotient" (LQ) for each state.

Specifically, we consider the calculation of a location quotient for state inspections per facility, LQIN, calculated as follows:

$$LQIN = (IN_{STATE} / FAC_{STATE}) / (IN_{US} / FAC_{US}), \quad (1)$$

where IN is the number of inspections and FAC is the number of facilities subject to inspections.⁷ Table 1 presents information ranking each state's LQIN. According to the data, the top five states that are most inspection-intensive are Maryland, Alabama, Connecticut, Utah, and West Virginia. The least inspection-intensive states are New Mexico, New Hampshire, Rhode Island, Alaska, and Iowa.

In principal one could use this measure, or a ranking based on it, to explain differences in the growth of manufacturing facilities across states, but this is too simplistic. This measure does not control for potentially important systematic differences among states that may affect inspection intensity, but that have little to do with the true level of enforcement intensity a particular facility may expect to receive. For example, the *LQIN* measure does not take into account the industry mix of the manufacturing base. It may be the case that most facilities subject to inspection in, say, New Mexico are

⁶ The data was made available to us in aggregate. That is, we do not have available CAA inspections separately from either CWA or RCRA inspections. Since our focus is on overall enforcement intensity the breakdown by statute is not of immediate interest.

⁷The inspections data are defined on a per facility basis because more inspections will occur where more polluting facilities exist.

inherently less polluting than most facilities in, say, Alabama. This does not mean, however, that a given type of facility (such as an oil refinery) will be inspected less in New Mexico than in Alabama.

Several factors other than industry mix may have similar effects and must be controlled for in order to develop a proper estimate of environmental inspection proclivity. These factors include an industry's historical compliance record in a given state, and the relative importance of the polluting industry or industries to a state's economy. Regulators, as a matter of course, inspect more frequently facilities that have poor environmental records, or those known to produce high levels of pollution (see, e.g. Gray and Deily (1996), Dion, Lanoie, and Laplante (1998), and Decker (2005). At the same time, inspectors may shy away from inspecting facilities that are important to a state's economy. Again, however, these concerns will have little to do with the inspection intensity faced by a new facility that may not be crucial to the state's economic base.

Additionally, our conditional ranking of inspection proclivity should control for the influence of the general political attitudes of the population and the government of the state. The rationale for purging the influence of these variables from our measure of environmental inspection intensity is that while they are widely thought to influence regulatory behavior, political attitude may also influence other variables that also might help or hinder the growth of a state's manufacturing sector. For example, political attitudes might lead to stricter or weaker requirements for the granting of construction permits for new facilities or the expansion of existing facilities. Thus, in explaining the growth of a state's manufacturing sector, it may be beneficial to include these political attitude variables as separate regressors in order to avoid collinearity problems.

3. Construction of the Conditional Ranking

In this section we develop a conditional ranking, based on LQIN, that has been purged of the systematic influences outlined in section 2. To this end, we assembled from a variety of sources a panel dataset that provides information on inspections and other variables across states over the period 1992 to 1998. We then ran fixed effects (FE) and random effects (RE) regression models on this data.

The FE model is:

$$y_{i,t} = \alpha_i + \beta X_{i,t} + \delta_t + \varepsilon_{i,t}, \quad (2)$$

where $y_{i,t}$ is each state i 's LQIN for years $t = 1992$ through 1998 , α_i is the time-invariant estimated state constant variable, δ_t estimated time constant variable (for the years 1992 through 1998), $X_{i,t}$ is a 50 by 7 matrix of independent variables believed to influence LQIN, and $\varepsilon_{i,t}$ is a white noise error. Since our goal is to isolate a time-invariant state enforcement proclivity statistic, our resulting conditional ranking should be reflected in the estimated α_i 's. These coefficients, by construction, give us a time-invariant measure of inspection activity by state that is not explained by the independent variables defining $X_{i,t}$. Companies can see this behavior but standard statistical analysis can't reveal this attitude.

A FE is appropriate when one is confident that the cross-section and time series units can be viewed as parametric shifts in the regression. However, if the cross-section and time series constant terms are random variables distributed across cross-sectional and time series units, then the RE model, $y_{i,t} = \alpha + u_i + \beta X_{i,t} + \delta_t + \varepsilon_{i,t}$, is appropriate. As we detail in Section 4, the Hausman test for FE versus RE strongly favors the FE model.

More complete definitions and explicit construction of the independent variables used in our regression analysis are described in greater detail in this paper's appendix (Table A1). Our fixed effects model is:

$$\begin{aligned}
LQIN_{i,t} = & \alpha_i + \delta_t + \beta_1 LQENAVG_{i,t} + \beta_2 LQTRI_{i,t-2} \\
& + \beta_3 LQELEC_{i,t} + \beta_4 LQCIT_{i,t} + \beta_5 LQGOV_{i,t} + \beta_6 LQDENSITY_{i,t} \\
& + \beta_7 LQGSP_{i,t} + \sum_{j=26,28,29,30,33} \beta_j LQGSP_{j,i,t} + \sum_{k=26,28,29,30,33} \beta_k LQTRIk_{i,t-2} + \varepsilon_{it}.
\end{aligned} \tag{2}$$

The independent variables enter equation (2) as location quotients to ensure consistency in the error term.⁸ The variable LQENAVG measures the average number of per facility enforcement actions levied over the four years prior to current inspections by states for CAA, CWA and RCRA violations (relative to the number of actions per facility levied at the US level). As with the inspection data, the enforcement data was provided by OECA. We expect higher relative prior enforcement actions to subsequently prompt more frequent inspections (see, e.g. Harrington, 1988).

In addition, as many studies have shown, higher per capita pollutant releases are likely to prompt greater state-level inspection activity. Our measure of pollution releases comes from the EPA's Toxic Release Inventory (TRI) database.⁹ Using this data, we constructed LQTRI, which measures per capital TRI releases for EPA designated core chemicals by state relative to per capita TRI releases. The reason we use the two-year lag of LQTRI as an explanatory variable is that the TRI data tends to be released to the

⁸To be sure, there are a number of possible specifications for equation (2) and we tried a number of them. The one we decided upon here offered the most reasonable results in terms of goodness of fit.

⁹ The TRI data can be obtained quite easily at <http://www.epa.gov/triexplorer/>. The population data was obtained by the US Department of Commerce's Regional Economic Information Service (REIS). The REIS data can be queried at <http://www.bea.doc.gov/bea/regional/reis/>.

general public with about an eighteen month lag. We would expect to see a positive coefficient result.

It is also reasonable to presume that certain industries might experience more inspections given the amount and nature of the pollutant releases involved. Indeed, the EPA has designated several industries as “high priority” industries requiring increased scrutiny.¹⁰ The five industries relevant here are pulp and paper (SIC 26), chemical manufacturing (SIC 28), petroleum refining (SIC 29), rubber and plastics (SIC 30), and iron and steel (SIC 33). To incorporate this effect, we constructed variables (LQTRI26, LQTRI28, LQTRI29, LQTRI30, and LQTRI33) to measure, for each state, an industry’s TRI releases per dollar’s worth of GSP in that same industry relative to each state’s overall TRI releases per dollar’s worth of state manufacturing GSP.¹¹ We would expect higher inspection intensity in those states whose TRI releases are proportionately larger in these sectors. Therefore, positive coefficients on these variables are anticipated.

In addition to pollutant releases, inspectors may consider the level of production as an additional indication of a firm’s potential to violate environmental law. As a measure of aggregate production, we utilize the US Department of Commerce’s real gross state product (GSP) data. We construct LQGSP to measure overall real gross state product per capita relative to US real gross national product per capita.

Moreover, for reasons stated earlier, we also consider production levels (as measured by industry-level GSP) for the five priority industries identified above as well.

¹⁰ The US EPA’s Office of Compliance and Enforcement publishes this list annually in its Enforcement and Compliance Accomplishments reports. See <http://www.epa.gov/Compliance/resources/reports/planning/results/fy98accomplishment.pdf> for details.

¹¹ Industry level gross state production (GSP) data is available from the US Department of Commerce at <http://www.bea.doc.gov/bea/regional/gsp.htm>. The reason we focus on industry releases relative to total manufacturing GSP is because during the 1990s the TRI data was collected only for these industries classified as manufacturing sectors.

Each of these LQs measure the share of each industry's GSP to total manufacturing GSP for each state divided by the same share for the nation as a whole.

The prior expectation of each of these variables' marginal effect on LQIN is unclear. While we might expect that greater industrial production generates the potential for greater environmental harm thereby prompting more inspections, it is possible that some of these sectors represent a relatively powerful economic interest within a particular state. To the extent that such industries may have been able to "capture" environmental enforcement officials, it might be the case that the resulting effects of all or some subset of these GSP LQs could have a negative impact on LQIN. Hence, a clear prior expectation is not easily identified.

Other control variables include population density (LQDENSITY), general political attitudes of the population (LQCIT and LQELEC) and elected officials (LQGOV). With respect to population density, we would expect to see greater inspection intensity the greater the concentration of citizens at risk of environmental harm. Political attitudes of a state's citizenry are measured by LQCIT and LQELEC. LQCIT comes from Berry, Ringquest, Fording, and Hanson (1998) and measures the ratio of a state's "citizen political ideology" score to the US average over the period 1990 to 1998. Citizen political ideology is generally thought of as a state's mean position on a liberal-conservative continuum primarily based on voting behavior in local, US congressional, and presidential elections. This index is constructed in such a way that the higher the index, the more "liberal" the state (see Berry et al. for details). These indexes don't necessarily give an indication of how politically active state' population is. To measure how politically active state citizens are, we include LQELEC. Because in general US

citizens are more active in presidential elections, LQELEC measures the percent of the voting population by state for the presidential elections 1988, 1992 and 1996. We expect each to have a positive effect on LQIN.

LQGOV, again based on Berry, et al. (1998), is the ratio of a state's "elected public official political ideology" score to the US average. Elected officials' political ideologies can be thought of generally as a state's mean position on a liberal-conservative continuum. But here the scores are based on publicly available voting behavior of these elected officials on a number of issues classified as "liberal" vs. "conservative." This index is constructed in such a way that the higher the index, the more "liberal" the state (see Berry et al. (1998) for details). Table 2 presents summary statistics of the variables used in equation (2) as well as the variables used in our subsequent business formation growth regressions.¹²

4. Panel Estimation Results

The FE and RE results are presented in Table 3. In order to test which model is better suited to the data we ran a Hausman test. We found the Hausman statistic to be 45.96 which, with 17 degrees of freedom, strongly favors the FE model. Moreover, we are explaining about 79 percent of the variation in LQIN and the F-statistic from our model suggests that we can safely reject the null hypothesis that our estimated coefficients on all of our independent variables are jointly equal to zero.

¹² Ideally, other important variables would be included in our model, such as number of inspectors employed, or perhaps a measure of state-level environmental budgets. However, we were unable to locate inspector employment data by state. We were, however, able to obtain some data for state-level environmental budgets for the sub-period 1994 to 1998 from the Environmental Council of the States. While this did limit the size of our dataset, we did introduce this variable in several ways (as a share of total state budgets, on a per-capita basis, and as an LQ where state environmental budgets per capita were divided by total state budgets per capita). In each instance the variable proved statistically insignificant and generated poorer overall statistical results. As such we have chosen to present the results without this data. To be sure, there is still merit in pursuing such data extensions. By way of future research, it may be beneficial to survey state environmental agencies to determine the number of inspectors employed.

In the interest of brevity, we will highlight only a few key results from the FE model. First, as evidenced by the significance of LQENAVG, we find that historical noncompliance does statistically impact subsequent inspection intensity. Moreover, the results indicate that in more densely populated states inspection activity is more intensive.

We also find that inspection intensity tends to be greater in states with more politically active residents (as indicated by the significance of the LQELEC and LQCIT variables). As far as specific sectors are concerned, we find that higher relative emissions in pulp and paper plants tend to lead to significant increases in relative inspection activity. Interestingly, results indicate that chemical plants are inspected relatively *less* intensively, *ceteris paribus*, which may be indicating the possibility of industrial capture in this sector or the possibility of industry self-regulation measures.¹³

In terms of the relationship between pollution releases and inspection intensity, there is some evidence that higher TRI releases per GSP prompt more intensive inspection activity in the pulp and paper and chemical manufacturing sectors, *ceteris paribus*. However, contrary to expectation, we find the higher TRI releases per GSP in the oil refining sector prompt less subsequent inspection intensity.¹⁴

In terms of the resulting conditional state ranking obtained from the FE model presented in Table 4, we find some significant differences when compared to the unconditional ranking. We find that the four states with the highest inspection proclivity

¹³ See Lyon and Maxwell (2004) for a detailed study of corporate motivations for self-regulation, including the American Chemistry Council's (formally, the Chemical Manufacturing Association) creation of the self-regulatory Responsible Care program.

¹⁴ This counter-intuitive result is certainly troubling and, while it is the case that relative to the other sectors TRI releases in this sector are relatively small, this result may suggest that for this sector, a more refined measure of pollution may be necessary.

are Wyoming, Utah, West Virginia, and Alabama, while the four with the least proclivity are New Jersey, Rhode Island, Massachusetts, and Connecticut.

It is worth pointing out some similarities and differences with existing state environmental rankings. For instance, List and McHone's (2000) rankings of states based on air pollution places Wyoming eleventh, a relatively high ranking. That is, Wyoming will tend to have relatively few ozone monitors indicating exceedance of federal air quality regulations. To be sure, there are some striking differences as well. In contrast to our finding that New Jersey has the lowest inspection proclivity, List and McHone (2000) find that New Jersey tended to have the smallest percentage of ozone monitors indicating larger than allowable pollutant releases.

5. State Environmental Regulatory Attitudes and New Business Formation

The growth model. One application of the state ranking is to test whether or not a state's inspection proclivity impacts the economic landscape of a state. There are a number of studies that have investigated the relationship between plant location, production decisions and environmental regulation.¹⁵ Using state-level data on new manufacturing plant construction, Gray (1997) for instance, found that fewer new plants were built in those states where environmental enforcement was more aggressive. Other studies suggest alternative conclusions. Goetz, Ready, and Stone (1996), for instance, investigated the impact various measures of state environmental quality have on the growth in state per capita income. Their state environmental policy index (which incorporates 17 policy areas including a number of enforcement policies such as hazardous waste management and groundwater protection plans) was found to have no statistical impact on per capita income growth.

¹⁵ See, for instance, Jeppesen, List, and Folmer (2002), List and Co (2000), and Gray (1997).

While both studies have substantial merit, there are a number of aspects that, in light of our results so far, deserve some re-consideration. First, Gray's (1997) results treated enforcement, measured as number of inspections, as exogenous and independent of his other model variables, including industry output. However, our results suggest that inspections are indeed endogenous, influenced by, among other variables, industry output. Hence, Gray's (1997) results linking enforcement with plant location may be premature and further investigation is in order. With respect to Goetz, Ready, and Stone (1996), their results are based on an environmental index measure that embodied a variety of policy variables, not simply enforcement and thus any deference to the enforcement effect on growth was at best indirect.

In this section we apply an economic growth model similar to Goetz, Ready, and Stone, which is largely an adaptation of Barro's (1991) growth study. Rather than focus on employment or income growth directly, more consistent with Gray's analysis, we use new establishment data for the period 1990 to 2000 from the Small Business Administration (SBA). We look at overall growth between 1990 and 2000 for manufacturing establishments and test the impact of our conditional (and unconditional) index on this growth. We then look at growth patterns between 1990 and 2000 for small establishments (generally defined by the SBA as having fewer than 500 employees) and large establishments (500 or more employees).

The empirical model specified is

$$\ln(MAN2000) - \ln(MAN1990) = \alpha + \beta_1 MAN1990 + \beta_2 PRODUCTIVITYGR + \beta_3 EDUC + \beta_4 TAXIND + \beta_5 INSRANK(COND) + \beta_6 GREENINDEX + e. \quad (4)$$

MAN1990 and MAN2000 measure the number of manufacturing establishments counted by state in 1990 and 2000, respectively. PRODUCTIVITYGR measures the growth in

GSP per worker between 1990 and 2000. One would expect this variable to positively impact growth. EDUC measures the percent of a state's population with a high school degree or higher. We would expect this variable to have a positive effect on new establishment growth. TAXIND is an index constructed by the Tax Foundation measuring the business tax climate by state.¹⁶ The higher the index, the more favorable the tax structure is to business. We would expect this variable to have a positive effect on growth. GREENINDEX is the same environmental policy index used by Goetz, Ready, and Stone (2000). INSRANK is simply the ranking based on INLQ from Table 1, and INSRANKCOND is the INLQ conditioned on the explanatory variables and what are represented in Table 4.

Econometric Results. In Table 5 we present the results of the above specification when using INSRANK and INSRANKCOND, respectively. In Table 6 we present the results of two estimations using only INSRANKCOND in both. The first looks at growth of large establishments where MANLG1990 and MANLG2000 measure the number of manufacturing establishments counted by state that employ 500 or more workers in 1990 and 2000, respectively. The second looks at growth of smaller establishments where MANSM1990 and MANSM2000 measure the number of manufacturing establishments counted that employ less than 500 workers.

Based on the adjusted R^2 and F-statistics, we see that the growth specification employing INSRANKCOND offers a better explanation of manufacturing establishment growth. There is little evidence of growth convergence across states as evidenced by the positive and insignificant sign on MAN1990. The educational attainment of a state's population proves insignificant (a result consistent with a variety of studies such as

¹⁶ This data was obtained from http://www.facilitycity/busfac/bf_03_06_exclusive1.asp, November, 2003.

Polzin, 2001). Moreover, TAXIND and GREENINDEX are not significant indicators of establishment growth.

There is some evidence to support the notion that firms are attracted to build new plants in states with more productive workforces and in states with lower poverty rates.¹⁷ Importantly, as indicated by the negative and significant impact of INSRANKCOND, we do see that manufacturing establishment growth is slowed in states with more intensive environmental inspection activity, *ceteris paribus*. While this impact conforms to prior expectation, it is worthwhile to point out that had just the unconditional ranking been employed, we would not have concluded that any impact exists. Nonetheless, once our conditional measure of inspection intensity is constructed, we do find a negative impact on business growth.

It is also interesting to note that, as we see in Table 6, INSRANKCOND's impact on establishment growth is consistent across size of production facilities. Growth in establishments generating 500 or more jobs is slower in states with a higher inspection proclivity ranking to nearly the same degree as growth in smaller establishments (employing less than 500 people) is retarded. That said, the results do point out some other differences in determinants of manufacturing establishment growth. For instance, smaller facilities tend to be attracted to states with higher productivity levels and lower poverty rates. However, firms tend to build larger facilities in states with a more favorable business tax climate.

¹⁷ The statistical significance of PRODUCTIVITYGR and the insignificance of EDUC may be picking up certain unobservable characteristics of the manufacturing establishment data. It may be that most of the establishments constructed are primarily the production and distribution of goods for which an established market exists. Were it possible to distinguish between production and distribution facilities and, say new product development and R&D facilities, EDUC may be a significant determinant of the latter and not of the former.

VI. Conclusion

When utilizing a more direct measure of enforcement to construct a conditional ranking of a state's proclivity towards environmental regulations, we find results that differ from existing rankings that measure such effects indirectly. When applied to the question of whether or not enforcement of existing regulations influences the growth of business establishment formation, we find that our conditional ranking of inspection proclivity does indeed have a significant deterring effect on such growth. Thus, our results generally support the notion that enforcement of environmental regulation hinders a state's manufacturing growth prospects.

There are several directions for future research. First, it may be of interest to conduct a similar analysis of the European Union and compare enforcement proclivity's impact on manufacturing growth with that of the United States. Second, it would be of interest to re-consider this analysis in a contemporary setting. For instance, states with a greater proclivity towards aggressive enforcement likely prompt improved compliance and better environmental stewardship on the part of its existing manufacturing base. If a cap-and-trade policy is adopted, these manufacturing firms may find themselves with a competitive advantage in carbon trading which many provide opportunities. We leave these questions for future research.

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Table 1. Unconditional State Rankings fore LQIN

STATE	Mean (unconditional)	Rank (unconditional)
AK	0.4475	47
AL	2.1967	2
AR	1.2579	12
AZ	0.5923	42
CA	0.8786	26
CO	0.8637	28
CT	0.6084	39
DE	1.8591	3
FL	0.9359	23
GA	0.8442	29
HI	1.1943	14
IA	0.4850	46
ID	0.7201	36
IL	0.9637	22
IN	1.1523	15
KS	1.0612	16
KY	1.4104	8
LA	1.2433	13
MA	0.5270	44
MD	2.3152	1
ME	0.7948	31
MI	0.7356	34
MN	0.5483	43
MO	0.7414	33
MS	1.2746	11
MT	0.9891	20
NC	1.3154	10
ND	0.9114	24
NE	0.9051	25
NH	0.4327	49
NJ	0.8766	27
NM	0.3640	50
NV	0.6003	40
NY	0.5060	45
OH	0.7051	37
OK	0.7791	32
OR	0.9811	21
PA	1.5049	6
RI	0.4378	48
SC	1.3211	9
SD	0.5979	41
TN	1.0445	18
TX	0.9898	19
UT	1.6624	4
VA	1.4746	7
VT	0.8239	30
WA	0.7210	35
WI	0.6213	38
WV	1.6180	5
WY	1.0524	17

Table 2. Summary Statistics

Variable	Mean	Standard Deviation	Observations
A. Variables used in inspections equation			
LQIN	0.978	0.501	450
LQENAVG	0.992	0.429	446
LQTRI	1.282	1.558	450
LQELEC	1.049	0.145	450
LQCIT	1.000	0.284	450
LQGOV	1.034	0.567	450
LQDENSIT	2.178	2.902	450
LQGSP	0.966	0.168	450
LQGSP26	1.099	1.031	450
LQGSP28	0.957	0.945	450
LQGSP29	1.406	2.269	450
LQGSP30	0.947	0.474	450
LQGSP33	0.940	0.810	450
LQTRI26	0.972	1.169	450
LQTRI28	1.152	2.902	450
LQTRI29	1.123	1.770	450
LQTRI30	1.070	0.977	450
LQTRI33	0.789	1.748	450
B. Variables used in establishment growth equations			
MAN2000	14,145.020	15,942.670	50
MAN1990	13,577.140	16,130.930	50
MANLG2000	4,186.840	4,414.917	50
MANLG1990	2,559.120	2,864.032	50
MANSM2000	9,958.180	11,696.210	50
MANSM1990	11,018.020	13,337.120	50
PRODUCTIVITYGR	1.161	0.115	50
EDUC	0.197	0.025	50
TAXIND	5.996	1.096	50
GREENINDEX			
INSRANK	25.500	14.577	50
INSRANKCOND	25.500	14.577	50

Table 3. Panal Regression Results (Fixed and Random Effects Models)
Dep. Var.: LQIN

Variable	Fixed Effects (FE)			Random Effects (RE)		
	Coefficient	p-value		Coefficient	p-value	
Constant	-1.3621	0.1230		0.6444	0.1502	
LQENAVG	0.0003	0.0315	**	0.0003	0.0276	**
LQTR[-2]	0.0130	0.7396		0.0326	0.2419	
LQELEC	0.5784	0.0540	*	-0.1280	0.5918	
LQCIT	0.2639	0.0808	*	0.0269	0.8306	
LQGOV	-0.0559	0.3127		0.0063	0.8883	
LQDENSIT	0.6083	0.0044	***	-0.0048	0.8255	
LQGSP	0.1826	0.7155		0.0921	0.7505	
LQGSP26	0.2104	0.0014	***	0.1429	0.0010	***
LQGSP28	-0.1248	0.0962	*	0.0818	0.0753	*
LQGSP29	-0.0015	0.9534		0.0053	0.7403	
LQGSP30	-0.1589	0.1527		-0.0375	0.6586	
LQGSP33	0.0619	0.3673		0.1317	0.0096	***
LQTRI26[-2]	0.0346	0.0835	*	0.0290	0.1233	
LQTRI28[-2]	0.0134	0.0658	*	0.0049	0.4718	
LQTRI29[-2]	-0.0562	0.0009	***	-0.0388	0.0113	**
LQTRI30[-2]	0.0257	0.4120		0.0020	0.9430	
LQTRI33[-2]	-0.0255	0.2224		-0.0091	0.6101	
Adj. R ²	0.79			0.35		
F Statistic (75,374)	18.88	0.000000	***			
LM Statistic (2 d.f.) ¹	567.80	0.000000	***			
Hausman Statistic (17 d.f.) ²	45.96	0.000175	***			

* - Significant at the 10% level.

** - Significant at the 5% level.

*** - Significant at the 1% level.

¹Higher values of the LM statistic favor the FE or RE models over the

²Higher values of the Hausman statistic favor the FE model over the RE model.

Table 4. Conditional State Rankings fore LQIN

STATE	FE state coeff.	Rank (conditional)
AK	0.80971	20
AL	1.67505	4
AR	0.94569	15
AZ	0.73872	21
CA	-0.3252	39
CO	1.00866	14
CT	-4.42904	47
DE	0.14131	33
FL	-0.71567	43
GA	0.23019	31
HI	-0.18953	37
IA	0.49044	27
ID	0.85098	17
IL	-0.12037	35
IN	0.32843	29
KS	1.24369	8
KY	1.025	13
LA	1.10689	10
MA	-5.0362	48
MD	-0.83883	44
ME	-0.58723	42
MI	0.21585	32
MN	-0.15012	36
MO	0.63607	24
MS	1.27902	7
MT	0.84638	18
NC	1.06685	12
ND	1.10178	11
NE	1.28257	6
NH	-0.54478	41
NJ	-6.97248	50
NM	0.59415	25
NV	1.19681	9
NY	-2.0142	46
OH	-1.19808	45
OK	1.55065	5
OR	0.66402	23
PA	-0.37936	40
RI	-6.35578	49
SC	0.93568	16
SD	0.72772	22
TN	0.40785	28
TX	0.83063	19
UT	1.7166	2
VA	0.58366	26
VT	0.24007	30
WA	0.07598	34
WI	-0.19915	38
WV	1.70364	3
WY	1.80528	1

Table 5. Growth in Manufacturing Establishments, 1990-2000
Dep. Var.: Ln(MAN2000)-Ln(MAN1990)

Variable	Coefficient	Coefficient	
C	-0.1397 (0.5991)	0.0394 (0.8302)	
MAN1990	-0.000003 (0.2575)	0.0000015 (0.2695)	
PRODUCTIVITYGR	0.0103 (0.1797)	0.0241 (0.0001)	***
EDUC	-0.6076 (0.4172)	0.2082 (0.7297)	
POVRATE	-0.3718 (0.5113)	-1.1897 (0.0288)	**
TAXIND	0.0307 * (0.1062)	0.0255 (0.1144)	
INSRANK	0.0014 (0.2909)		
INSRANKCOND		-0.0062 (0.0023)	***
GREENINDEX	0.0029 ** (0.0255)	0.0004 (0.8330)	
Adj. R ²	0.13	0.35	
F Statistic	2.09 * (0.0659)	4.76 (0.0005)	***

Note: White Heteroskedasticity-Consistent Standard Errors & Covariance.

p-values in parentheses.

* - Significant at the 10% level.

** - Significant at the 5% level.

*** - Significant at the 1% level.

Table 6. Growth in Manufacturing Establishments by Size, 1990-2000
Dep. Var.: Ln(MANx2000)-Ln(MANx1990)¹

Variable	Employment > 500		Employment <500	
	Coefficient		Coefficient	
C	-0.6386	*	0.1064	
	(0.0807)		(0.5454)	
MANx1990	-0.000001		0.000002	
	(0.9582)		(0.1690)	
PRODUCTIVITYGR	0.0194		0.0280	***
	(0.6510)		(0.0000)	
EDUC	1.2950		0.1579	
	(0.1772)		(0.7910)	
POVRATE	(1.2208)		-(1.6253)	**
	(0.1748)		(0.0038)	
TAXIND	0.0469	*	0.0235	
	(0.0657)		(0.1469)	
INSRANKCOND	-0.0078	***	-0.0061	**
	(0.0007)		(0.0032)	
GREENINDEX	-0.0012		0.0010	
	(0.6217)		(0.5731)	
Adj. R ²	0.41		0.26	
F Statistic	5.69	***	2.53	**
	(0.0001)		(0.0345)	

¹_x=LG, SM.

Note: White Heteroskedasticity-Consistent Standard Errors & Covariance.

p-values in parentheses.

* - Significant at the 10% level.

** - Significant at the 5% level.

*** - Significant at the 1% level.

Appendix Table A1. Variable Construction

Variable	Definitions	LQ Construction
LQIN	Inspections	$LQIN = \frac{IN_{STATE} / FAC_{STATE}}{IN_{US} / FAC_{US}}$
LQEN	Enforcement Actions	$LQEN = \frac{EN_{STATE} / FAC_{STATE}}{EN_{US} / FAC_{US}}$
LQENAVG	Enforcement actions	Four-year average of LQEN prior to LQIN
LQTRI	Per capita TRI releases (only the original core chemicals)	$LQTRI = \frac{TRI_{STATE} / POP_{STATE}}{TRI_{US} / POP_{US}}$
LQELEC	% of voting population by state for presidential elections 1988, 1992 and 1996	$LQELEC = \frac{VOTE_{STATE} / POP_{STATE}}{VOTE_{US} / POP_{US}}$
LQCIT	Ratio of a state's "citizen political ideology" score to the US average (Berry, Ringquist, Fording, and Hansen, 1998)	$LQCIT = \frac{CITSCORE_{STATE}}{CITSCORE_{US(avg.)}}$
LQGOV	Ratio of a state's "elected public official political ideology" score to the US average (Berry, Ringquist, Fording, and Hansen, 1998)	$LQGOV = \frac{GOVSCORE_{STATE}}{GOVSCORE_{US(avg.)}}$
LQDENSITY	population per square mile by state	$LQDENSITY = \frac{POP_{STATE} / AREA_{STATE}}{POP_{US} / AREA_{US}}$
LQGSP	real 1996 gross state product per capita	$LQGSP = \frac{GSP_{STATE} / POP_{STATE}}{GDP_{US} / POP_{US}}$
LQGSP26	% GSP in SIC 26 (pulp and paper) of total manufacturing GSP	$LQGSP26 = \frac{GSP26_{STATE} / GSPMAN_{STATE}}{GDP26_{US} / GDPMAN_{US}}$
LQGSP28	% GSP in SIC 28 (chemicals) of total manufacturing GSP	$LQGSP28 = \frac{GSP28_{STATE} / GSPMAN_{STATE}}{GDP28_{US} / GDPMAN_{US}}$
LQGSP29	% GSP in SIC 29 (petroleum refining) of total manufacturing GSP	$LQGSP29 = \frac{GSP29_{STATE} / GSPMAN_{STATE}}{GDP29_{US} / GDPMAN_{US}}$
LQGSP30	% GSP in SIC 30 (rubber and plastics) of total manufacturing GSP	$LQGSP30 = \frac{GSP30_{STATE} / GSPMAN_{STATE}}{GDP30_{US} / GDPMAN_{US}}$
LQGSP33	% GSP in SIC 33 (iron and steel) of total manufacturing GSP	$LQGSP33 = \frac{GSP33_{STATE} / GSPMAN_{STATE}}{GDP33_{US} / GDPMAN_{US}}$
LQTRI26	% TRI PER UNIT GSP in SIC 26 (pulp and paper) of total TRI PER UNIT GSP	$LQTRI26 = \frac{(TRI26_{STATE} / GSP26_{STATE}) / (TRIMAN_{STATE} / GSPMAN_{ST})}{(TRI26_{US} / GSP26_{US}) / (TRIMAN_{US} / GSPMAN_{US})}$
LQTRI28	% TRI PER UNIT GSP in SIC 28 (chemicals) of total TRI PER UNIT GSP	$LQTRI28 = \frac{(TRI28_{STATE} / GSP28_{STATE}) / (TRIMAN_{STATE} / GSPMAN_{ST})}{(TRI28_{US} / GSP28_{US}) / (TRIMAN_{US} / GSPMAN_{US})}$
LQTRI29	% TRI PER UNIT GSP in SIC 29 (petroleum refining) of total TRI PER UNIT GSP	$LQTRI29 = \frac{(TRI29_{STATE} / GSP29_{STATE}) / (TRIMAN_{STATE} / GSPMAN_{ST})}{(TRI29_{US} / GSP29_{US}) / (TRIMAN_{US} / GSPMAN_{US})}$
LQTRI30	% TRI PER UNIT GSP in SIC 30 (rubber and plastics) of total TRI PER UNIT GSP	$LQTRI30 = \frac{(TRI30_{STATE} / GSP30_{STATE}) / (TRIMAN_{STATE} / GSPMAN_{ST})}{(TRI30_{US} / GSP30_{US}) / (TRIMAN_{US} / GSPMAN_{US})}$
LQTRI33	% TRI PER UNIT GSP in SIC 33 (iron and steel) of total TRI PER UNIT GSP	$LQTRI33 = \frac{(TRI33_{STATE} / GSP33_{STATE}) / (TRIMAN_{STATE} / GSPMAN_{ST})}{(TRI33_{US} / GSP33_{US}) / (TRIMAN_{US} / GSPMAN_{US})}$

