The Persistence of Economic Factors in Shaping Regulation and Environmental Performance: The Limits of Regulation and Social License Pressures.

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This paper draws on a research project that explores the regulation of air pollution from heavy-duty diesel trucks, addressing two puzzles in the study of regulation:

(1) what factors affect the basic *design* of regulatory laws and programs?

(2) what accounts for *variation across individual firms* in environmental performance?

I. Why Trucks?

In explaining how regulatory programs are designed, one kind of theory, formalized by Chicago School economists such as George Stigler (1971), is that regulatory laws are shaped by well-organized business interests who use government regulation to limit competition and capture economic rents at the expense of diffuse, unorganized interests. Some political scientists have challenged that notion. They have shown that the political influences on regulatory policy design are more variable. Not infrequently, for example, regulatory laws are shaped by ideologically-motivated *policy entrepreneurs* who mobilize diffuse interests (Wilson, 1980), or who capitalize on the political opportunities that arise in the wake of widely publicized disasters, scandals, or frightening research findings (Bardach & Kagan, 2002: 22-25; D. Vogel, 2004; Levine, 2006: 217-223).

At the level of individual firm behavior, the traditional economic theory has been that business firms are "amoral calculators.' They spend time and money on complying with

regulations only to the extent the threat of costly legal sanctions, discounted by the probability of detection and punishment, outweigh the costs of compliance. And the implication of this theory is that regulated firms will not spend money on achieving regulatory goals, such as environmental protection, that are not required by law at all.

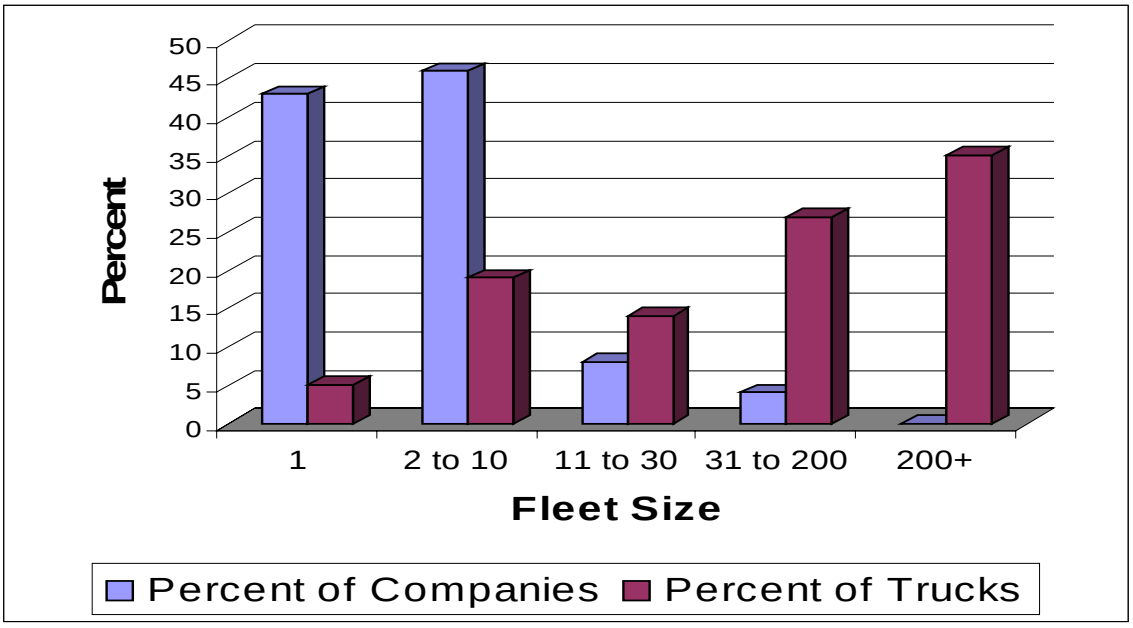
Sociolegal studies of regulation and compliance, on the other hand, have complicated the "criminology of the corporation" (Kagan & Scholz, 1984), showing that compliance efforts are not driven entirely by the risk of detection and punishment (Thornton, et al 2005), and indeed is common even when enforcement risk is fairly remote. Many firms spend money on "beyond compliance" environmental measures (Gunningham et al, 2003). To explain this, sociolegal scholars have pointed to the role of social norms (Vandenbergh, 2003) and of "social license" pressures – that is, pressures from employees, neighbors, activist organizations, and the news media (Gunningham et al, 2005). Many managers, these and other studies have shown (May,2004), are concerned about their own and their firms' reputation for law-abidingness, or being a good environmental citizen.

This research project was designed to explore the *limits* of such "social license" pressures in shaping firm behavior. Our own previous research concentrated on highly visible, closely-regulated industries – like large pulp and paper mills, and chemical companies – that have been subject of a great deal of regulatory attention. We conjectured, however, that social license pressures and corporate environmental management style (which we had found to be significant variables) might be less important in settings involving smaller firms, with less economic resources, and which receive less direct regulatory attention and social scrutiny. Those same

factors, we hypothesized, would provide new insight into economic and political theories of regulatory design.

To explore those ideas, we focused on the regulation of emissions from heavy-duty diesel-powered trucks in the United States, and did so for several reasons. First, the trucking industry constitutes a big, tough, and environmentally important regulatory target. Collectively, the industry operates a huge, ubiquitous, fleet of mobile sources of pollution, and collectively, their emissions are huge and particularly hazardous. Second, a large portion of the trucking market is served by thousands of small trucking firms. We found, as shown in Figure 1**,** that in 2005, there were 336,000 heavy duty diesel trucks registered in the state of Texas; 38% of them belonged to firms with no more than 30 trucks, and 24% were owned by 32,000 small companies with 10 or fewer trucks. Many of these firms operate on small margins. Finally, trucking companies, especially small trucking companies, have not been a major target of environmental regulation or of environmental activist groups, so that social license pressures presumably would be less salient.

Figure 1: Texas Fleet Size Distribution (2005)



II. Research Design

Our basic research design was first, to use archival sources to trace the political evolution of federal and state regulatory programs for diesel emissions. At the state level, we decided to concentrate on two – Texas and California – both large states with seaports, and lots of truck traffic, but with contrasting political climates, especially with respect to environmental policy in general and vehicular air pollution in particular. We also gathered statewide data on state programs and age of registered vehicles that enable us to compare overall progress in California and Texas in reducing emissions from heavy duty diesel vehicles.

To study variation in firm level environmental performance, we conducted intensive case studies of 16 small or medium sized trucking companies, 8 in Texas, 8 in California,

interviewing company officials in their primary places of business about their operations, motivations, and attitudes.

III. Regulatory Context and Regulatory Design

There are approximately 3 million heavy duty diesel trucks in the US involved in interstate commerce, and far more in intra-state commerce. They are the workhorses of the economy. Diesel engines are powerful and very durable. A new heavy duty diesel truck today costs in the neighborhood of $150,000, but a driver can buy an old one for $20,000 or less and start his own business. Barriers to entry into the market, therefore, are very low. This generates the economic contours of the regulatory context: a market for a vital service, but a market that comes very close to perfect competition, with many small firms, intense price competition, and low profit margins.

Then there are the environmental features of the regulatory context. The more diesel emissions are studied, the more dangerous they turn out to be. California regulators found that fine *particulate matter* (PM) in diesel emissions posed the highest risk of any air contaminant they had examined. A study of post-menopausal women found that living in areas with high levels of fine particulates had very substantial risk of death from cardiovascular problems. [1]Reviewing the evidence, the California Air Resources Board (CARB) estimated that PM and

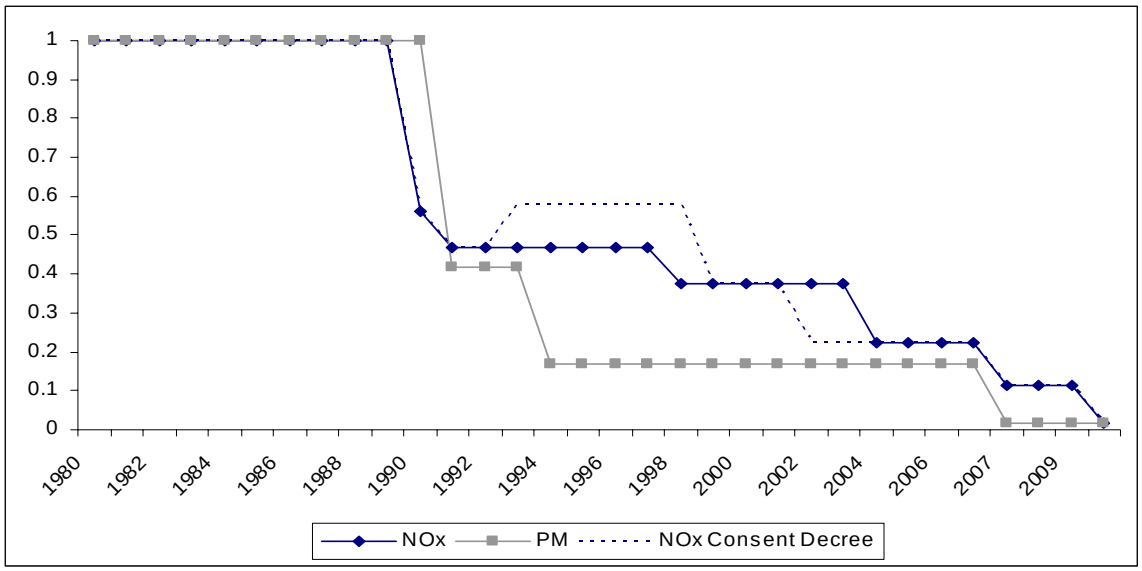
[1] Miller et al, 2007 found that in 2000, levels of PM2.5 exposure varied from 3.4 to 28.3 μg per cubic meter (mean, 13.5). Each increase of 10 μg per cubic meter was associated with a 24% increase in the risk of a cardiovascular event and a 76% increase in the risk of death from cardiovascular disease. UCLA researchers found "Children and adults who suffer from asthma and live near heavy vehicular traffic are nearly three times more likely to visit the emergency department or be hospitalized for their condition than those who live near low traffic density. For adults with asthma, medium to high traffic exposure increases the likelihood of chronic symptoms by approximately 40% to 80%. Moreover, living in areas of heavy traffic is a burden borne disproportionately by asthma sufferers who are ethnic/racial minorities or from low-income households. The issue is more pronounced among children than adults with asthma." (Meng et al, 2006)

another diesel engine pollutant -- NOx – are responsible for an average of 2,880 premature deaths per year in California alone.

A. Federal Regulation

Faced with this regulatory task environment, what have Congress and the EPA done? First, they imposed technology-forcing emissions-reduction standards on diesel engine *manufacturers*. The Clean Air Act Amendments of 1990 instructed U.S. EPA to set maximum emissions for heavy duty diesel engines Accordingly, as illustrated by Figure 2, EPA has periodically ratcheted down the maximum NOx and dPM standards for *new* heavy-duty diesel engines. For instance, 1992 models had to have maximum particulate emissions that were 50% below the level of engines produced in the 1980s; 1994 model years had to be still lower. 2007 model year engines had to cut emission from 1980 levels by over 95%. To achieve the 2007 model year standard, a new cleaner-burning diesel fuel was required, so EPA regulated oil refineries, compelling to make that kind of fuel available by 2005.

Figure 2: Proportional Declines in Federal NOx and PM Diesel Engine Emissions Limits (1980-2010) [2]



On the other hand, neither Congress nor EPA has required *owners and operators* of heavy-duty diesel trucks to scrap their old engines and *use* this gradually improving "best available control technology." In effect, older, dirtier trucks are "grandfathered in." And remember, diesel trucks last a long time. So while some companies will buy the greener new model year trucks, there is no restriction on their selling the older trucks to other truckers, who can sell their still older trucks to other trucking companies. Nor are operators of older engines subjected to any legal incentives to scrap them, such as sharply higher annual license fees or taxes.

[2] NOx emissions in 1993 – 1998 model years are shown 24% higher than the legal emissions limit, because most truck manufacturers used software in the electronic engine control module of the truck engine to switch to a more fuel-efficient (but higher NOx) driving mode when the truck was not being operated under federal test conditions. This resulted in a lawsuit charging the manufacturers of using "defeat devices." The dispute was settled and manufacturers in the resulting consent decree agreed to introduce engines meeting the 2004 standard in 2002.

The federal regulations, in short, don't deal with the obvious, hard problem – getting the old, dirtier trucks off the road. How can we explain this obvious gap in the federal regulatory scheme?

The Economic Problem. The standard "polluter pays" regulatory design is based on the theory that the costs of engineering, purchasing and using best available technologies will be passed on to the ultimate users of the products or service in question. Prices will then reflect *all* the costs of production, including the internalization of environmental harm. But trucking companies operate in a market that comes very close to perfect competition – profit margins are very thin; firms are small, numerous, have little pricing power, and can't coordinate price increases; and hence can't pass on the cost of new environmental control technology – new engines – to their customers. And a large proportion of firms simply cannot come up with the capital costs for the best available control technology (a new truck). The general lesson for policymakers is that perfect competition of that kind jeopardizes the traditional "polluter pays" regulatory strategy, especially in the face of expensive control technology.

The Political Problem. Consequently, banning old, heavily-polluting trucks (or accomplishing the same through high fees or taxes) would destroy tens of thousands of small businesses, in effect confiscating their sole business assets (on which many of them owe money). It might also result in consolidation of ownership into a smaller number of trucking firms who *could* finance the new trucks, and result in higher rates and shipping costs – precisely what the deregulation of trucking in 1980 was designed to stop. Hence neither Congress nor the EPA was close to being willing to face the political storm that would come from mandatory, rapid phasing-

out of older, more polluting trucks. That was the case even though, by our rough calculations, the aggregate national cost of replacing the diesel fleet – which would run into the billions of dollars – is still less than the aggregate monetary benefits of lives saved by reduction of the dangerous emissions.[3]

Contrary to standard theory, therefore, in terms of the politics of regulatory design, the best-organized industries, with small numbers of very large corporations – motor vehicle engine manufacturers and petroleum refiners – were subjected to demanding technology-forcing regulations, and a diffuse industry with many very small firms was *not* forced to bear the regulatory costs. Even the policy entrepreneurs on the environmental side did not seem to want to go after them, because the political risks of driving many small entrepreneurs out of business seemed too high. The sheer economic cost of compelling them to upgrade, it seems, was the controlling factor -- an economic explanation, to be sure, but not the traditional economic theory.

One might imagine that *large* trucking firms would comprise a powerful political lobby for regulatory mandates requiring rapid phase-out of old trucks, since big firms would be better able to afford the new trucks and raise rates as thousands of small firms dropped out of the industry. As best as we can tell, such a lobby has not materialized because many large trucking firms rely

[3] Here are our estimates for California:

Deaths per year	Number of years	Cost of premature death	Total Cost
3,000	10	$2,000,000	$60,000,000,000
Trucks in California		Cost to replace a truck	Total Cost
250,000		$150,000	$37,500,000,000

If a new best-pollution technology model currently costs approximately $150,000, replacing the approximately 3 million heavy-duty diesel trucks nationally would cost $450 billion.

primarily on subcontracts with small truckers – and those large firms' costs could be expected to increase sharply if their subcontractors were required to buy new green trucks (and their ranks were sharply depleted). Put another way, the American Trucking Association, dominated by large firms, was divided between members who profited from the intense competition among smaller trucking firms with cheaper, older trucks, and those that didn't.[4]

B. Delegating the Problem to the States

Faced with the economic and political problems discussed above, what *did* the federal government do to accelerate the phasing-out of old trucks?. First and foremost, it passed the problem on to state governments. In 2002, after much political contention and litigation, EPA sharply tightened National Ambient Air Quality Standards (NAAQS) for ozone and fine particulates. NOx, a precursor of ground-level ozone, is one of the major emissions of diesel engines, and diesel trucks are a major source of NOx and particulates. Pursuant to the Clean Air Act, state governments must file with EPA state implementation plans (SIPs), showing how they will attain the NAAQS. After the new standards were promulgated, therefore, EPA could pressure state governments that couldn't meet the new PM and ozone standards to do more to phase out the older, more polluting diesel engines. EPA's regulatory stick in that regard is its legal authority to cut off federal highway funds to states that don't meet their SIP air quality goals.[5]

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[4] See generally Levine (2006) (noting that deregulation typically makes firms in an industry more *diverse,* and hence likely to have different policy goals).

[5] The threat is real enough that in states with "non-attainment areas," state bureaucrats work hard to achieve what is called "transportation conformity," constantly estimating total emissions from transportation sources and searching for regulations that will reduce those total vehicle-generated emissions.

Additionally, the federal government offered carrots rather than sticks. States were offered federal funding for carefully formulated plans that would provide substantial financial *subsidies* for vehicle owners who purchased new cleaner vehicles (either new diesel engines or alternative fueled vehicles) and retired (not re-sell) the old dirty ones.

C. State Programs: Texas and California.

So what did the states do? We looked at policy-design in Texas and in California. Texas did comparatively little, partly because, unlike California, it has few "non-attainment areas." As of the end of 2006, there was still nothing in Texas SIPs or new regulations that apply directly to trucking companies. Texas *did* establish a substantial *subsidy program,* however, using state as well as federal funds.

California has been more aggressive. As in the case of automobile emissions, strong demand for lower emissions from Los Angeles and Riverside Counties have driven state policy, since populous southern California is so powerful in Sacramento. Thus California adopted its own progressively tighter standards for new diesel *engines,* paralleling and occasionally leading federal regulations. California regulations require truck fleet owners to perform annual tests on their own vehicles (to prevent extra emissions due to poor maintenance) and state officials periodically inspect fleets to see that this is done. The California Air Resources Board (CARB) deploys roadside "strike teams" of inspectors who move from locality to locality to pull over diesel-powered trucks to check for excessive smoke. California also raised annual registration fees for all motor vehicles to help pay for subsidies for the purchase of new, lower-polluting

vehicles, although officials directed these subsidies mostly to operators of school and urban transit bus fleets.

Moreover, after declaring diesel emissions a toxic air pollutant under state law, (CARB) imposed restrictions on idling of heavy-duty diesel vehicles, first for school buses, and in 2005 for commercial trucks. CARB also promulgated regulations requiring companies to, in effect, phase-in a ban of older trucks. CARB required this first in vehicles that operate in residential neighborhoods - urban transit buses and garbage trucks – then in October 2006 for publicly-owned diesel truck fleets (with first actions required by December 2008), and then in December 2007 for port drayage fleets. CARB's drayage truck rule was designed to bolster a phased-in ban of older diesel vehicles by the Ports of Los Angeles and Long Beach. In conjunction with the ban, the Ports imposed fees on the beneficial cargo owner of containers moving in and out of the ports, beginning January 1, 2008, and the fees are to be used to subsidize the purchase of new trucks by private drayage companies. Exactly how the subsidy/financing program will work has yet to be decided. And at best, the plan is expected to drive hundreds of small owner-operators out of business, which raises questions about its ultimate viability. Port action has been driven by local communities' ability to prevent any further port expansion unless environmental health concerns are addressed (a good example of social license pressures at work), as well as by the Ports' distinctive ability to regulate access and to impose higher fees on shippers and their customers.

Nevertheless, California has only *proposed* phase-out controls on the *major* source of diesel emissions from heavy-duty trucks– the thousands of over-the-road private diesel truck companies who operate older trucks in the state.

D. Consequences.

Due to its subsidy programs and fleet average improvement regulations, California has made considerable progress in reducing diesel emissions from urban bus fleets.[6] But for trucking firms, which are much more numerous, there are no fleet emissions reduction regulations in California or Texas. And because of the huge economic costs of improvement in that sector, government subsidies have amounted to little more than a drop in the bucket. We found that Texas, for example, has spent $57 million in subsidies. But that has replaced only 1,300 trucks. Yet in 2006, there were approximately still 38,000 trucks in Texas with 1990 or earlier model year engines. If we extrapolate the average subsidy cost per new green truck in Texas – $44,000 – to all the 38,000 pre-1990 trucks, it would cost $1.7 billion in subsidies to get them off the road. And that is just Texas!

The first conclusion of our project, therefore, is that in highly competitive, populous and unprofitable markets, like trucking, *economic variables* are *primary* in structuring the politics that shape regulatory laws and programs. In this case, the sheer enormity of the economic cost of "greening" the national fleet of heavy-duty diesel vehicles has limited the coerciveness of direct regulation of vehicle owners and operators. BAT regulations would drive too many firms out of business to be politically feasible. Only when there have been countervailing economic pressures

[6] According to 2004 data, alternative fuel vehicles constituted 43% of the 10,000+ urban bus fleet in California, and 17% of the entire *diesel* bus fleet has had a particulate emissions control system installed.

(such as port communities' threat to limit port expansion) have these politically difficult steps been taken. And that same economic factor – the enormous cost of upgrading a huge fleet of vehicles – has dwarfed the reach and effectiveness of the governmental subsidy programs.

IV. Company-Level Variation in Environmental Performance

Progress in reducing harmful emissions from heavy-duty diesel-powered trucks ultimately depends on the behavior of the thousands of companies that purchase and operate the vehicles. Yet as we have seen, those companies are not legally *obligated* to buy the newest, "greenest" engines. With rare exceptions, trucking firms are not obligated to reduce idling or adopt other measures (including fuel-efficiency measures) that incrementally reduce emissions. Any rapid improvement of air quality in this sector, therefore, depends on individual firms' willingness to engage in what regulatory scholars have labeled "beyond compliance" behavior. Another, and major, part of our research, accordingly, focused on trucking companies. We sought to determine why some firms, but not others, had purchased newer, less-polluting engines and why some, but not others, had adopted day-to-day operating practices that reduce emissions (such as introducing controls on driving speeds and idling time, or superior engine maintenance).

A. Framework for Analyzing Company-Level Variation

We approached the problem of explaining company-level variation in environmental performance by using a conceptual framework that was derived from our previous research. We viewed facility-level environmental performance as shaped first of all by the interaction of a firm' environment – the terms of (1) their *economic license* (that is, the market-based imperatives and constraints they face; (2) their regulatory license (that is, legal obligations and threats); and (3) their social license (that is, pressures from communities, advocacy groups,

employees, newsmedia). But our prior research provided clear evidence that these external license pressures are interpreted, filtered, and negotiated by *management attitudes and commitments,* which vary from indifference or resistance to environmental concerns to higher levels of environmental awareness and engagement. Firms' environmental management styles, we found, had significant effects on the environmental performance of individual facilities, reinterpreting, amplifying or dampening the impact of the economic, regulatory and social license factors the facility encountered.

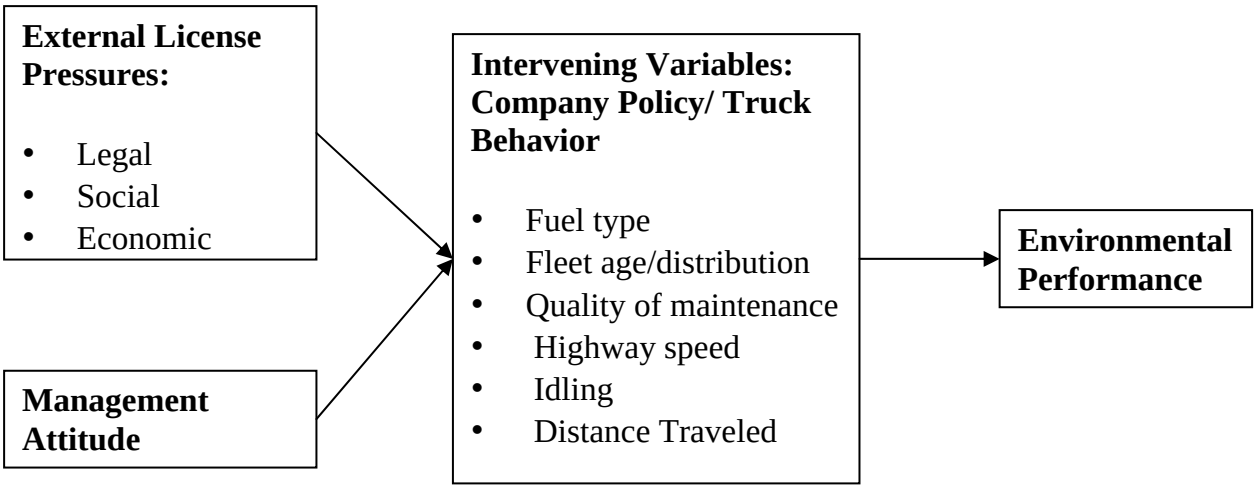
Applying this framework to trucking firms, we soon found, is complicated by the number and technical factors that affect each truck's (or fleet of trucks') environmental performance. Emissions of NOx and PM from a particular diesel engine can vary dramatically depending on the model year of the vehicle, the ambient temperature and humidity, the altitude and incline at which the truck is being driven, the speed and load of the vehicle, and the kind of fuel it is burning, and the amount of time the vehicle idles.[7] Regulators' models of environmental performance posit that in broad terms, a trucking company's environmental performance is determined by six basic factors: (1) the type of fuel used (diesel versus natural gas), as well as the formulation of the diesel fuel it regularly has access to; (2) the age-distribution of the fleet, qualified by deterioration in its trucks' emissions systems over time; (3) the quality of its maintenance program; (4) the average speed at which its trucks travel, as affected by the average time its fleet spends cruising the highway versus battling traffic on city streets; (5) the amount of time its trucks, on average, spend idling; and (6) the number of miles its trucks travel.[8]

[7] When one reads estimates of 'grams per mile' for a given vehicle's emissions, they are actually estimates of emissions over average driving conditions and loads.

[8] The relationships among these factors are complex. For example, for some model years, a cruising speed of 65 miles per hour will result in increased NOx emissions, and for other model years, a decrease.

All of these factors can be affected, of course, by a firm's economic license, by regulation, and by company policy. Thus we conceptualized the six technical or operating factors as intervening variables, between the external license factors and management attitudes, on the one hand, and firm environmental performance on the other, as indicated graphically in Figure 3.

Figure 3 : The Relationship Between External License Pressures, Management Attitude and Environmental Performance is Determined by a Series of Intervening Variables Amenable to Regulatory and/or Company Policy



B. The Sample

We conducted a series of 16 case studies of small and medium-small trucking companies, focusing closely in each case on the relationship between the external factors and the six intervening variables. We conducted in-depth interviews 8 firms in California, 8 in Texas. As in our pulp mill study, we used this small-n sample because of the gaps and bluntness of most official sources of aggregate compliance-related data, and because of the inability of large-n research to plumb the attitudes and motives of company officials. The remedy, we believe, is *in-depth* interviews and *detailed firm-specific* environmental performance data. That is a very labor

intensive research strategy, however, ,as is the process of contacting prospective respondents and inducing them to participate in the study. Hence only a 16 firm sample seemed feasible, given budget constraints.

We devised a stratified sampling framework to assure that we would get some medium-sized and some very small trucking firms. And within those categories, in order to assure we had some variability, we used state data that provided some indication of which firms had good environmental performance (e.g. average age of trucks) and which were average or poor, and sampled within those. We interviewed company owners or operations managers at their primary place of business, obtaining technical information about their operations (including their relative performance on the six intervening variables, their economic license, and management policies and attitudes. [9]

C. Findings

Our most important finding is that in an extremely competitive market like trucking, dominated numerically by small companies with low social visibility and few direct pressures from environmental regulators, *social license pressures are weak and managers' environmental consciousness is minimal*. Company-level variation in environmental performance does exist, but it flows primarily from *economic* variables.

[9] More specifically, we asked participants to describe specific policies or practices they had put in place in order to improve fuel economy; criteria they considered in making truck purchases; what they saw as the industry's environmental and health impacts; which government regulations had the biggest impact on their company; what role (if any) government subsidies had played in their company; and what role environmental agencies, community groups, and environmental groups had played in the life of the company. We obtained data on the age distribution of their truck fleet, fuel used (diesel vs. alternative), maintenance practices, amount of time their trucks idled, policies to decrease idling times, miles per year their trucks traveled, the speed at which their trucks were governed (or other policies the company had in place to influence truck speed), and the fuel economy of the fleet. We also asked companies to rate their own environmental and economic performance on a scale of 1 (worse than average) to 5 (excellent). We asked companies about their prior experience with environmental and safety regulators. We asked for relatively detailed information about the maintenance practices at the company, and technologies the company had considered and/or adopted that would impact fuel efficiency and idling.

Economic license pressures on trucking companies operate on three levels: (a) *the general market* – how well the economy is doing, the price of fuel, the price of labor where the company operates (California generally has more expensive fuel, labor, worker's compensation and other costs.); (b) the particular firm's *market niche* – the kinds of goods are being hauled, how far they are being hauled, day-to-day decisions designed to decrease costs and meet specific customer demands; and (c) company-level *financial condition*. The choices made by a company regarding determinants of environmental performance reflect a mixture of these elements, but certain choices tend to be dominated by one particular level. Figure 4 summarizes the impact of economic license pressures on company-level fleet characteristics that determine fleet emissions. It shows clearly that most economic factors have both positive and negative effects on emissions. Unfortunately the *net effect* of each economic factor is difficult to predict.

Figure 4: The Impact of Economic License Pressures on Company-Level Fleet Characteristics that Determine Truck Fleet Emissions

Economic Factors		Effect of Economic Factors on the Determinants of Environmental Performance	
		Better Emissions	**Worse Emissions**
General Economy	Expanding Economy → higher revenues, More capital*	• Younger fleet (more capital) within niche limits*	• More miles***
	More Expensive Diesel Fuel → Incentive for fuel cost controls** Less capital**	• Less idling • Better maintenance • Better logistics (fewer miles for same deliveries) • Lower highway speed	• Older fleet (higher costs, less capital)
	More Expensive Labor, Workers' Compensation, etc. → Less available capital*, more incentive for fuel cost controls**	Fuel cost controls viz.: • Less idling • Better maintenance • Better logistics (fewer miles for same deliveries) • Lower highway speed	• Older fleet
Market Niche	Long Trips → need for more reliable trucks**	• Younger fleet • Better maintenance	• More idling • More miles
	Sensitive goods More reliable trucks**	• Younger fleet • Better maintenance	
	Customers demand speedy delivery More reliable trucks**	• Newer fleet • Better maintenance	• Faster highway speeds
Company Financial Condition	Company doing well (more capital)**	• Better maintenance • Newer fleet within niche limits • Able to install idling-control equipment	

* based on inference; ** based on interview evidence; *** based on literature

We measured company-level environmental performance in a variety of ways, since no single summary measure captures it. We estimated each firm's NOx and PM emissions per truck and per mile, relying both on formulas created by the California Air Resources Board and on information provided by each company – the age distribution of their fleet of trucks, average miles driven per year per truck, the quality of the firms' maintenance practices, average highway speed of operation (which may be mechanically governed), and the intensity of the company's controls on idling time. We then ranked the 16 firms on each measure, and averaged the company's environmental performance rankings across all measures.

Using this summary measure, we find that no single explanatory or intermediate factor dominates. Some companies that report their financial conditions as "excellent" are only middling environmental performers. The same is true for companies in market niches that encourage younger fleets and better maintenance. Texas and California differ in terms of the general economy factor (with higher labor costs in California, for example), but within each state some companies are excellent environmental performers and others are weak. Similarly, competition and high fuel prices impel many of the companies we studied, particularly those based on California, to emphasize fuel economy in their operations – and fuel economy tends to reduce harmful emissions. But some of our California companies worked on fuel economy more intensively than others, and hence had better environmental performance. But as noted above, they did so not to reduce emissions but in order to control fuel costs.

To state our findings more generally, trucking companies that had better environmental performance most often did so as a byproduct of actions undertaken primarily for economic reasons, such as avoiding the cost of external repair services, late delivery penalties, customer complaints about reliability, and rising prices for fuel.

We also found that medium-sized companies – those with more than 100 vehicles – had a higher proportion of newer trucks (2003 or later model year), and they were much more likely than smaller truck companies to say they were 'doing well' economically. That indicates that size and profitability also are important factors in enabling companies to acquire the capital necessary to turn over their fleets – and thereby reduce emissions.

V. Conclusion

In sum, in the regulation of emissions from heavy-duty diesel trucks in the United States, economic factors have been the dominant factors shaping both company-level environmental performance and the substance of regulatory laws and regulations. More specifically, in an extremely competitive market like trucking, dominated numerically by small companies with low social and regulatory visibility, social license pressures are weak and environmental consciousness is minimal. Company-level variation in environmental performance flows primarily from economic variables – which induce technological investments and management practices designed to reduce costs – and may reduce emissions as a side effect.

At the aggregate level, even in a 'green' state like California, regulators and politicians have only recently begun to consider direct regulations requiring private trucking companies -- by far the largest source of harmful NOx and PM emissions -- to rapidly phase out older, more polluting diesel trucks or engines. The reason, we speculate, again is an economic one: the staggering cost of retrofitting or replacing large portions of the entire diesel fleet, destroying the residual economic value of old trucks. That is why, we believe, both federal and state regulators have focused on new vehicle emissions standards while ignoring how long diesel trucks are kept in operation; why they have shied away from requiring trucking companies (by direct regulation or by fees) to install best available control technologies and scrap older polluting vehicles; and why they have focused on subsidy programs that are too small to have more than a marginal impact on the dangerous emissions of older diesel trucks.

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