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Regulating with Carrots, Regulating with Sticks

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Abstract

The United States has a highly complex regulatory program to reduce harmful emissions from diesel-powered vehicles, such as trucks, urban buses, and school buses. Federal policy-makers have employed not only the familiar regulatory tools of legal mandates and deadlines – in this case, addressed to state governments, engine manufacturers, and diesel fuel refiners – but also a set of governmental financial incentives to vehicle owners and operators, offering to pay a substantial part of the cost of acquiring newer, less-polluting vehicles.

In this paper we address several questions raised by the diesel-emissions regulatory scheme. How does the variety of, and variation across, regulatory targets affect the politics of regulatory design and the choice of regulatory tools employed? Why, and under what circumstances, do governments ignore the polluter pays principle and subsidize polluters in their pollution reduction efforts? How do programs that offer regulatory carrots compare in effectiveness to programs that rely on regulatory mandates and sticks? With respect to the last question, we present data comparing progress in statewide modernization of diesel bus fleets from California (which has employed a mixture of regulatory sticks and financial carrots) and Texas (which has relied primarily on carrots).

Regulating with Carrots, Regulating with Sticks*

Dorothy Thornton, Robert A. Kagan, Neil Gunningham

This paper is a first report from a research project that examines regulatory efforts in the United States to reduce harmful emissions from diesel-powered vehicles, particularly over-the-road trucks, urban transit system buses, garbage trucks, and school buses. The regulatory program is extremely complex. It involves enactments and enforcement actions by many regulatory bodies, federal, state and local. It addresses many different kinds of entities, both public and private. It seeks to change the behavior not only of the large, relatively easy-to-monitor business corporations that make diesel engines, diesel fuel, and alternative fuel vehicles, but also of hundreds of local transit agencies and school boards, thousands of over-the-road trucking companies, large and small, as well as millions of individual truck and bus drivers. The program uses many regulatory tools, employing not only the familiar regulatory sticks (legal mandates and sanctions), but also regulatory carrots – governmental efforts to improve the environmental performance of trucking companies and bus systems by offering subsidies that cover all or part of the cost of compliance (e.g., the cost of new vehicles, or of new or rebuilt engines). The complexity of the multi-pronged diesel-emissions-control regime enables us to address some interesting issues concerning regulatory design and implementation.

Sociolegal scholars have frequently found that the regulation of many, dispersed, smaller polluting entities (or individuals) -- often environmentally unsophisticated, financially pinched, and difficult to monitor – raises different challenges than those faced by regulatory regimes that

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concentrate on a smaller number of large, technologically-sophisticated business corporations, which often are subject to strong “social license” pressures (Gunningham et al, 2003, 2004) to comply with regulatory requirements.¹ One question the complex diesel-emissions program enables us to address, therefore, is this: *How does the variety of, and variation across, regulatory targets affect the politics of regulatory design and the choice of regulatory tools employed?*

Our exploration of that issue intersects with another salient aspect of the diesel-emissions control regime. The “polluter pays” principle – the idea that polluters, not government and the taxpayer, should be compelled to bear the financial costs of preventing and reducing pollution – pervades contemporary regulatory policy in the United States and in Western Europe. It is politically attractive to proponents of tougher environmental regulation. And it has the backing of economic theory: by compelling polluting entities to “internalize” the costs (adverse health effects, reduced environmental amenity, ecosystem degradation, etc.), they presumably will pass most of the costs of reducing pollution on to their customers, in the form of higher prices. The customers will then pay the real costs of the goods and services they demand, thereby contributing to the allocative efficiency the economy and shifting demand to less polluting products.

But governmental regulatory programs sometimes depart from the polluter pays principle. In the 1970s, the U.S. federal government enabled private corporations to issue ‘tax free’ bonds (at lower-than-market interest rates) to finance costly pollution control measures.² More directly, the Clean Water Act Amendments of 1972 pledged the federal government to

¹On differences in regulation of smaller vs larger entities, see, e.g., Shover et al, 1984; May, 2005; Gunningham et al, 2005.

² Technically, the pollution control bonds were issues by local governmental bodies, at standard municipal bond rates. They did so as part of an agreement by which the funds raised were directed to a business corporation for an environmental control project, and the business undertook to pay interest and principal to the bondholders.

subsidize up to 90 percent of the capital cost of local government sewage treatment plants that met federal standards. Although sociolegal scholars have paid scant attention to that kind of regulatory strategy, it raises interesting theoretical and empirical questions. *Why and under what circumstances do governments ignore the polluter pays principle and subsidize pollution reduction efforts by polluters? How do such subsidy programs actually work? And how do programs that offer regulatory carrots compare in effectiveness to programs that rely wholly on regulatory mandates and sticks?*

Part I of this paper summarizes the nature of the regulatory challenge posed by emissions from heavy-duty diesel engines, and provides a simplified account of the major regulatory measures that have been adopted. Part II describes the mixture of regulatory sticks and carrots employed by federal regulators. Part III describes the regimes established by the states of California and Texas for the reduction of emissions from diesel-powered urban bus fleets. We focus on those two states because California employs a complex and innovative array of legal sticks and subsidies, whereas Texas, while seeking to implement the federal government's legal mandates, has been less innovative and has relied more fully on carrots rather than sticks. Part IV uses aggregate data from both states to determine which state has been more successful in prodding urban transit fleets to scrap older, more polluting diesel buses for newer less polluting diesel buses or buses that use alternative fuels.³

³ In subsequent reports from this project, we will extend this two-state comparison to examine their relative success in getting trucking companies to switch to newer less-polluting diesel engines, and we will examine variation across regulated entities – trucking and bus companies – in responding to both regulatory sticks and carrots.

I. Regulating Diesel Emissions: Roads not Taken, Roads Taken

A. The Regulatory Problem. Diesel-powered trucks and buses are a crucial part of the transportation infrastructure of the United States. In 2005, there were 2.9 million tractors (heavy tandem conventional vehicles) involved in interstate commerce, allowing for the just-in-time delivery systems that have improved economic efficiency. In a suburbanized society, millions of children come and go to school in buses. And even in a world of automobiles and SUVs, urban dwellers and especially the poor rely on buses to get to and from work. Diesel powered vehicles collect our household wastes each week. Operators of all these kinds of vehicles favor diesel engines because of their fuel efficiency and durability.⁴

Unfortunately, diesel engines also emit particulate matter (dPM) and nitrous oxides (NO_x, a precursor to ground-level ozone)⁵. In 1998, according California's Air Resources Board, a typical diesel-fueled bus emitted more NO_x and particulate matter than would all bus riders if they had driven the same route in individual automobiles. EPA estimates that 14% of nitrous oxide emissions and 7% of particulate matter emissions are from diesel vehicles, the majority of which are heavy duty trucks and buses. Exposure to ozone has been linked to significant decreases in lung function, inflammation of the airways, and increased respiratory symptoms. Exposure can also aggravate lung diseases such as asthma and chronic obstructive pulmonary disease leading to increased medication use, hospital admissions and emergency room visits. Long-term exposure to moderate levels of ozone may cause permanent changes in lung structure, leading to premature aging of the lungs and worsening of chronic lung disease. Exposure to diesel exhaust can also cause cancer.

⁴ There are additional, important sources of diesel emissions – e.g, agricultural and construction machinery, ocean-going ships docked at seaports, and electric power generators. The focus of our study, and of this paper, however, is limited to on-road trucks and buses.

⁵ We do not address greenhouse gas emissions from diesel vehicles, but rather emissions that are of particular concern from diesel engines (rather than all vehicles) and which have more direct health effects.

In a study of diesel exhaust, the California Office of Environmental Health Hazard Assessment found dPM posed the highest cancer risk of any air contaminant they had evaluated, accounting for some 70% of the risk the average Californian faced from breathing toxic air pollutants. In studies with human volunteers, dPM made people with allergies more susceptible to their allergens (e.g., dust and pollen). Similar to ozone, exposure to diesel exhaust also causes inflammation in the lungs, aggravating chronic respiratory symptoms. Because children's lungs and respiratory systems are still developing, they are also more susceptible than healthy adults to fine particles, which are associated with increased frequency of childhood illnesses and can also reduce lung function in children. Individual exposures to diesel exhaust are increased where large numbers of trucks or buses idle in concentrated areas, such as near ports' marine terminals, highway toll booths, large truck stops, or (with respect to buses) at large sports events or outside schools.

Older trucks and buses are much worse polluters than those with engines built since the late-1990s. However, the durability of diesel engines creates incentives to keep them in operation for decades. Older trucks are typically resold rather than scrapped. The oldest trucks can be bought for as little as \$2,500 allowing an individual to become a self-employed trucker, moving goods short distances e.g., from a railhead to a local warehouse.

B. A Menu of Regulatory Strategies. What could government do to reduce diesel emissions and exposures? The possibilities include a menu of possible legal requirements, each backed by the stick of legal penalties for those who fail to comply: (1) setting *maximum emission limits* for diesel engines, and requiring engine *manufacturers* to sell only engines that meet those standards; (2) requiring *petroleum refiners* to develop and market less polluting diesel fuel (“clean diesel”); (3) requiring diesel-powered vehicle owners (truckers, urban transit agencies,

school buses systems, etc.) to use only new or rebuilt clean-fuel-ready engines, or switch to vehicles powered by alternative fuels, such as natural gas or electricity; (4) requiring vehicle owners to ensure that their vehicles are maintained so as to stay continuously within those maximum emission limits, and prohibiting drivers from prolonged idling;⁶ (5) imposing substantial and progressively larger annual registration fees on owners of trucks and buses with higher-polluting engines; (6) imposing a pay-at-the-pump tax on *conventional* diesel fuel high enough to generate incentives for switching to alternative fuel vehicles or to clean diesel fuel (which would be taxed only at current rates) and to the less polluting modern engines that require clean diesel fuel.

C. Regulatory Roads Not Taken. Of all these approaches, the last two – a substantial and progressively higher annual fee on higher-polluting vehicles and a stiff tax on conventional diesel fuel – have a certain theoretical appeal. Either would compel conventional diesel vehicle operators, and their customers, to pay something close to the full economic and social costs of the services they demand. Both would generate “bottom-up” financial pressures on engine manufacturers, refiners and vehicle owners to make many of the other changes in the menu. The progressive license fee would give diesel engine manufacturers ongoing incentives to develop ever-less polluting vehicles, and vehicle operators ongoing incentives to keep upgrading to cleaner engines. Both would be relatively simple to administer. But of all the approaches, (5) and (6) seem least congruent with contemporary American political culture and least appealing to politicians. As we shall see, neither the federal government nor any state government has instituted such fees or licenses. And that is one important reason why the actual regulatory assault on diesel emissions is so enormously complex.

⁶ Preventing prolonged idling might entail another mandate (although it is not clear to whom): improve logistics so that truckers do not have to wait to be loaded, to require engines be turned off while waiting, and/or to require non-diesel-engine powered heating and air-conditioning systems.

Another item on the menu, too, was distinctly unappealing to most American politicians -- requiring diesel-powered vehicle owners and operators (truckers, urban transit agencies, school bus systems, etc.) to use only the best available technology – either the lowest-polluting new engines, or vehicles powered by alternative fuels, such as natural gas or electricity. Such a requirement, too, would have given diesel engine manufacturers strong incentives, without any government mandate, to increase sales by developing ever-less polluting engines at the lowest possible price, and it would have given similar incentives to makers of alternative-fueled buses and trucks.

Here, the most immediate obstacle is the cost of the best available, greener engines. The lowest price for a conventional diesel bus is currently approximately \$280,000. A full-sized alternative-fuel bus costs 13%- 18% more. The ultra low sulfur diesel needed for the lowest-polluting diesel engines costs approximately 10c/gallon more than ordinary diesel. Currently, a new diesel *truck* meeting the 2004 emissions limits costs in the range of \$150,000.

The polluter pays principle has a ready response to this problem. Trucking companies would pass on the high capital costs of the best-available-green-technology vehicles to their customers, who would in turn reflect higher shipping charges in the price of goods sold. Walmart customers would pay a little more for their purchases, but it surely would be worth it when they and their children are stuck next to a diesel truck or bus in a traffic jam. Similarly, the polluter pays theory goes, urban transit systems would increase fares to cover the higher capital costs of cleaner buses. Urban residents would pay a little more to have their trash collected by the least polluting trucks, and school districts would increase charges to users of the greenest school buses, or taxpayers would pay slightly higher property taxes to enable the school districts to pay for the buses.

Few readers of this paper, we are reasonably confident, finished the preceding paragraph without thinking that those cost-pass-through scenarios are economically and politically implausible. And they would be correct. Moreover, the obstacles to the pass-through of cleaner vehicle costs in the sectors mentioned above go a long way toward explaining why federal and state governments did not employ taxes and license fees to prod vehicle owners to buy newer and costly greener vehicles, and why those governments (with partial exceptions in California) did not legally *require* trucking companies, urban transit systems, or local school districts to switch to vehicles with the best available technologies.

It is worth analyzing, however, *why* the cost pass-through assumption did not hold in those cases. For the reasons are different for the three kinds of vehicle operators. And the reasons give us some insight into the conditions under which political leaders and regulators face strong incentives (a) *not* to impose best-available-technology mandates, backed by legal sticks, on polluting entities, and, sometimes (b) to resort to *regulatory carrots instead*, offering polluting entities financial subsidies to adopt greener technologies.

Small Firm Trucking Sector: Excess Supply/Almost Perfect Competition. There are many large trucking companies in the United States -- including FedEx, UPS, YRC Worldwide (which owns Yellow Transportation and Roadway Express), Schneider, and Con-way, Inc. – that own and operate thousands of diesel trucks. And some large companies that are not directly in the trucking business – such as Home Depot, Walmart, Dell, and the large petroleum companies – that operate large truck fleets themselves. Nevertheless, owner-operators and small trucking companies with fleets of fewer than 70 trucks account for more than half the diesel trucks on the road. Tough regulatory mandates to switch to least-polluting engines, and to do so quickly, might be feasible if most *older* trucks were owned by large companies. But wringing the necessary investments out of the intensely competitive, and functionally important small-company sector is

a daunting prospect. In Texas alone, there were more than 30,000 small trucking companies operating some 80,000 trucks in 2005.

Table 1: Texas 2005 Truck Fleet Size Distribution

Fleet Size	No. of Company's	Percent of Companies	No of trucks in fleets of this size	Percent of trucks in fleets of this size
1	15,672	43	15,672	5
2 to 10	16,755	46	64,340	19
11 to 30	2,806	8	48,200	14
31 to 200	1,321	4	89,152	27
Greater than 200	225	0	118,521	35
Total	36,779	100	335,885	100

In the wake of the rapid deregulation of the American trucking industry in the 1979-81 period,⁷ governmental rate-setting ended, small truckers flooded into market niches from which they had long been excluded by regulation, competition intensified, the Teamsters' Union's ability to demand high wages faded rapidly, the rates charged by trucking companies fell dramatically. Trucking is now a market in which barriers to entry remain very low, and pricing is extremely competitive. With "too many" trucking companies engaging in what New Deal regulators called "destructive competition" and sought to tame through competition-limiting regulation, owner-operators and small trucking companies today work very long hours for the equivalent of blue-collar wages. Most cannot afford the capital cost of new engines or vehicles.

In such a populous, competitive market, collective action problems leave them incapable of passing on the costs of new low-emitting vehicles to the shippers who hire them. Put another

⁷ For a concise account of the advent of competition-limiting regulation by the Interstate Commerce Commission, 1935-1980 and the advent of deregulation during the Carter Administration, see Moore (1986)

way, in such a populous, intensely competitive market, the assumptions of the polluter pays principle, on which so much “technology-forcing” regulation is based, do not hold.

Urban Transit Systems: Insufficient Demand. The cost pass-through assumptions of the polluter pays model do not hold with respect to urban bus systems either, but for the opposite reason. Urban bus systems have monopolies on their bus routes; they don’t worry about excess competition. Their problem is that they are obligated, for reasons of social policy, to operate many routes and long hours; universal service is treated, politically, as a public good. Nevertheless, there is insufficient demand (in the financial sense) for bus service on their less busy routes, and at less busy times of day. Thus urban bus systems typically operate at a loss, and are subsidized by local governments. If they tried to pass on the high cost of new, less-polluting buses to their generally low-income clientele in the form of higher fares, many urban transit systems would lose riders and their revenues might well decline.⁸ In other words, in many cities, there is a paucity of effective demand for high-cost, very-low-polluting urban bus service. Too much of the middle class has already left for the car culture in suburbs and exurbs for efficient bus service.

The alternative for urban transit systems is to pass the high cost of new, green vehicles on to the cities and counties that are already subsidizing them, asking for even larger subsidies – the cost of which presumably would be passed on to property-owners in higher taxes, or in user-fees to clients of other governmental services. In some cities, where political demand for less pollution is strong (see our discussion of Los Angeles, below), or where middle class demand for bus service remains high (e.g, Manhattan), local politicians are willing to increase subsidies for new, less-polluting buses. In a great many, they are not.

⁸ Note, this is probably not the case for bus systems or bus routes that serve white collar and professional commuters from middle class suburbs, commuting to and from the city at rush hours only.

School Buses: Political Resistance. For somewhat different reasons, public school bus transportation services – sometimes operated directly by public school districts, sometimes contracted out to private companies for a price certain – have trouble passing the costs of greener vehicles on to their customers in the form of higher “prices.” Most school districts do not charge for transporting children to and from school. The school districts – and the local property-tax payers and state-wide tax payers who finance the schools – bear the cost of the bus systems. The issue is whether school district officials are likely to give spending more on cleaner buses higher priority than the insistent demands they face for better and more teachers, special educational services, better teaching materials, and better facilities --- and if they *do*, whether the voters who elect them would agree and be willing pay higher taxes for them. Again, in some districts, popular demand for cleaner buses is high (particularly where parent groups are especially aware of the health risks to children from PM emissions) and voters will support new school bond issues or slight tax increases. In many districts they are not.

Put more generally, the polluter pays cost-pass through assumption does not hold for polluting local governmental bodies, or private entities whose services are paid for by local governments – and hence the pass-through depends on voter approval for higher expenditures and tax increases.

Financial Carrots for Environmental Improvements. The situation of the small-firm trucking sector, urban transit systems, and school bus systems thus help us answer the question of when higher levels of governments are likely to add financial subsidies to the menu of regulatory tools. In the case of diesel emissions, advocates of rapid reduction in diesel emissions pressured both state and federal governments to offer *subsidies* to vehicle owners who purchase, replace, rebuild, or retrofit older engines or switch to alternative-fuel vehicles. The larger the subsidy (in

relation to the market cost of the new engines or vehicles) and the larger the overall appropriation of funds for any of those purposes, the faster (presumably) the progress toward meeting regulatory goals.

As noted earlier, governmental subsidies for polluting entities to help them meet the cost of compliance, are not without precedent, as in the case of the massive federal government subsidies to municipalities for sewage treatment plants that used best available technologies to meet standards set under the federal Clean Water Act. And local politicians who would not be eager to propose local tax increases to subsidize the purchase of expensive new buses by urban transit fleets and school buses, do have political incentives to urge the federal government (and taxpayers from other districts) to provide such subsidies.

On the other hand, subsidy programs raise significant budget and administrative challenges for the federal or state government.⁹ Can the government afford to (or should it) buy *everybody* a new truck or bus? There are approximately 3 million heavy-duty diesel trucks on the road, and if a new best-pollution technology model currently costs approximately \$150,000, then replacing all these trucks would cost \$450 billion. If not all vehicle operators are to be subsidized, the issue becomes who gets the subsidies, who decides, and is it possible to prevent fraud and waste? Is it politically feasible to subsidize truck and bus companies and not other small businesses that can ill-afford costly environmental protection measures? Should equal attention be given to financing a shift away from all older, dirtier diesel vehicles, or should priority be

⁹ Congressional appropriations for local water treatment plants (initially \$18 billion – in 1972 dollars) proved far from adequate, and by 1977 only a third of 12,500 municipalities had met the secondary treatment requirements. In 1977, Congress pledged an additional \$25 billion. Audits indicated considerable inefficiencies, as many municipalities which were funded ordered inappropriately large treatment plants and then failed to operate them adequately, as the federal government did not subsidize operating costs (Rehbinder & Stewart, 1988:119)

given to small truckers, urban transit systems, or school buses? The answers to most of these questions, of course, are likely to be decided by political factors.

The Roads Taken. With the array of options set forth above in mind, in the next section of this paper we lay out the regulatory strategies government *has* adopted, starting first with the U.S. federal government, then turning to a comparison of the approaches taken by California and Texas. In brief, the federal government, in a series of steps, has required diesel engine manufacturers to meet progressively tighter emissions standards for NO_x and PM emissions from diesel engines, and has required petroleum refiners to develop and sell “clean diesel” fuel that is necessary for the low-emissions vehicles to work properly. The higher costs of the new cleaner engines and fuels presumably are reflected in the price of the vehicles. But the federal government has not promulgated regulations requiring truck and bus operators to scrap or retrofit their older, higher-emission engines and buy the new ones. In essence, the regulatory regime has a “grandfather clause” that permits vehicle operators to continue to use their existing engines.

To overcome vehicle owners’ incentive to stick with their older, less expensive, more-polluting vehicles, the federal government has deployed a series of sticks and carrots. First, by tightening nationwide ambient air quality standards (NAAQS) for NO_x and PM, and pushing states that contain “non-attainment areas” to meet those standards, federal regulators have delegated to state governments the problem of prodding diesel vehicle operators to shift to newer-model, less polluting vehicles. The federal government pushes the states to do so with a combination of sticks and carrots: it threatens to withdraw federal highway funds from states that don’t make significant progress toward meeting NAAQS, and, through EPA and especially through the Department of Transportation, it has offered substantial subsidies for state and local projects that help school districts and urban transit systems retrofit or purchase new model diesel or alternative-fuel engines.

Pushed to meet federal ambient air quality standards, state governments, in turn, have used federal funds, and in many cases, their own funds, to administer subsidy programs and in some cases, as our California case study will show, to mandate the purchase of new vehicles by bus systems (which in turn get richer subsidies).

C. Diesel Emission Regulation by the Federal Government¹⁰

1. The Politics of Motor Vehicle Emissions Regulation

The story of the regulation of motor vehicle emissions in the United States can be viewed in terms of a political dialogue between Los Angeles and the federal government. The rapid growth of motor vehicles and population in Los Angeles in the 1940s and '50s, combined with the city's particular geographic position and climate, generated disturbing and unhealthy smog conditions. Moreover, Los Angeles bulks large in California state politics. As pointed out in a classic article by Elliott, Ackerman, & Millian (1985), "Since Midwestern auto workers don't vote on whether California should ban the internal combustion engine to control smog," local politicians, by sponsoring tough environmental legislation by local and state government, could "garner public credit for bringing a benefit to *their* constituents at somebody else's expense." By the middle of the 1960s, therefore, California had begun to demand emission controls on motor vehicles sold in that state. Since the California market was so large, the motor vehicle industry could not ignore it. And other large states, such as Pennsylvania and New York, were starting to emulate California's legislation.

¹⁰ The U.S. Clean Air Act Amendments of 1970, 1977 and 1990 are immensely complicated and detailed. The 1970 statute was over 100 pages long. The 1990 statute covers more than 400 pages. EPA regulations are even more voluminous, of course, as is the body of court decisions interpreting the statutes. The account that follows, therefore, is only a thumbnail sketch, sacrificing much detail and some significant qualifications in the interest of necessary brevity.

To vehicle manufacturers, inconsistent and escalating emissions controls by different states threatened to create significant inefficiencies. Hence their interest to support *federal* emissions controls that would pre-empt or limit ever-stricter legislation by states (Elliott et al, 1985). Yet the decentralized nature of American political parties gives large state governments considerable weight in Congress. The result has been a series of federal environmental statutes that give the federal government primary responsibility for establishing air quality standards and limits for motor vehicle emissions, but that allow states to enact legislation and promulgate regulations that are more stringent than the federal standards.

In consequence, Los Angeles, which remains a serious “non-attainment” area vis-à-vis national pollution standards,¹¹ has continued to push California regulations toward greater stringency, and the importance of the California market has continued to push the motor vehicle technology and federal emissions standards.¹² At the same time, the community of environmental advocacy groups has continually prodded U.S. EPA to investigate environmental risk more deeply and to gradually tighten nationwide air quality standards, pushing environmental regulators in most states, including California, toward higher levels of professionalism and more stringent implementation tactics.

With respect to diesel emissions, the dominant federal regulatory strategy has been to transform the entire national fleet from older, higher-polluting diesel engines towards new, low-polluting diesel vehicles, and to some extent alternative-fueled vehicles that emit less NO_x and little or no PM. Given the size of the national fleet of trucks and buses, the regulatory strategy

¹¹ This despite aggressive and innovative regulatory programs, and in the face of explosive growth in both population and economic output.

¹² This political-regulatory dynamic has come to be known as “the California effect”, for in other cases as well, stricter regulatory standards in “green” political jurisdictions that constitute large economic markets has induced both industry and regulators from other jurisdictions to emulate the green standards, creating a slow-motion race to the top (Vogel, 1995). The factors that promote and that limit such “California effects” and races to the top in regulatory policy are explored in Vogel & Kagan, 2002).

necessarily had to be a gradual, multi-pronged one – not a prohibition of the use of high-polluting vehicles by a relatively imminent day certain, but more like a long cattle drive, and one that included an indeterminate number of highly-recalcitrant cattle.

2. Regulating Engine Manufacturers: Cleaner Diesel Engines

Although Congress first enacted a statute concerning motor vehicle emissions in 1965, its first stringent action was a staggeringly ambitious provision of the 1970 Clean Air Act that mandated a 90% reduction of hydrocarbon and CO₂ emissions from new cars within five years, and of nitrous oxides within six (Tabb & Malone, 1997: 461). Motor vehicle manufacturers successfully argued in court that the requirement was technologically unfeasible, and also won a reprieve from Congress, delaying the deadline until 1980 (and even later for NO_x). But the law and the court decisions, including one related to diesel engines, led to more carefully calibrated legal doctrine concerning how rapidly EPA could force manufacturers to adopt control technologies that had not yet been well-tested.¹³

The Clean Air Act Amendments of 1990 generally strengthened the regulatory push for less-polluting vehicles, including diesel-powered and alternatively-fueled. Congress rejected demands by some industry groups for federal preemption of more stringent state laws, thus keeping the door open for California to enact still more stringent requirements, and for other states to adopt them as well.¹⁴ The 1990 Act gave EPA the duty and authority to use a best available technology standard to set maximum emissions for heavy duty diesel engines, taking into account costs and providing adequate lead times; and also authorized the agency to establish onboard diagnostic

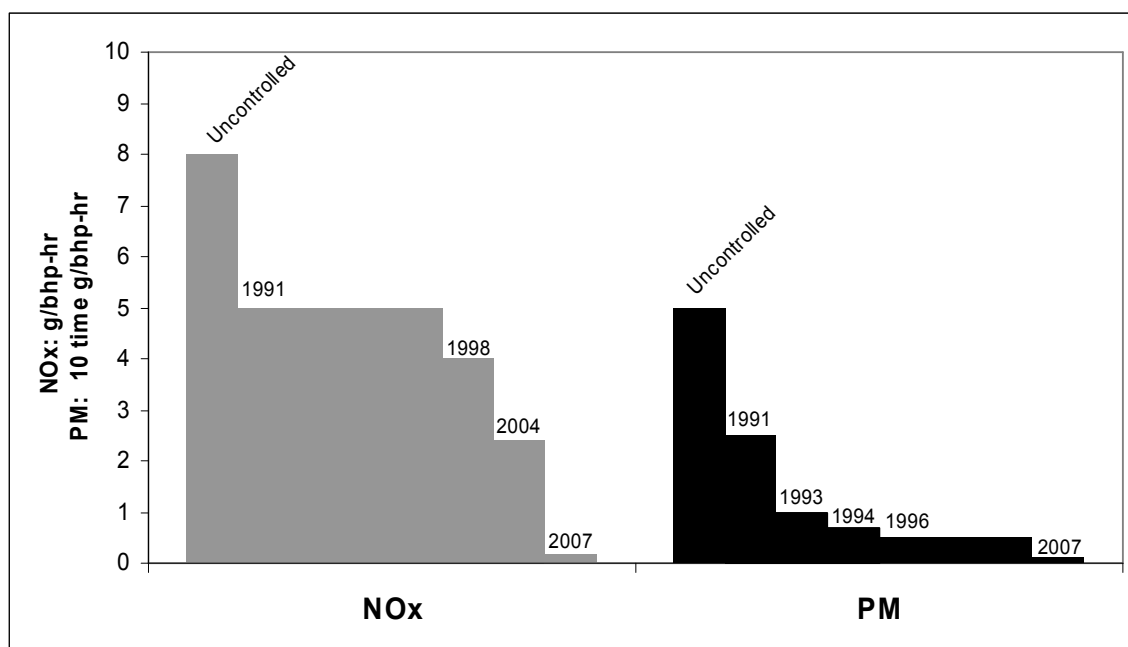
¹³ In *NRDC v Thomas*, 805 F.2d 410 (D.C. Cir. 1986), the court held that EPA could not simply order the whole industry to adopt technologies that had been tried by a single leader in environmental control effort, but must (1) respond to industry objections to the use of the proposed leading-edge technology, (2) identify the basic steps necessary for development and diffusion of the technology, and (3) offer a plausible basis for concluding that those steps could be taken by most firms within the deadline EPA had selected.

¹⁴ California had already adopted Low Emission Vehicle standards for cars and light trucks that were considerably more stringent than then-existing EPA standards.

control requirements for heavy-duty diesel vehicles, designed to ensure that factory-set emissions limits are being met continuously (Walsh, 1991).

Using its authority under various Clean Air Act amendments, EPA has periodically ratcheted down the maximum NO_x and dPM standards for *new* heavy-duty diesel engines, but proceeding at a pace that seemed to provide adequate lead time.

Figure 1: Federal NO_x and PM Emission Limits for Urban Transit Buses



As noted earlier, truck *owners* and bus fleet *operators* were not required to *replace* their older vehicles or engines with new, lower-polluting models. The regulations imposed obligations only on engine and vehicle manufacturers.

3. Regulating Refineries: Cleaner Diesel Fuel

In order to meet the demanding reductions in NO_x and PM required for 2007 model year vehicles, EPA expected that end-of-pipe emissions control devices would be needed, and that these devices would be disabled by high levels of sulfur in diesel fuel, just as lead in gasoline disabled catalytic converters. Therefore, in January 2001 EPA required diesel refiners and importers to formulate, produce and market by June, 2006 diesel fuel that reduced sulfur content by 97 percent.¹⁵ What EPA did not do, however, was to mandate the distribution of alternative fuels (such as natural gas) or, as noted above, to require truck and bus operators to use only the new model vehicles that would benefit from the new cleaner diesel fuel.

4. Regulating Vehicle Owners Indirectly: Delegating Implementation to, and Regulating, State Governments

a. NAAQ Standards, Non-Attainment Areas, and SIPs

The 1970 Clean Air Act, as amended in 1977 and 1990, required EPA to set National Ambient Air Quality Standards (NAAQSs) for a key set of “criteria” pollutants which EPA has determined endanger public health. The current criteria pollutants are sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulates, and lead. The federal laws place on state governments the primary responsibility for attaining and maintaining the EPA-selected “safe” level of pollution. Each state must devise a state implementation plan (SIP) designed to achieve the NAAQSs by prescribing and enforcing limitations on individual sources and "such other

¹⁵ EPA states that, in tandem with the 2007 model year limits on diesel engine emissions, the Clean Diesel Fuel rules will, by the time the current heavy-duty vehicle fleet has been completely replaced (2030 or before), result in more than \$70 billion annually in environmental and health benefits, as a cost of \$4 billion per year. (U.S. EPA, 2006)

measures as may be necessary" (Tabb & Malone, 1997:368).¹⁶ The 1977 Clean Air Act Amendments required EPA, using the NAAQSs as the standard, to classify regions throughout the states as attainment and nonattainment areas. For the nonattainment areas, the deadline for attaining the primary NAAQSs was extended to 1982; for ozone, NO₂ and carbon monoxide (all closely associated with motor vehicle emissions), the deadline was extended to 1987, provided the states implemented a vehicle emission inspection and maintenance program (Tabb & Malone, 1997: 380-81).

To ensure that the state governments take their regulatory responsibilities seriously, the Clean Air Act arms EPA with several regulatory sticks – potentially potent, but often politically difficult to use. States face legal deadlines for submission of SIPs, and must meet standards prescribed by EPA reviewers. If the state fails to submit an acceptable SIP, the EPA can (a) promulgate its own implementation plan, which could be less responsive to local concerns and interests; (b) cut off federal highway funds to the state; (c) for non-attainment areas, require emissions offsets of at least 2:1 for new or modified sources seeking permits.¹⁷ (Tabb & Malone, 1997: 370). That is, emissions from existing sources must be reduced by twice the amount of pollutants that the new or modified source will generate.¹⁸

¹⁶ This regulatory strategy – environmental standard-setting by central governments and implementation by states or local regional governments – is common to all economically advanced federal democracies (Kelemen, 2004).

¹⁷ Prior to 1990, the Secretary of Transportation was required to impose the highway fund sanctions. There was no 18-month grace period, and no provision for invoking 2:1 offsets [CRS report:97-959]. EPA has given formal notice of disapproval 855 times between 1990 and 1997 and imposed sanctions 14 times in the same period then. In each of those 14 cases, the offset sanction was imposed. In 2 of the 14 cases, highway fund sanctions were also applied.

¹⁸ Because the offset rule threatens severe limits on industrial growth, some studies have indicated that state regulators in nonattainment areas are more stringent in regulating sources of pollution than their regulatory counterparts in attainment areas. For a case study illustrating this finding, see Dwyer et al, 2000.

In 1997, following several years of pressure from environmental organizations, public health advocates, and some states (most notably, from California and the Northeast)¹⁹ and after two major lawsuits demanding action, EPA tightened the NAAQSs for ozone and fine particulate matter. The regulations, challenged in court by the American Trucking Association, took effect only in 2002.²⁰ Since then, however, the EPA has classified 474 counties around the country as non-attainment areas with respect to the new ozone NAAQS, and 208 counties as failing to meet the PM standard. This in turn forced states to file SIPs containing credible strategies to reach attainment. Reductions in emissions from diesel-powered vehicles are often a significant element in those state plans.

b. The Carrot-Stick: the Threat to Withhold Highway Funding

The Clean Air Act requires states to submit to EPA inventories of emissions every 3 years, until NAAQSs are met. To do so, state environmental and transportation planning agencies must establish emissions budgets for point, area and mobile sources, assigning specific emissions reduction levels to each source category. For the on-road mobile source category, the emissions reduction level is further refined into a "motor vehicle emissions budget".²¹ Transportation

¹⁹ At the same time, industry groups, and after 1994, a Republican Congress, pressured EPA to go slow and gather more data (Oren, 2006). Throughout this period, there were periods of cooperation between EPA and diesel engine manufacturers in the development of standards for lower-emission engines, but also episodes in which the government sued some manufacturers for installing computer-regulated features in their engines that had the purpose and/or effect of undermining compliance with agreed-to standards when trucks were in operation.

²⁰ The American Trucking Association's legal appeal was joined by the U.S. Chamber of Commerce, organizations representing utilities, manufacturers and the United Mine Workers, inter alia). It challenged the validity and certainty of the adverse health-effect data relied on by EPA and the rationality of the limits set by EPA. The U.S. Court of Appeals agreed, but in 2002 the Supreme Court reversed, and on remand, the D.C. Circuit court upheld the regulations (Oren, 2006).

²¹ Ozone non-attainment regions must have a specific "motor vehicle emissions budget" (MVEB) tied to their SIP. The MVEB calculations are based on the number of vehicles in the region, their age, the rate of fleet turnover to newer and cleaner vehicles, seasonal temperatures in the region, vehicle miles traveled, and population growth. (www.fhwa.dot.gov/environment/conformity/ref_guide/partiii.htm)

planners must ensure that anticipated emissions remain within the SIP's emissions budget, thus demonstrating what is called "transportation conformity."

If transportation conformity is not demonstrated, hundreds of millions of dollars of federal transportation funding can be withheld from the region. Although this does not happen often, the threat is severe enough, and the adverse headlines politically important enough, that state agency officials and transportation planners take "transportation conformity" very seriously. The conventional wisdom is that no other SIP control measure reviews are as stringent or occur as frequently as EPA's conformity check with respect to "transportation control measures" (Eisinger & Niemeier, 2004). The threat of losing the highway funds carrot, therefore, is a meaningful stick; it gives states the incentive to devise imaginative ways to reduce emissions, promote use of mass transit, and accelerate fleet turnover.

c. Carrots for States and Cities: Demonstration Projects and Transportation Project Funds

The federal statutes and regulations described above have imposed obligations on diesel engine and vehicle manufacturers, on producers and marketers of diesel fuel, and on state governments. The success of the regulatory effort to reduce diesel emissions, however, depends on the speed with which trucking companies, urban bus systems, and school bus operators replace older, higher-polluting vehicles and engines with new or rebuilt diesel engines/vehicles or alternative-fueled vehicles. The need to stay within and shrink "the emissions budget" embedded in their SIP gives states some incentive to directly mandate changes by vehicle owners. But as suggested earlier, buying new vehicles can be prohibitively costly for small trucking companies, urban mass transit systems struggling not to slip further into red ink, and school districts with inadequate funding. Federal regulators, therefore, have sought to provide a further set of incentives – (1) monetary grants to help diesel vehicle operators afford to retrofit, rebuild or

replace old vehicles, and (2) funding demonstration projects that help determine the cost-effectiveness of different modes of dispensing subsidies and/or test the feasibility of new control measures.

The U.S. EPA, whose budget for such subsidy programs is limited, has concentrated on offering relatively small carrots -- funding for demonstration projects²² -- and on the hope that its pressure on non-attainment areas will force state governments to subsidize diesel fleet replacement from state funds. More substantial funding comes from the U.S. Department of Transportation (DOT). In addition, the Department of Energy provides funds for alternative fuel vehicles through its Clean Cities program. Between 1998 and 2003, the DOT's Congestion Mitigation and Air Quality (CMAQ) program spent \$1.2 - \$1.4 billion dollars each year (slightly more than in the 1991-1997 period) on state and local projects designed to reduce pollution from

²² The EPA's *National Clean Diesel Campaign* creates partnerships between state and local organizations, and funds demonstration projects. For example, the Trucking Sector Workgroup of the *West Coast Diesel Collaborative*, shares information and seeks funding for projects such as (a) idle reduction along major corridors and near population centers; (b) retrofits, repairs and replacements of inter-state trucks and short-haulers; and (c) use of biodiesel. In 2004, EPA awarded 18 clean diesel project grants, including \$50,000 to the Los Angeles Public Works Department to retrofit diesel particulate filters on its vehicles.

The EPA's *Voluntary Diesel Retrofit Program* distributes information about retrofit technologies, verifies the appropriateness, effectiveness and durability of retrofit devices available on the market, and offers limited economic incentives from a small pot of grant funding.

The EPA's *Smartway Transport Partnership* seeks to harness the various incentives that large, highly-visible corporations now experience to cultivate a public reputation for good environmental citizenship (Vogel, 2006). In order to become a Smartway Partner, companies that hire freight delivery services (i.e., shippers) must commit to shipping the majority of their goods with Smartway Transport Carriers. To become a "Smartway carrier," a trucking company must measure its current environmental performance, commit to improve it, and report on progress made. There are currently 270 Smartway Transport carriers, including some of the largest carriers in the U.S.

The *National Idle Reduction Program's* goal is to eliminate long duration idling and associated emissions. The program involves anti-idling demonstration projects, including truck-stop electrification and auxiliary power units (EPA and the carrier each pay 50%).

Clean Schoolbus USA is a public-private environmental partnership that seeks to reduce children's exposure to air pollution from diesel school buses. The program emphasizes three ways to reduce emissions: eliminate unnecessary school bus idling, retrofit buses with better emission control equipment or use cleaner fuels, and replace the oldest school buses with less polluting newer buses. This is achieved in part through funding demonstration projects. The amounts involved are not large, however: in 2003, the program spend about \$5 million on 17 projects. The program's budget in 2005 was increased to \$7.5 million.

transportation-related sources.²³ In addition, although it is less closely targeted on air quality problems, DOT's Surface Transportation Program (STP) was authorized to spend \$4 billion in 1997 rising to \$5.9 billion in 2003, allocated to states and localities for intracity and intercity bus terminals and facilities and capital projects for mass transit, as well as (and primarily) for highway projects.

III. State Regulation of Diesel Emissions: California and Texas

Since federal law delegates to the states the task of getting truckers and bus systems to update their fleets with new model, lower-polluting vehicles it is substantially up to state regulators, and the state politicians on whom they rely for funding and support, to determine the pace of change. Measuring and comparing how different states are doing in that regard is both complex and difficult. It is complex because of the multi-pronged nature of each state's programs. It is difficult to get and compare the data on the age distribution of each state's fleet of diesel vehicles and the percentage of alternative-fuel vehicles on the road— the best measures of the overall pace of change. It is even more difficult to get and compare data on vehicle maintenance and implementation of controls on idling. To approach this research task, therefore, we decided to concentrate on just two states, working with state officials and transit agencies to get meaningful quantitative data.

²³ The CMAQ funds are apportioned annually to each region largely according to the severity of the air quality problem and the number of people exposed to low air quality. The highest priority for funding under the CMAQ program is for implementation of SIP measures – and as noted earlier, states that fail to ensure timely implementation of SIP requirements can trigger the cut-off of these funds by the EPA. To provide an indication of the scope and allocation of these funds: in FY2000, \$589 million in CMAQ funds were spent in California on 293 projects, of which 63 (22%) funded alternative vehicle purchases, repowering, or infrastructure. Alternative fuel projects accounted for 39% of all California's expenditures of CMAQ funds, including the purchase of at least 1,210 alternative fuel buses and the building and/or upgrading of seven alternative fueling stations.

In selecting states for this case study in implementation, we decided that California should be one. As noted above, California has long been a leader in regulatory efforts to control vehicle emissions, often more aggressive than the federal government. It has sophisticated regulators, strong public support for environmental measures in general and, in several non-attainment areas (particularly Los Angeles), for reduction of NO_x and PM levels. California has two large and busy seaports – Los Angeles/Long Beach and the Port of Oakland in the San Francisco Bay – which generate heavy concentrations of diesel truck (as well as diesel powered ship) traffic. California’s experience in reducing diesel emissions, we figured, would serve as a benchmark for what a relatively activist regulatory regime could accomplish, given the major challenges to generating rapid and comprehensive replacement of older diesel-powered vehicles.

For the other state we chose Texas, for a variety of reasons. Like California, Texas is a geographically large state. Like California, it is an important venue for import-export traffic, both through the ports of Houston-Galveston and on highways that cross the Mexican border. The EPA has designated both the Houston-Galveston and Dallas-Forth Worth areas as non-attainment areas for NO_x – although they are classified as “moderate” non-attainment as contrasted with the “severe” designation for Los Angeles. The dimension along which Texas differs most significantly from California, however, is a political one. Texas has generally been significantly more politically conservative than California. Its civil society has reputation for being less “green” and more laissez-faire capitalist. By varying the political climate, we hope to get a sense of whether inter-state differences in diesel-emissions regulation are more-or-less neutralized by federal regulation and prodding of state governments, whether state-level regulations differ significantly, and whether and why state-level outcomes differ significantly.

A. Diesel-Emission Regulation in California and Texas: An Overview

In the last 15 years, California has paralleled and sometimes led the federal government in adopting legislation and regulations designed to reduce diesel emissions. It has, in addition, developed innovative subsidy programs to help users finance replacement and retrofits of older engines, and has been innovative and aggressive in generating a range of mandatory requirements and enforcement mechanisms to implement its policies, employing a variety of sticks.²⁴

Texas, in contrast, has been more a follower than a leader, copying federal standards and often adopting implementation requirements pioneered by California regulators. It has focused primarily on NO_x, in contrast to California's more intense focus on particulate matter as well. In implementing federal standards, Texas relies primarily on carrots – subsidy programs – and has not emulated California's use of mandates and the stick of legal sanctions. On the other hand, whereas California's incentive program is fragmented into 35 decentralized air pollution control districts, Texas's incentive program is more centralized, more streamlined (imposing fewer administrative burdens on applicants) and its legislative appropriations process has been steadier and provided more certainty. In its greater reliance on carrots alone – as compared to California's carrots plus sticks approach – Texas provides us with a natural experiment to examine the relative efficacy of the carrot approach alone.

²⁴ For example, California regulators, pursuant to California law, have developed their own ambient air quality standards covering a slightly larger number of criteria pollutants than the federal regulations. California 'clean diesel fuel' regulations, in contrast to EPA's, cap not only sulfur content but also the aromatic component of the fuel sold. California has required owners and operators of off-spec diesel engines manufactured in 1993 through 1999 to install "rebuild kits" designed to counteract features of those engines that had defeated the operation of certain emissions control devices. California regulations require truck fleet owners to perform annual smoke tests on their own vehicles (to prevent smoking vehicles) and 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, as well as for the installation of "rebuild kits."

For a more detailed view of the important differences between California's and Texas's approach to the problem of on-road diesel air emissions, we will focus on each state's regulations and strategies for reducing emissions from transit buses.

B. California Policy for Diesel-Fueled Buses: Innovation, Sticks and Carrots

The history of California regulation of diesel-powered buses begins, like many other accounts of air pollution regulation, in Los Angeles. In 1993, the *Los Angeles Times* reported, diesel-powered buses prompted more air pollution complaints than any other source.²⁵ NOx emissions from the LA areas bus fleet in 1993 exceeded those from Chevron's El Segundo refinery by almost 300 tons per year.²⁶ The local transit authority, the MTA, began testing alternative fuel (methanol) buses in 1989, as soon as they became available. In 1993, when MTA's plans to buy over 340 methanol-fueled buses appeared to be in jeopardy due to budget constraints, environmental activists pressured the MTA board to follow through on its commitments. Methanol bus manufacturers offered to lower the price of methanol fuel from 48 to 42 cents. The South Coast Air Quality Management District (SCAQMD) brokered a complex deal in which the Los Angeles Times would buy pollution credits from the MTA for \$230,000 – the estimated reduction in NOx emissions that the methanol buses would deliver.²⁷ The clean fuels officer at SCAQMDS's technology advancement office noted that failure to buy the methanol buses “would be a major step backward for our planned phaseout of diesel buses, and a

²⁵ LA Times, July 18, 1993, pg 1

²⁶ LA Times October 28, 1993

²⁷ The methanol buses' NOx and PM emissions were 40% and 10% of diesels' respectively. Those credits would enable the Times to obtain a permit to run backup generators (SCAQMD at the time was requiring offsets as a condition to issuing permits to new sources) in order to enter into a long-term contract with Southern California Edison for cheaper electricity, requiring it to be able to go off-line during power emergencies.

potential death-knell for market demand for cleaner buses. It could kill manufacturers' plans to commercialize cleaner engine technology."²⁸

This short story illustrates three important aspects of California's approach to reducing emissions from transit fleets. First, regulators – at least at SCAQMD and the statewide California Air Resources Board (CARB) -- see themselves as leaders. They quite consciously try to cultivate new technologies and a market for those technologies. Initially this is done by developing expertise within the agency, in collaboration with industry. Second, the regulatory response to new problems is local, speedy, and innovative. In this example, it involved neither rule-making nor direct subsidy, but rather the application of dense local knowledge to bring about a useful collaboration.

Third, to fund these leading and innovative regulatory efforts, California's 1988 Clean Air Act authorized air management districts with the worst air quality to collect an additional \$4 for each motor vehicle registered each year; the districts could use those funds to reduce air pollution from motor vehicles and for related planning, monitoring, enforcement and technical studies. In 1990, this program was expanded to include all management districts in the state, and a further \$2/vehicle registration could also be charged. This pattern of a local program being expanded to the whole state is another recurring aspect of California's story.

In contrast, some initiatives have started at the state level and have then been implemented at a local level. Two important examples of this 'top-down' approach for the bus diesel emissions story are the Diesel Risk Reduction Plan and the Carl Moyer Program.

²⁸ LA Times October 28, 1993

The Diesel Risk Reduction Plan: Regulatory Mandates to Transit Fleet Operators. In 1998, the state of California formally recognized that diesel emissions were an especially serious health hazard. The state found that the cancer risk to people in the South Coast Air Basin was as high as 1 in 1000, and that diesel PM emissions are responsible for about 70% of the total ambient air toxics risk. This assessment formed the basis for a decision by CARB to formally identify particles in diesel exhaust as a toxic air contaminant and to develop a diesel risk reduction plan.

The plan contained three major components, the first two of which were harmonized with the federal EPA's requirements: (1) new regulatory standards for all *new* on-road diesel-fueled vehicles to reduce diesel PM emissions by approximately 90% from their 2000 levels. (2) new *diesel fuel* regulations to reduce sulfur content levels to no more than 15 ppm. The third component -- new regulatory requirements for *in-use* diesel fueled vehicles -- was designed to focus first on those fleets with the greatest public exposure to diesel PM, and finally on the entire in-use fleet.

CARB focused first on diesel emissions from transit buses because of exposures to passengers and to the public as transit buses moved slowly through residential areas, often stopping and idling. In 2000, CARB adopted the Fleet Rule for Transit Agencies. *The rule requires urban transit fleets to reduce the diesel particulate emissions to 15%²⁹ of their 2002 baseline, to achieve average NOx emissions from the fleet of less than 4.8 g/bhp-hr and to choose a diesel or alternative path to do so. In addition, larger agencies with more than 200 buses must participate in zero emission bus demonstration projects by placing at least three zero-emission urban buses into revenue service. And beginning in 2008, 15% of new bus purchases in some*

²⁹ The original rule required retrofitting of older buses, but the rule was changed in 2002 when it was shown there was no feasible technology for improving emissions from pre-1993 buses

agencies must be of zero-emission vehicles. More stringent requirements apply in SCAQMD which requires public transit fleets of 15 or more vehicles to acquire alternative fuel heavy-duty vehicles when buying or leasing these vehicles.

The transit fleet rule, in addition to improving emissions from the in-use fleet, was also designed to spur the development of new retrofit and alternative fuel bus technologies by providing an avenue for demonstrating new technology and by creating a market for these devices.

The Carl Moyer Program: Financial Carrots for Fleet Conversion. In 1998, in conjunction with CARB's designation of diesel emissions as a toxic air contaminant, California introduced a state-wide grant program, designed in part to accelerate diesel fleet conversion to cleaner engines. The Carl Moyer program, which requires local air boards to match a portion of the funds provided by the state government, makes grants to pay the incremental cost of purchasing engines or vehicles that were *cleaner than required by current regulatory standards*. Of the \$140 million³⁰ allocated in the first 4 years of the program, 28% was spent on on-road projects, resulting in the purchase of 1,730 alternative fuel on-road engines (many of them transit buses) and 155³¹ re-powers or retrofits of on-road diesel engines. In the LA area air district, Carl Moyer funds are only used to purchase alternative energy vehicles, to encourage the development of the new technology. This is done even when buying diesel would be more cost effective in terms of dollars per ton of NOx reduced.

The Carl Moyer Program initially was criticized because no specific on-going funding source had been identified, so that each year's appropriations were somewhat unpredictable. In

³⁰ This total includes state Carl Moyer funds, district matching funds, California Energy Commission funds, and CARB administrative funds.

³¹ Table 111-1, 2004 CARB report re Carl Moyer

2004, however, steadier funding was provided through additional fees from vehicle registrations, smog check fees, and taxes on new tire purchases. At the same time, the program was expanded to focus on PM emissions as well as NOx emissions from heavy duty engines. The program's funds are disbursed to the 35 Air Quality Management Districts, each of which has different application requirements and different funding priorities (agricultural pumps vs. transit buses, for example). This decentralized administrative scheme has been particularly difficult for the trucking companies that typically operate in more than one district.³²

C. Texas Policy for Diesel Fueled Buses: Following the Leaders, Carrots not Sticks

In contrast to the innovative character of California's legal and subsidy strategies, Texas has simply mimicked federal and California programs, sometimes incorporating whole programs by reference. Texas air pollution regulators have relied on federal and California certifications to determine which new technologies and diesel fuel formulations should be incorporated into Texas law. And in contrast with California, Texas has only used incentives to improve the emissions from the in-use diesel fleet and has not imposed specific legal mandates on transit fleet operators. Texas' regulatory efforts are entirely focused on reducing NOx emissions, rather than particulate emissions as well.³³

Texas' single, centralized incentive program, Texas Emission Reduction Plan (TERP), was enacted in 2001, and was intended to generate reductions of some 55.2 tons of NOx per day

³² Communication of guidelines is further complicated by the existence in California of numerous other local programs that provide incentive funding for fleet modernization (getting rid of old buses and replacing them with newer ones), alternative vehicle purchases and vehicle retrofits. However, most of these programs are funded through once-off allocations and are only available in a particular locale. This makes providing information on an industry-wide basis to small operators very difficult.

³³ This is important because in both states, incentive funds are generally allocated on the basis of cost effectiveness, i.e., expected tons of pollution reduction. A project with high PM reductions but low NOx reductions will be seen as far more cost effective in California (which weights PM emissions by a factor of 20) than it will be in Texas where only the benefits of the NOx emissions reductions will be examined.

from the Dallas-Ft. Worth and Houston-Galveston non-attainment areas. The incentive program *replaced* two previous *mandatory* measures in those areas -- time restrictions on use of diesel-powered construction and industrial equipment, and requirements to replace older off-road diesel equipment with new equipment -- that those localities had claimed were too burdensome to implement. Because NOx reductions from the non-attainment areas are part of the Texas SIP, the state faces possible EPA sanctions (suspension of highway funds, etc.) if the TERP program is found to be ineffective -- which puts Texas politicians and regulators under considerable pressure to ensure that TERP incentives produce real reductions.

TERP was developed after extensive consultations with California's Carl Moyer staff. It provides monetary incentives for diesel engine projects (on- and off-road, agricultural and marine) to improve air quality in the state's non-attainment areas. TERP has focused only on reduction of NOx emissions and unlike the current California program, it has not preferentially funded alternative vehicle purchases in an effort to create a market for this emerging technology. In addition, TERP focuses only on cost-effectiveness in deciding which projects to fund. It does not give preferential funding to alternative fuel vehicles. On the other hand, TERP's more centralized administration has made it easier for the trucking industry to use traditional information channels to inform industry members about the program. In addition, the TERP program has benefited from longer-term committed funds (from 2001 through 2008). By 2004, TERP funding exceeded that of the Carl Moyer program.

IV. Comparing Outcomes: A Case Study of California and Texas Bus Fleets

Lennart Lundqvist's *The Hare and the Tortoise* (1980) compared air pollution regulation in the U.S. and Sweden. The U.S. was the hare, sprinting into the regulatory arena with the ambitious 1970 Clean Air Act Amendment, laden with strict deadlines, demands for tight

nationwide standards based on health considerations only (not economic costs), severe penalties for violations, and provisions for citizen suits to prod both federal and state regulators to implement the law vigorously. Sweden's approach to air pollution control was less legalistic and adversarial, more informal and cooperative, and seemingly less urgent. But by the end of the decade, Lundqvist maintained that if one looked at actual accomplishments in pollution reduction, the Swedish tortoise had overtaken the American regulatory hare in some important respects. Lyle Scruggs (1999) study of pollution reduction in all OECD countries tells a similar story. That suggests that one cannot assume, based on the comparison of California's and Texas's legal approach to regulating diesel emission, that innovative and aggressive California, with its use of mandates and sticks as well as carrots, has automatically achieved significantly better results, in terms of pushing transit fleets toward newer, less polluting vehicles, than has Texas, with its primarily reliance on carrots (financial subsidies).

Obtaining and comparing relevant data sets from the two states has been an arduous and slow process. Nevertheless, at this point, we can provide a picture of the transit fleets of the two states, and draw some inferences about the relative success of the two regulatory efforts to shift away from older, more polluting vehicles. The key indicators of success we use are first, the number and percent of the vehicles in the transit fleets that operate on less-polluting alternative fuels, rather than diesel; and second, the percent of older diesel vehicles in the fleet.

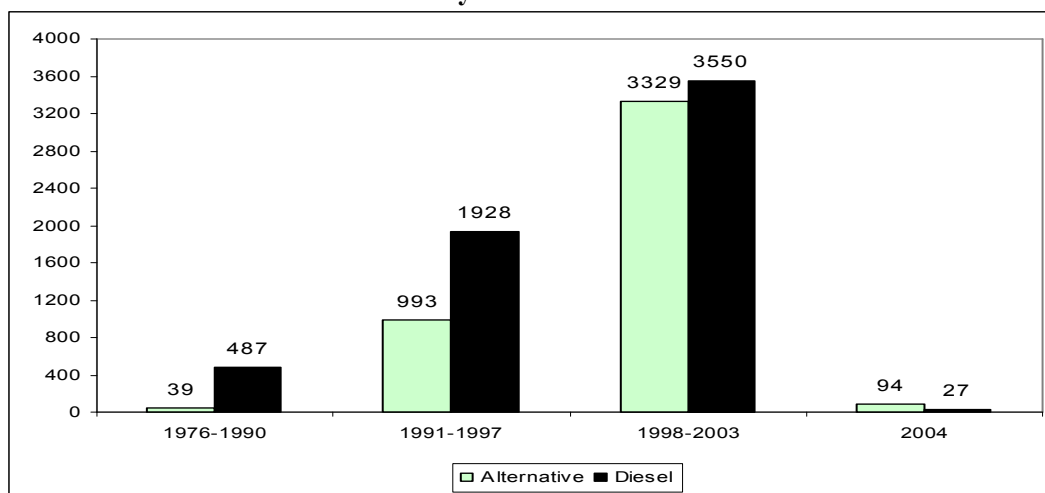
A. California

The 2004 California urban bus fleet consisted of 10,481 buses operating in 77 transit agencies. There is tremendous variation in the size of the bus fleets, from 3 urban buses in Lincoln to 2,637 in the Los Angeles County Metropolitan Transportation Authority (LA MTA).

LA MTA accounts for 25% of the total bus fleet in California. The median fleet size of transit agencies in California in 2004 was 37.

Most strikingly, 43% of the urban bus fleet in California already consists of alternative fuel vehicles, including the oldest vehicles in the entire fleet: 33 electric buses in San Francisco and 6 CNG buses in Glendale. More than half of the 77 transit agencies (53%) reported having at least one alternative fuel urban bus. Nine of the 77 transit agencies report *only* alternatively fueled urban buses in their fleets. The largest alternatively-fueled fleet included 2,009 buses at LA MTA and 536 alternatively-fueled buses in the San Diego Metro fleet.

Figure 2: Number of Alternative and Diesel Buses in the 2004 California Transit Bus Fleet by Model Year



Of the total number of buses reported 56% (5,652) were diesel-fueled buses. 88% of fleets had at least one diesel bus, and 33 fleets (42%) were entirely made up of diesel vehicles. The oldest diesel buses in the fleet have 1982³⁴ model year engines, but 50% of the diesel fleet have model engine years from 1999 on.³⁵ Figure 2 above shows the number and age distribution

³⁴ These buses have been maintained in the fleet because buses of their size and specifications are no longer available in the U.S. market. These buses have all been retrofitted with a '0.1 engine kit'.

³⁵ On the whole, the alternative fleet is younger than the diesel fleet; 50% of alternative fuel urban buses have a 2000 engine model year or later.

of diesel fueled urban buses in California as of 2004, along with the number and age of alternative fueled vehicles.³⁶ The vehicle counts are aggregated according the prevailing federal emissions limits for NOx. Alternative fuel bus purchases shot up in 2001 after the adoption of the California transit fleet rule in 2000 but dropped again to pre-rule levels in the years immediately after.

B. Texas

The Texas urban bus fleet is far smaller than the California fleet, consisting of approximately 3,481 buses.³⁷ The state fleet is made up of 28 urban fleets. Almost half the fleets (13) have a fewer than 10 vehicles and 8 have only one or two vehicles. The Houston Metropolitan Transit Authority had 1295 vehicles, some 36% of buses in the state fleet. Thus both the California and Texas fleets are dominated by a few large metropolitan bus fleets – the four largest Texas bus fleets account for 81% of the state bus fleet, while the four largest fleets in California account for 48% of the urban bus fleet.

In contrast to California, a far smaller percentage (13% v. 43%) of the urban buses were alternatively fueled. While interviews reveal that Houston was a very early adopter of alternative fuel buses, the district no longer operates any alternative fuel buses, and the oldest alternative fuel bus in the 2006 fleet have 1992 engine model years. Eleven transit agencies (38%) in Texas have at least one alternatively fueled bus in their fleet, but only three small fleets³⁸ had only

³⁶ This data is based on reports submitted by the transit agencies in 2005 to the California Air Resources Board regarding their 2004 urban bus fleets. The figure is based on the overall fleet description, rather than on data reported to calculate NOx and PM fleet emissions. Emissions limits prior to 1991 are the federal truck limits in the case of NOx and twice the federal truck limit in the case of PM.

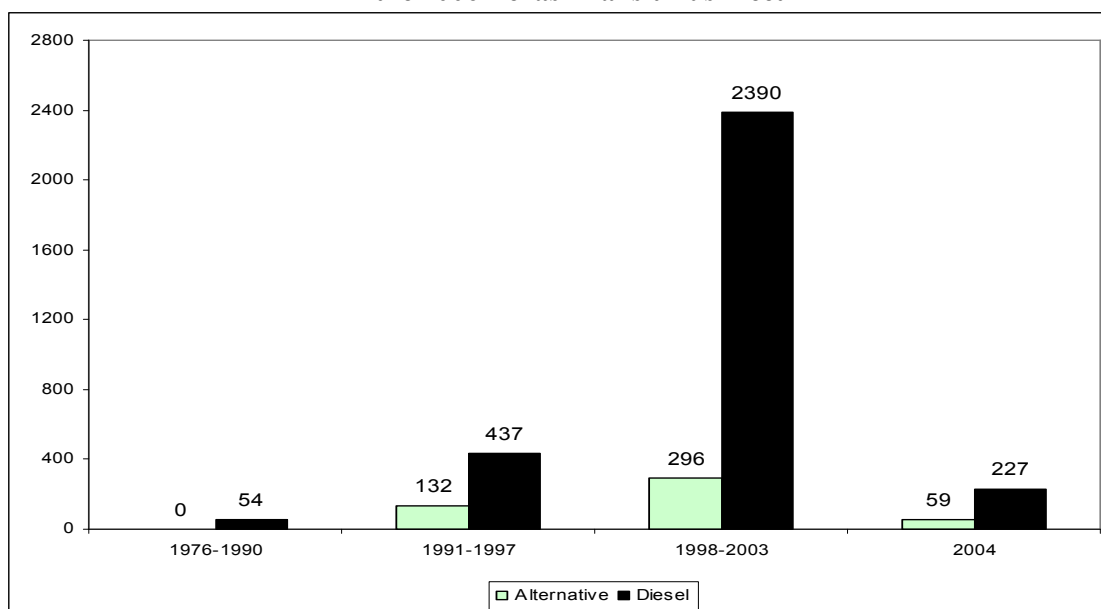
³⁷ We had data for the Texas fleet available through early 2006. Consequently, to make the best comparison possible with the California data, we deleted all buses from the Texas fleet bought in 2005 or 2006 (26 alternative buses and 88 diesel buses) but could unfortunately not add in to the dataset those older buses that these 114 buses had replaced). Thus the Texas data we are looking at has incomplete data for its older buses, as these were presumably the buses first replaced.

³⁸ South Plains – 2 HD buses, City of Mesquite – 1 HD bus, and Hill Country Transit District – 1 HD bus

alternatively fueled buses. The largest alternatively fueled fleet in Texas was the 138 buses in the 744 bus Dallas Area Rapid Transit fleet.

Of the total number of buses reported 86% (3,107) were diesel-fueled buses. Eighty-nine percent of fleets had at least one diesel bus in the fleet. The oldest diesel buses in the fleet include have 1980 engine model year engines. Figure 3 below shows the age distribution of both alternative and diesel fueled urban buses in Texas fleet.³⁹

Figure 3: Number of 2004 Model Year and Earlier Alternative and Diesel Buses in the 2006 Texas Transit Bus Fleet

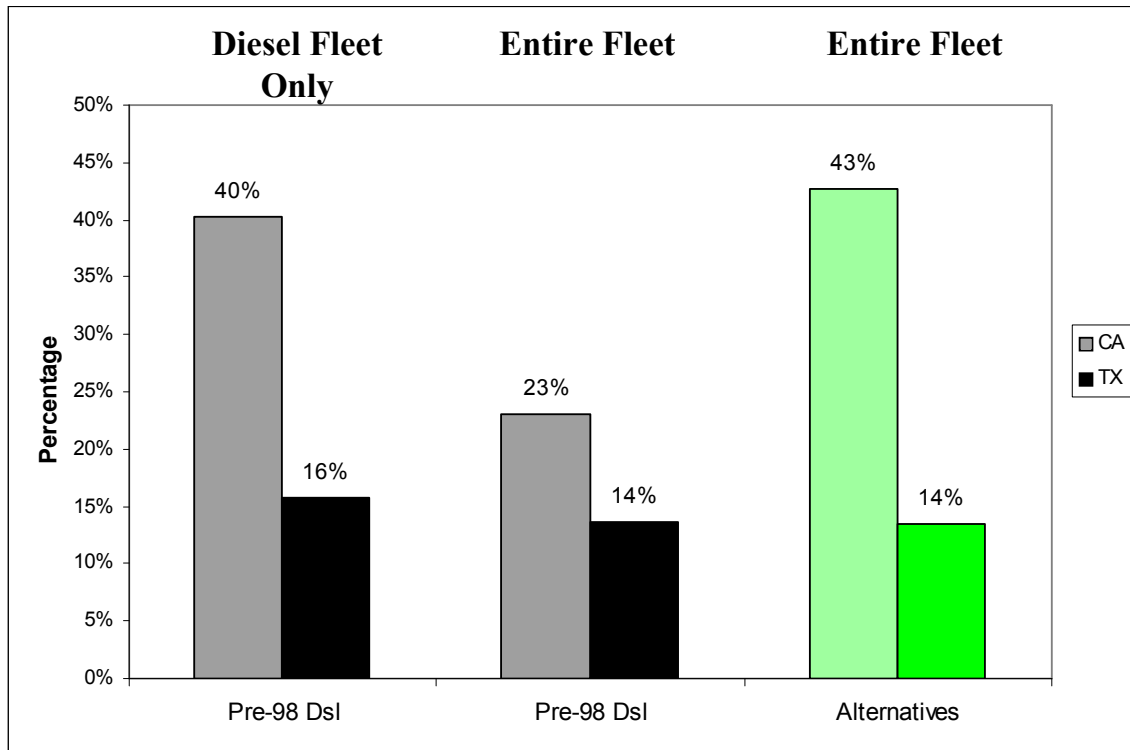


Texas's alternative fleet is older than California's, where 50% of the alternative fleet has a 1998 or later engine model year. By contrast, and contrary what one might have expected, Texas's diesel fleet seems to be *more modern* than California's, with 50% of buses having a 2000 or more recent engine model year, and 40% of California's diesel fleet being pre-98 diesels vs.

³⁹ This data is based on information provided by the fleet managers at the eight metropolitan, regional and municipal transit agencies in the state in conjunction with a single dataset of all remaining urban, rural, elderly and disabled bus fleets in the state provided by Paul Moon, Planner for the Texas Department of Transportation, and is maintained to provide financial and technical assistance to the agency.

16% of Texas' diesel fleet.⁴⁰ Figure 4 below shows the percent of alternative fuel vehicles and percent of diesel vehicles with MY1998 and earlier.

Figure 4: Percent of Pre-98 Diesel Buses (in Diesel and Entire Fleets) and Percent of Alternative-Fuel Transit Buses in California and Texas



In Texas, bus purchases were very high in 1998-2001. The pattern is quite different in California, where purchases of diesel transit buses is high in 2000 and 2001, and alternative bus purchases are high throughout the late 1990s but surge in 2001. By contrast, 2001 purchases of diesel buses in Texas are almost the same as those in 1998, and alternative bus purchases decline that year. The 2001 surge in California alternative bus purchases is driven by the LA MTA's purchase of 786 CNG buses that year (vs 346, 246, 321, 215 in the years 1997-2000).

⁴⁰ To a small degree this is an artifact of the data: if we assume that the 114 new buses bought in 2005-2006 replaced old pre-98 diesels, the results remain essentially the same. However, the differences in percent of pre-98 vehicles are a little smaller- 40 to 19 for diesel buses, 23 to 16 for all vehicles (see Figure 4).

Thus in Texas, a state that has relied exclusively on subsidy programs to encourage turnover in its bus transit fleet, we found that only 14% of buses in the fleet were pre-1998 diesels. And given the number of buses that were bought with both federal and state incentive funds, it seems clear that this turnover was at least facilitated by those programs.

In California, a state that relies on both carrots and sticks, we find that a much higher percent (23%) of the fleet consists of old diesel buses. However, this statistic alone is misleading because much of the California subsidies have gone towards retrofitting older buses so that despite their engine older model year, they have relatively clean emissions. In addition, the proportion of alternatively-fueled buses in the California fleet is very high (43%) driven largely by the LA MTA's 1993 -- pre-legal mandates -- decision to only buy alternatively fueled buses. Most of the alternatively fueled buses and fueling infrastructure acquired by the MTA were paid for out of federal, state, and local incentive funds. So once again, it is clear that incentive programs have at least facilitated turnover of the California transit fleet, and the move towards alternative fuel buses. The degree to which these improvements were facilitated by or caused by legal mandates we were unable to assess.

However, the urban transit sector, unlike trucking, has a relatively small number of relatively large regulatory/incentive targets. Thus incentive programs might work well in this transportation sector, but not in the trucking sector with its tens of thousands of companies, many of which are small and unsophisticated. The effectiveness of subsidy programs in that more challenging scenario we hope to be able to address at a later date.

In comparing the effectiveness of programs that rely solely on regulatory mandates versus those that use both carrots and sticks, we find that California has both worse (more older diesels) and better (more alternative buses) outcomes than Texas, and some of its outcomes

(retrofitting old diesels) we have been unable to measure. In addition, it is all but impossible to disentangle the effect of legal mandates from other political/economic forces that shape the urban transit fleets in both California and Texas. For example, the Los Angeles area MTA ordered its massive 2001 fleet of nearly 800 alternative fuel buses in 1998/1999, at the height of the dot.com bubble in California. And finally, Texas' incentives-only program benefits from California's incentive-mandatory program in a number of important ways: First, California's mandates provide a clear and steady signal to the manufacturing industry that they will have a market for the new alternatively-fueled buses and extra-clean diesel buses they develop. Second, California demonstrates, tests, and certifies new technologies. Those tests and certifications are then used by Texas regulators in the calculations of cost-effectiveness for their incentive programs. Thus our data is inconclusive in this regard.

Conclusion:

This paper has addressed the question of how variation across regulatory targets can affect the politics of regulatory design, and the choice of regulatory tools employed. In particular, we have theorized that in circumstances when regulatory targets cannot pass on the costs of pollution prevention efforts to their customers or clients, and when the services they provide are so crucial that they must be maintained, then there are likely to be significant political pressures to relax the polluter pays principle, and subsidy programs are more likely to occur. And we have shown why, in the case of diesel emissions from small trucking companies, urban bus agencies, and local public school buses in the United States this combination of circumstances has indeed arisen, producing a regulatory program that relies substantially on regulatory carrots.

We also addressed the question of whether subsidy programs work. In our case-study we find that subsidy programs have had a substantial effect in reducing emissions from buses

operated by transit agencies. Further research needs to be done to see if this success can be replicated in the case of trucking companies, which are far more numerous than transit agencies, and which are much less sympathetic targets of government monies than public agencies.

Finally, regarding the question of whether legal mandates in conjunction with subsidy programs provide an important ‘value added’ to the regulatory mix, we find that our study has been inconclusive. We hope to re-visit this question as we examine regulations to reduce diesel emissions from the trucking sector.

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