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Compliance Costs, Regulation, and Environmental Performance: Controlling Truck Emissions in the United States

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In explaining regulatory policymaking and the behavior of regulated business firms, scholars have supplemented economic models by emphasizing the role of public-regarding entrepreneurial politics and of normative pressures on firms. This article explores the limits of such entrepreneurial politics and “social license” pressures by examining regulation of emissions from diesel-powered trucks in the United States. We find that the economic cost of obtaining the best available control technology – new model lower-emissions engines -- has (a) limited the stringency and coerciveness of direct regulation of vehicle owners and operators; (b) dwarfed the reach and effectiveness of the governmental programs that subsidize the purchase of new less-polluting vehicles; and (c) elevated the importance of each company’s “economic license” – as opposed to its “social license” – in shaping its environmental performance. The prominence of this “regulatory compliance cost” variable in shaping both regulation and firm behavior, we conclude, is likely to recur in highly-competitive markets, like trucking, that include many small firms that cannot readily afford or pass on the cost of best available compliance technologies.

Two theoretical problems run through the literature on regulation: what is the relative importance of economic versus social pressures in (1) shaping regulatory programs and (2) influencing how responsive (or resistant) regulated enterprises are to regulatory laws and norms? This article reports the results of an empirical study of the regulation of emissions from heavy-duty diesel trucks in the United States. As a single case study, it cannot provide any definitive answer to the two problems. But the study casts some light on both issues by pointing to the kind of regulatory environments in which one significant economic variable -- the magnitude of the costs to regulated firms of meeting regulatory objectives -- is likely to be a dominant causal factor both in policymaking and in influencing individual firm behavior.

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I. Two Regulatory Dilemmas

The traditional “market failure” theory of regulation holds that government regulation is necessary, and often comes about, when markets fail to provide the information that individuals need to protect themselves from harm and injustice, or to correct for the frequent negative side-effects of or externalities of business activity (Coglianese & Kagan, 2007). In contrast to this “public-interested theory” of regulation, the “public choice” theory, most prominently propounded by economist George Stigler (1971), is that regulatory programs, at least in the United States, are shaped by an economic logic. In the fragmented American political party system, where members of Congress must seek their own campaign funds to retain office in frequent elections, legislators depend on support from organized interest groups. Moreover, the logic of collective action (Olson, 1965) holds that concentrated groups, such as potentially regulated businesses, have an inherent organizational advantage vis-à-vis diffuse, unorganized interests, in delivering support and information, and hence in influencing Congress. Using that advantage, the “public choice” theory goes on, concentrated business interests induce Congress to enact or add amendments to regulatory statutes that shield those businesses from competition, enabling them to gain economic rents at the expense of diffuse, unorganized interests and the society at large. Furthermore, public choice theorists assume, concentrated interests use their organizational and other advantages to influence policymakers in regulatory agencies, both directly and by mobilizing their political allies in Congress to lean on agency officials.

But challenging that economic “producer dominance” theory, some political scientists and legal scholars have offered a “neo-public-interest” account of regulation. They point out that

the political influences on regulatory policy design and on agencies – and hence on regulatory outcomes - are more diverse. Not infrequently, these scholars observe, regulatory laws are shaped by ideologically-motivated policy entrepreneurs – politicians, regulatory officials, advocacy groups -- who fight for laws and regulations that do protect diffuse, unorganized interests, such as those who would benefit from strict environmental regulation (Wilson, 1980). Such policy entrepreneurs can overcome the advantages of concentrated business interests, for example, by exploiting the broad-based social pressures and political demands that arise in the wake of widely publicized disasters, scandals, or disturbing research findings (Bardach & Kagan, 2002: 22-25; Levine, 2006: 217-223; Rothenberg, 1994). Moreover, post-1960s administrative law, it is argued, grants regulatory policymakers a good deal of independence from members of Congressional and industry group pressure, compelling them to base regulations on reliable data and rational policy-analysis (Croley, 2008). Thus, it is argued, regulation often – but not always – emerges from a process that is more pluralistic, more responsive to widespread social expectations, more likely to serve the public interest than the economists’ producer dominance image of the process (Croley, 2008; Farber 1992). Left unclear is when and under what conditions the political entrepreneurs and rational regulatory officials or the concentrated regulated business groups get the upper hand in shaping regulation.¹

In addition to this ongoing debate, it seems likely that a third causal factor – what we might label the “regulatory cost theory” – would play a role in regulatory regime design. Even if public opinion, as articulated by policy entrepreneurs, provides the impetus for the enactment of regulatory regimes, it is likely that economic factors still matter. One could hypothesize that the more ambitious the proposed regulatory standard, the more it threatens to change or disrupt

¹ It is of course possible, and indeed quite common, that regulatory statutes are influenced by both the public-regarding political entrepreneurs and the self-seeking industry groups, containing some provisions favored by one, some by the other.

existing ways of living and doing business, the more costly and technically difficult it is for regulated businesses to comply with, then the more likely it is that affected groups or businesses will protest and that democratic politicians will moderate the stringency of proposed regulations. Regulatory rule-makers, attentive to their political overseers and funding sources, would do the same.² Stringency may be moderated because politicians dislike being charged with passing laws whose social costs exceed their social benefits – a good public-regarding reason. But stringency also may be moderated if the *political* costs of imposing significant levels of disruption are seen to be too high. Thus is it common for new environmental regulatory regimes to impose tougher controls on new facilities than on those long in existence, due to the higher cost of retrofitting old ones (Nash & Revesz, 2007), and also to impose less demanding requirements on small businesses, which find it much harder to afford to comply in full (Gunningham, 2002; **Johnston, 2006**). In this way, economic factors not infrequently trump idealism or public opinion in shaping regulatory rules. But not always, as indicated by the analyses showing that many regulatory statutes and rules impose compliance costs that are far higher than necessary or even exceed likely social benefits (Yandle, 1999; Hahn , 1996).

It seems clear, therefore, that none of the theories propounded always holds; they merely to point to causal factors or variables that often matter and that interact in shaping regulation. The challenge is to figure out under what conditions each of the factors mentioned – the influence of concentrated business interests; broad-based public desires as advanced by policy

² This regulatory cost scenario differs from the traditional public choice theory in that it does not hinge on how concentrated or well-organized the affected regulatory targets are. The threat of unaffordable regulatory costs, in this view, can stimulate mobilization on behalf of large, unorganized or loosely organized groups, and the anticipation of mobilization of large numbers of firms may influence legislators and regulatory officials *ex ante*. Moreover, the regulatory cost scenario, in contrast to the original public choice theory of regulation, does not entail interest-group mobilization to gain protection from competition or a comparative advantage over competitors.

entrepreneurs; or the relative economic cost of regulation –are likely to play the most prominent role in the politics and design of regulatory regimes.

Yet another dilemma concerns the relative importance of economic variables and social pressures in affecting business response to regulatory programs and goals. With respect to individual firm behavior, traditional economic theory has held that business firms are “amoral calculators” who 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. This theory implies that regulated firms will not spend money on achieving regulatory goals, such as environmental protection, that are not required by law at all, unless they think they can cut costs or improve market share by doing so. Sociolegal studies of regulation and compliance, however, illustrate a more complicated “criminology of the corporation” (Kagan & Scholz, 1980); they have shown that compliance efforts are not driven entirely by the risk of detection and punishment (Thornton, et al 2005), and indeed are common even when enforcement risk is fairly remote. Many firms spend money on “beyond compliance” environmental measures even when there is no clear positive return on investment (Gunningham et al, 2003). To explain this, sociolegal scholars have pointed to the role of social norms (Vandenberg, 2003) and of “social license” pressures – that is, direct pressures on firms from employees, neighbors, activist organizations, and the news media (Gunningham et al, 2005). Many business firm managers, these and other studies have shown (May, 2004), are concerned about their own and their firms’ reputation for law-abidingness, or for being a good environmental citizen. But not always and not for all firms. Again, the question is under what circumstances do economic motives versus social and normative pressures dominate in shaping the response of individual firms to regulatory values?

The research project discussed in this article was designed partly to explore the *limits* of “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 which have skimpier economic resources and which receive less direct regulatory attention and social scrutiny (see Lynch-Wood & Williamson, 2007). In those settings, we also hypothesized, the politics of regulatory design might depart from both the public choice and neo-public-interest theories and be shaped more by the economic costs of compliance -- and hence cast new light on existing theories of regulatory policymaking.

To explore those ideas, we focused on the regulation of emissions from heavy-duty diesel-powered trucks in the United States. The trucking industry constitutes a big, tough, and environmentally important regulatory target. Collectively, the industry operates a ubiquitous fleet of mobile pollution sources. Collectively, their emissions are enormous and particularly hazardous. Moreover, a large portion of the trucking market is served by thousands of small trucking firms. For example, 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.

Our research design was first, to trace the political evolution of federal and state regulatory programs for diesel emissions, using primarily archival sources. At the state level, we concentrated on two jurisdictions – 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 enabled 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. Our methods in that phase of the study are discussed in Section II, below.

II. 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. In 1998, according to California's Air Resources Board (CARB), a typical diesel-fueled bus emitted more nitrous oxide (NO_x) and particulate matter (PM) than would a busload of riders who drive the same route in individual automobiles. The more diesel emissions are studied, the more dangerous they turn out to be. California regulators found that *fine particulate matter* in diesel emissions (dPM) posed the highest risk of any air contaminant they had examined. Individual exposures to diesel exhaust are intensified where large numbers of trucks or buses sit idling their engines, such as near seaports' marine terminals, highway choke points, large truck stops, and (with respect to buses) outside schools or large sports events.³ 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.⁴ Reviewing various studies, CARB estimated that PM and another diesel engine pollutants – are responsible for an average of 2,880 premature deaths per year in California alone.

A. Federal Regulation

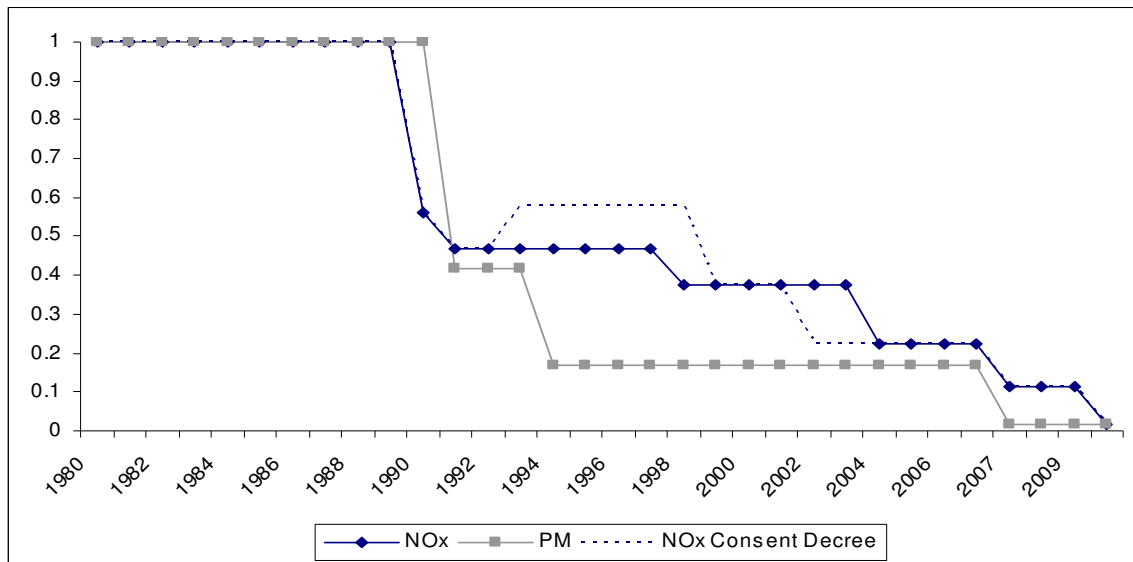
Faced with this regulatory task environment, what have Congress and the U.S. Environmental Protection Agency (EPA) done? First, they imposed technology-forcing emissions-reduction standards on diesel engine *manufacturers*. The Clean Air Act Amendments of 1990 instructed U.S. EPA to set maximum emissions for heavy duty diesel engines, taking

³ 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)

⁴ Miller et al, 2007 found that in 2000, levels of PM_{2.5} 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.

both cost and best available technology trajectories into account (Walsh, 1991). Accordingly, as illustrated by Figure 2, EPA has periodically ratcheted down the maximum NO_x and PM standards for *new* heavy-duty diesel engines.⁵ 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 also regulated oil refineries, compelling them to make that kind of fuel available by 2005.

Figure 2: Proportional Declines in Federal NO_x and PM Diesel Engine Emissions Limits (1980-2010)⁶



⁵ The Act also authorized the agency to promulgate onboard diagnostic control requirements, designed to ensure that factory-set emissions limits are being met continuously (Walsh, 1991).

⁶ NO_x 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 NO_x) 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.

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.” The basic structure of the Clean Air Act, in place since 1970, authorized EPA to regulate *new model year* vehicles and engines, but not in-use vehicles. Banning, mandatory phasing out, or requiring radical rebuilding of old diesel engines would have required a fundamental revision of that regulatory structure – a step that was not prominent in any of the leading proposals or political debates surrounding the major amendments to the Act in 1977 and 1990.

In effect, therefore, older, dirtier trucks are “grandfathered in.” And as noted, diesel engines last a long time. So while some companies buy the greener new model year trucks, there is no restriction on their selling their older (and more-polluting) trucks to other truckers, who can sell their still older (and still-more-polluting) trucks to other trucking companies. Nor did Congress (or EPA) give operators of older trucks legal incentives to retrofit or scrap them, such as by imposing sharply higher annual license fees or taxes on older engines.

The federal laws and regulations, in short, don’t deal with the obvious, hard problem – getting the old, dirtier trucks off the road. How can one account for 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, or

“internalize,” all the product’s environmental costs. But trucking companies operate in a market that comes very close to perfect competition. Profit margins are very thin. The majority of firms are small, precariously financed, have little pricing power, and can’t coordinate price increases with others.⁷ Hence most truckers *can’t* expect to be able to pass on to their customers the cost of new environmental control technology – new or retrofitted engines. Moreover, 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 is that perfect competition of the kind seen in trucking jeopardizes the traditional “polluter pays” regulatory strategy, especially when most regulated enterprises can’t afford the required 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 in a much smaller number of trucking firms who *could* finance the new trucks, leading to less competition, higher rates and higher shipping costs – precisely what the deregulation of trucking in 1980 had finally ended. Hence neither Congress nor the EPA was close to being willing to face the political storm that could be expected to follow a 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

⁷ According to the American Trucking Association’s former Vice President for Environmental Affairs, Allen Schaeffer, low barriers to entry have driven freight rates down to the point that for every dollar earned, profit levels are about 2-3 cents, and that margin is easily eroded by jumps in fuel costs (since most carriers are too small to do anything about hedging price and are reluctant to add fuel surcharges). Moreover, small companies, Schaeffer thinks, probably do not charge the full costs of moving goods (e.g. failing to charge for such costs as drivers’ waiting time). Interview, December 5, 2006. That situation has surely been exacerbated by the very large, sudden increase in diesel fuel prices in 2007 and 2008.

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.⁸

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 (Oren, 2006; Crowley, 2008), EPA sharply tightened the National Ambient Air Quality Standards (NAAQS) for ozone and fine particulates. NO_x, a precursor of ground-level ozone, is one of the major emissions of diesel engines, and diesel trucks, as noted earlier, are a major source of NO_x 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 (Tabb & Malone, 1997:368-370). 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.⁹

⁸ Here are our estimates for California, using CARB's estimate of excess deaths from diesel emissions:

Deaths per year	Number of years	Cost per 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 heavy-duty diesel trucks nationally would cost \$450 billion..

⁹ 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 in addition to sticks. States were offered federal funding for carefully formulated plans that would provide 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.

What did the states do in response? 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 smoggy 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); state officials periodically inspect fleets to see that this is done. CARB also deploys roadside “strike teams” of inspectors who move from locality to locality to pull over and check diesel-powered trucks. In addition, California raised annual registration fees for all motor vehicles to help pay for subsidies for the purchase of new, lower-polluting diesel or alternative fuel vehicles, although officials directed these subsidies mostly to operators of school bus and urban transit bus

fleets. And 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.

Most significantly, CARB has also promulgated a series of regulations that require certain categories of companies to reduce the average age of their fleets -- in effect, a phased-in ban (or compelled retrofitting) of older trucks. CARB required this first for urban transit buses and garbage trucks -- vehicles that operate in residential neighborhoods. In October 2006, CARB extended this requirement to publicly-owned diesel truck fleets (with first actions required by December 2008). In December 2007, CARB further extended the phase-out requirement to port drayage fleets, bolstering a phased-in *ban* of older diesel vehicles in 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; the fees are to be used to subsidize the purchase of new trucks by private drayage companies.¹⁰ The Ports' phase-out policy 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 use higher fees on shippers and their customers to subsidize truckers who retrofit engines or buy new low-polluting ones.

¹⁰ The program would only allow port-licensed concessionaires operating "clean trucks" to enter port terminals without having to pay an "impact" gate fee. "Clean trucks" are defined as 2007 or newer trucks, retrofitted trucks manufactured in 1994 or newer, or trucks that have been replaced through the Gateway Cities truck modernization program. In addition, the Port of Los Angeles (not the Port of Long Beach) requires the major drayage firms who use independent owner-operators to haul containers to hire those drivers as employees within six years. By the time the Ports' initiative is completed in 2012, it is expected to cut diesel pollution from the 17,000 trucks working the waterfront by 80 percent, and cost \$2.4 billion (Hanson, 2008).

The fact remains, however, that as of July 2008, California has only *proposed* phase-out controls on the *major* source of truck emissions – the thousands of over-the-road private truck companies who operate older diesel trucks in the state. CARB’s proposed regulation has triggered an active administrative and political lobbying effort by the California Trucking Association and the American Trucking Association, seeking to block it or water it down.

D. Subsidy Programs

Due to its subsidy programs and direct regulations, California has made considerable progress in reducing diesel emissions from urban bus fleets.¹¹ But for trucking firms, which are much more numerous, in both California and Texas, government subsidies have not been large enough to make much of a dent in the problem of getting older, dirtier diesel trucks off the roads/ By the end of 2006, for example, the State of Texas had spent \$57 million in subsidies,¹² but had replaced only 1,300 trucks. In 2006, there were approximately still 38,000 trucks in Texas with 1990 or earlier model year engines. Extrapolating 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.

E. Implications for Theories of Regulatory Policymaking

From one perspective, the failure of both the federal and the state governments to require rapid adoption of the best available control technology appears to contradict public choice theories of the politics of regulatory design. The best-organized industries, with small numbers

¹¹ 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.

¹² Costs of vehicle replacements have risen steadily. Average cost was \$29,364 in 2004, \$43,371 in 2005, and \$59,424 in 2006. Original data taken from Appendix 5, Texas Emissions Reduction Plan (TERP) Biennial Report to the Texas Legislature, December 2006.

of very large corporations – motor vehicle engine manufacturers and petroleum refiners – were subjected to demanding technology-forcing regulations.¹³ Trucking companies, a more diffuse industry with thousands of small firms, was *not* forced to absorb high compliance costs. That result did not reflect direct interest-group pressure from the trucking industry. Based on the public record, the American Trucking Association, did not play a prominent role in shaping the 1990 Clean Air Act Amendments that authorized EPA to prescribe progressively tougher emissions standards for new diesel engines. There was no prominent proposal requiring truckers to use the newest, greenest engines, and the ATA did not mount either a grass-roots or inside-Washington lobbying campaign to block one. Even environmental advocates did not seem to push for legislation authorizing EPA to require trucking companies to phase out old trucks rapidly. It seems likely that environmental groups believed that legislators would recoil from the political risk associated with enacting a standard that could drive many small entrepreneurs (in virtually every Congressional district) out of business. In other words, the controlling factor in shaping the regulatory policy was the sheer economic cost of compelling individual truckers to upgrade -- an economic explanation, to be sure, but not the traditional economic theory.

From the perspective of Stiglerian public choice theory, one might imagine that *large* trucking firms would have lobbied *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. But those pressures did not materialize, presumably because many large firms (which dominate the American Trucking Association) did not relish the thought of incurring a regulatory obligation to purchase expensive new model trucks while

¹³ Engine manufacturers in general are not likely to benefit from technology-forcing mandates for new engines because they are more costly than earlier models, thereby giving trucking companies an incentive to keep their old models in use for longer periods of time – which is the tendency of all regulations that “grandfather in” – rather than require replacement of – existing technologies (Hsu, 2006)

their older ones were still desirable. Moreover, many large trucking firms rely 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 the ranks of potential subcontractors were sharply depleted).¹⁴ Thus the trucking associations neither pushed for more stringent rules nor played a strong role in structuring the prevailing “grandfathering” of older trucks and engines. That quiescence on the grandfathering front may be beginning to change. In 2008 in California when the CARB proposed a regulation requiring all private trucking firms to modernize their fleets, the ATA and its California affiliate reacted strongly, mounting a lobbying and public relations campaign to stop or slow down the regulatory requirement.¹⁵

Of course, while regulatory law has imposed more obligations and costs on the tightly-organized diesel engine manufacturers and refiners than on the more diffuse and varied trucking industry, a still more populous and diffuse population -- asthmatics and all others who suffer from exposure to high levels of truck emissions – have been forced to forego the benefits that a mandatory “use the best available control technology” rule would have produced. While that result seems consistent with the traditional public choice theory, we think that in this case the “regulatory costs theory” of regulatory policymaking is more persuasive. As noted above, the

¹⁴ Put another way, the American Trucking Association, dominated by large firms, is divided between members who profit from the intense competition among smaller trucking firms with cheaper, older trucks, and members that would benefit from a mandatory phase-out. See generally Levine (2006) (noting that deregulation typically makes firms in an industry more *diverse*, and hence likely to have different policy goals). Although the ATA was a powerful lobby in the 1935-1980 period when all trucking companies were regulated (and shielded from competition) by the Interstate Commerce Commission (Robyn, 1987; Rothenberg, 1994) and thus had many shared interests, in the now-deregulated market, there are many more firms, their interests are more diverse, and in terms of interest-group politics, they are a less cohesive, more diffuse group

¹⁵ In addition, the American Trucking Association did join the larger coalition of manufacturing and public utility companies that fought fiercely, both in Congress and in the federal courts, against EPA’s 1997 regulation reducing National Air Quality Standards for ozone and fine particulates, which increased pressures on states to reduce diesel emissions.

grandfathering of existing diesel engines did not stem from the efforts of the trucking industry. Indeed, truckers did not seem to have to fight hard for their interests at all. Legislators simply shied away from imposing a regulatory obligation that was so costly for small truckers to comply with.

On the other hand, it should be noted, diffuse environmental and public health policy advocates were far from powerless. They succeeded in obtaining legislation requiring progressively more stringent emission standards for new diesel engines and, over fierce industry and significant Congressional opposition, to tighten National Air Quality Standards for ozone and particulate matter. The reason they thus far have failed to win laws and regulations requiring truckers to scrap old diesel engines and obtain new, greener ones is less the overt political pressure of organized industry groups and more a fundamental economic (and hence political) factor.

In sum, it is the enormous cost of “greening” the fleet of heavy-duty diesel vehicles – in the aggregate and for individual firms -- that has limited the stringency and coerciveness of direct regulation of vehicle owners and operators. Rapid imposition of “best available technology” requirements on all companies would drive too many firms out of business to be politically feasible. That politically difficult step has been taken only when there have been countervailing **social** pressures and subsidy sources (such as port communities’ threat to limit port expansion and the ports’ capacity to impose fees on shippers to fund subsidies for truckers).¹⁶ And that same basic economic factor – the enormous cost of upgrading a huge fleet of vehicles – has dwarfed the reach and effectiveness of the governmental subsidy programs.

¹⁶ Where California has compelled gradual phasing out of old diesel engines – for school buses, garbage trucks, and soon other governmental bodies – it has been made possible by the government’s ability to concentrate its subsidy programs on a smaller subset of vehicles -- in markets in which the regulated entities are relatively free from competition.

All in all, our findings suggest that in populous, highly competitive markets akin to trucking, the politics of regulatory policy-making is likely to be shaped primarily by the capacity of most regulated firms to afford and pass on the cost of expensive compliance technologies.

III. 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 (Gunningham et al, 2003). We view facility-level environmental performance as shaped first of all by the interaction of three elements of a business firm’ environment – the terms of its *economic license* (that is, the market-based imperatives and constraints it faces); its *regulatory license* (that is, legal obligations and threats); and its *social license* (that is, pressures from

communities, advocacy groups, employees, newsmedia). Our prior research also provided clear evidence that these external license pressures are interpreted, filtered, and negotiated by *management attitudes and commitments*, which can 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 (*Ibid*).

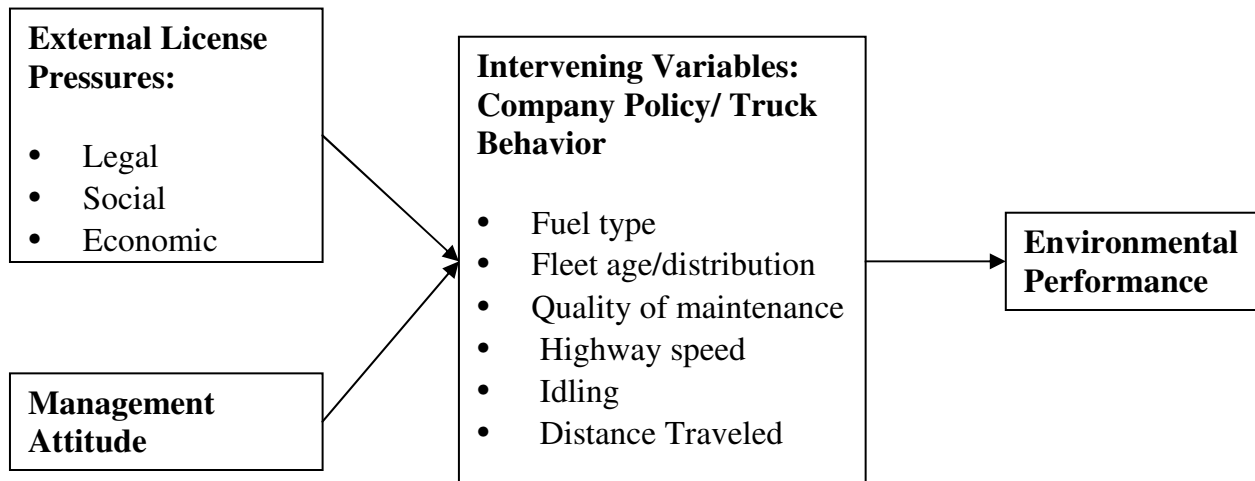
Applying this framework to trucking firms, we found, is complicated by the complex array of technical factors that affect each truck's (or fleet of trucks') environmental performance. Emissions of NOx and PM from a particular diesel engine can vary dramatically depending not only on the model year of the vehicle, but also on 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.¹⁷ Thus 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.¹⁸

¹⁷ 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.

¹⁸ 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. Therefore we conceptualized the six technical or operating factors as intervening variables situated 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. Firm-Level Research Method

We conducted 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 of 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 large-n research cannot plumb the

attitudes and motives of company officials with any sophistication. The small-n study can overcome those problems via *in-depth* interviews and access to *detailed firm-specific* environmental performance data. Gaining access and conducting on-site interview is a costly, labor intensive research strategy, a 16 firm sample seemed the largest 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. Within those categories, in order to assure we had some variability, we used state data that provided some indication of which firms were likely to have good environmental performance (e.g. average age of trucks) and which were average or poor, and sampled within those subcategories. 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).¹⁹

C. Findings

Our most important finding will not surprise most readers. As we had conjectured, in the extremely competitive trucking market, with many small companies with low regulatory and social visibility, the firms we studied are driven entirely by the terms of their economic licenses.

¹⁹ 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.

Truckers experience little direct scrutiny from environmental regulators with respect to diesel emissions. Social license pressures are weak. Trucking firm managers' environmental consciousness is minimal. In some regulatory settings, when an industry (such as American metal-finishing) has been subjected to intense regulatory scrutiny and enforcement, trade associations or voluntary self-regulatory arrangements have played a significant role in encouraging better environmental performance by small companies (Johnston 2006; Gunningham et al, 2004). But in the absence of direct regulatory mandates requiring trucking companies to scrap or upgrade older diesel engines, social and political pressures have been insufficient to induce state or national trucking associations to take up that cause. To the contrary, the trucking associations are lobbying against California's proposed phase-out regulation for old engines.

Nevertheless, our field research shows considerable company-level variation in environmental performance – variation that is determined not by regulatory or social pressures but by *economic* variables, the specific terms of each trucking firm's economic license. 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 a number of economic license factors on company-level fleet characteristics (which in turn influence fleet emissions). The Figure shows that most economic factors have both positive and negative effects on emissions. Unfortunately the *net effect* of each economic factor is difficult to predict in the abstract. And in our analysis of firm-level data, limited by the small size of the sample and the large number of operating factors affecting firm-level emissions, the net impact of each of the economic variables was unclear.

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*	<ul style="list-style-type: none"> • Younger fleet (more capital) within niche limits* 	<ul style="list-style-type: none"> • More miles***
	More Expensive Diesel Fuel → Incentive for fuel cost controls** Less capital**	<ul style="list-style-type: none"> • Less idling • Better maintenance • Better logistics (fewer miles for same deliveries) • Lower highway speed 	<ul style="list-style-type: none"> • 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.: <ul style="list-style-type: none"> • Less idling • Better maintenance • Better logistics (fewer miles for same deliveries) • Lower highway speed 	<ul style="list-style-type: none"> • Older fleet
Market Niche	Long Trips → need for more reliable trucks**	<ul style="list-style-type: none"> • Younger fleet • Better maintenance 	<ul style="list-style-type: none"> • More idling • More miles
	Sensitive goods More reliable trucks**	<ul style="list-style-type: none"> • Younger fleet • Better maintenance 	
	Customers demand speedy delivery More reliable trucks**	<ul style="list-style-type: none"> • Newer fleet • Better maintenance 	<ul style="list-style-type: none"> • Faster highway speeds
Company Financial Condition	Company doing well (more capital)**	<ul style="list-style-type: none"> • 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 found 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.

IV. Conclusion

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’ jurisdiction like California, regulators and politicians have only recently begun to consider direct regulations requiring private

trucking companies -- by far the largest source of harmful NO_x and PM emissions -- to rapidly phase out older, more polluting diesel trucks or engines. The reason, again, is an economic one: the very high cost of retrofitting or replacing older, more polluting, but still economically useful trucks, a cost that would be multiplied if truckers were obliged to scrap rather than resell those vehicles. To compel such a costly change would be both economically disruptive and politically problematic, as unless subsidized, thousands of small truckers would be driven out of business. That cost-of-compliance factor 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.

One implication of these findings is that any theory of regulatory policy design and firm behavior must pay close attention to the cost of reducing the harms sought to be regulated, particularly how difficult it is likely to be for regulated firms to afford the initial capital costs associated with compliance and to pass those costs on to customers. The higher compliance costs associated with retrofitting or reconstituting existing facilities or operations, as compared with new facilities or operations, helps explain the common tendency of regulators to “grandfather in” existing enterprises and practices and to impose lighter burdens on small firms. Those policy incentives are exacerbated, this study suggests, when regulatory change would require large expenditures by small firms in populous, highly competitive markets. And unless regulators are prepared to maintain

significant threats of enforcement and sanctions, then in markets akin to trucking social license pressures are unlikely to induce firms to invest in costly harm-reduction efforts. At the same time, even in such industries, as shown in our analysis of particular trucking firms, certain types of “market niches” induce firms to make “win-win” investments and adopt practices that both improve earnings and reduce harmful emissions or practices. Attention to such market niches and the incentives they create may be of significant value for regulatory policymakers.

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