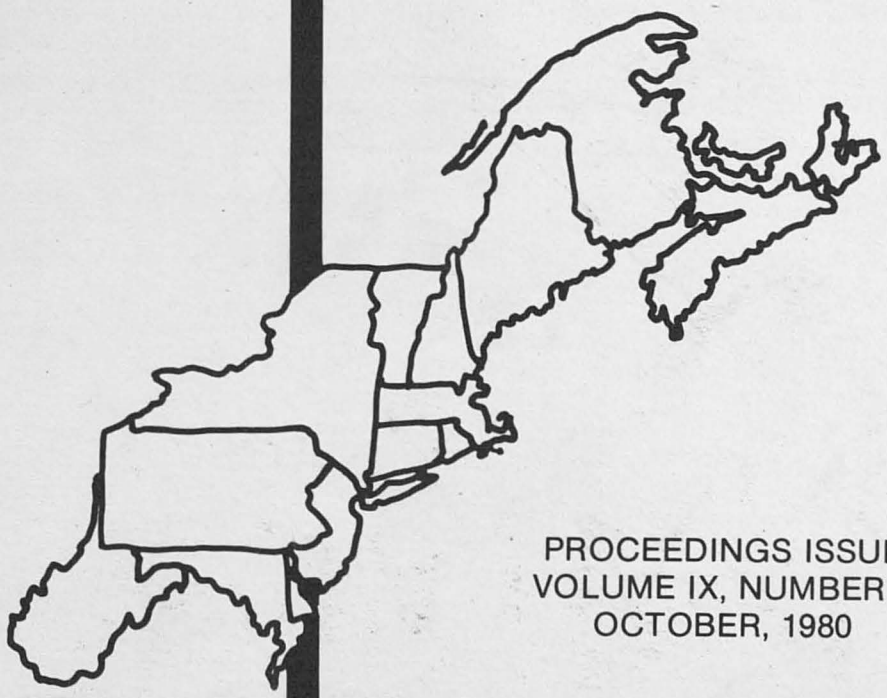
JOURNAL OF THE

Northeastern Agricultural Economics Council



PROCEEDINGS ISSUE
VOLUME IX, NUMBER 2
OCTOBER, 1980

THE COST OF AIR POLLUTION ABATEMENT— THE CASE OF NEW JERSEY'S MOTOR VEHICLE EMISSIONS INSPECTION PROGRAM

Daniel Rossi and Dennis J. Palmini

New Jersey is the most urbanized state in the nation; correspondingly, it also has the highest motor vehicle density, averaging 467 vehicles per square mile in 1976. In some metropolitan areas of the state, vehicle density may exceed 15,000 vehicles per square mile (New Jersey, Department of Environmental Protection 1976). Motor vehicles are considered responsible for significant emissions of carbon monoxide, hydrocarbons and nitrogen oxides (New Jersey, Department of Environmental Protection 1978). Because of growing concern about these emissions, the New Jersey Department of Environmental Protection (DEP) decided to adopt an in-use motor vehicle exhaust emission testing program; this could be incorporated easily into the already-existing automotive safety inspection program and thus was calculated to be more cost effective than alternative strategies as well as being less disruptive to the state's transportation system (New Jersey).

The emissions testing program requires, with a few minor exemptions, that all light-duty gasoline-fueled motor vehicles more than two years old be checked annually for their exhaust pipe emissions of carbon monoxide and hydrocarbons. The program began on July 1, 1972 on an advisory basis; Phase I of the mandatory program was instituted February 1, 1974, with the stricter emissions standards of Phase II being put into effect on November 1, 1975. Vehicles rejected for failing the emissions test are allowed thirty days to correct the problem and can either return to a state inspection station or go to a certified private garage for the re-inspection.

This study focuses on the costs of the current motor vehicle emissions testing program in New Jersey. While several partial studies of such programs have been attempted in the past usually emphasizing the budgetary costs to state and/or local government, this research will provide the first comprehensive review of the costs of the program, both to the motoring public and the state. A cost estimation methodology which can be utilized recurrently in the future has been developed and was used to calculate total program costs for the specific year 1977.[1]

The 1977 Clean Air Act Amendments require states having areas that will not meet the ambient air quality standards by 1982 to include in their Implementation Plans a motor vehicle inspection/maintenance program. The Environmental Protection Agency has identified twenty-nine states (eight of which are located in the Northeast) that will need such programs (U.S. Environmental Protection Agency 1979a). Development of a documented cost estimation methodology and cost estimates for the longest on-going mandatory state-wide motor vehicle emissions inspection program should be of assistance to states considering such a program.

CONCEPTUAL FRAMEWORK

The costs of the motor vehicle emissions testing program are borne by both the motoring public and the state government. The motoring public bears the costs of travel and time for both inspection and repairs as well as the costs of repairing their cars to required emissions standards. These costs are a direct burden to the public in the form of their time that is consumed and the out-of-pocket costs for travel and repairs. The state government bears the costs of planning and operating the inspection program through the Department of Environmental Protection (DEP) and the Division of Motor Vehicles (DMV). The DEP designed the program, establishes standards, and provides and maintains the emissions analyzers among other activities. The DMV conducts the actual testing of emissions and monitors the private reinspection program. Total program costs would be the sum of the costs to the motoring public and to the state government. The costs to the state government budget are financed by automobile registration fees so that the motoring public ultimately bears the full cost of the emissions program. Nevertheless, it is analytically useful to separate the costs showing up in the state government budget from those costs borne more directly by the motoring public.

The Motoring Public

The costs to the motoring public may be divided into out-of-pocket expenses and opportunity costs of time. Out-of-pocket expenses include expenditures on parts and/or labor for the repair of the emissions failure, on travel to and from the repair and reinspection, and penalties for failing to undergo inspection or reinspection. The second category, opportunity costs, is the value of the motorist's time used for travel, repair and reinspections. The time so spent could have been used in some other manner and its value to the motorist is a real economic value which must be counted in tallying up the total costs of the program.

The basic cost model is summarized in Equation (1):

(1) NACMP = OCTI + OCTR + TCR + RRC + TCF + -FEG - EMB

Where:

NACMP = net annual cost to the motoring public

OCTI = opportunity cost of the time to undergo the initial emissions inspection

OCTR = opportunity cost of the time required for repair and reinspection

TCR = out-of-pocket money cost of traveling for repairs and reinspection

---

Daniel Rossi and Dennis J. Palmini are assistant professors, Department of Agricultural Economics and Marketing, Cook College. Paper of the Journal Series, New Jersey Agricultural Experiment Station, Cook College, Rutgers University, New Brunswick, New Jersey 08903. This work was performed as a part of NJAES Project No. 02514. Supported by the New Jersey Agricultural Experiment Station and the New Jersey Department of Environmental Protection.

[1]This study does not attempt to measure the benefits of improved air quality. Lave and Seskin provide a comprehensive analysis of the relationship between air quality and human mortality. Seneca and Asch have recently applied the epidemiological approach developed by Lave and Seskin to New Jersey. However, neither study provides the relationship between levels of carbon monoxide and hydrocarbons, those pollutants controlled by the emissions inspection program, and human mortality.

RRC = out-of-pocket money cost of repairs and reinspection
TCF = total cost of fines for driving a vehicle without current inspection sticker
FEG = fuel economy gains from tune-ups (negative cost)
EMB = engine maintenance benefits from tune-ups (negative cost)

To place a value on the additional time spent at the initial inspection (OCTI) it was assumed that the driver could be working and earning an income.[2] An average hourly wage for New Jersey production workers was utilized in this calculation.[3]

OCTR represents the value of the time devoted to travel by the motorist to and from repair and reinspection stations and to waiting for repair and reinspection as well as the time devoted to self-repair of engines. The travel costs for repair and reinspection (TCR) are out-of-pocket expenses such as the cost of gasoline, taxes and depreciation on the vehicle. It is assumed for simplicity that all travel is by automobile. The costs of repairs (RRC) is for only emissions-related malfunctions and includes out-of-pocket expenditures for parts and labor and, for those vehicles being reinspected at private inspection stations, the costs of reinspection and the inspection sticker.

Two "negative costs" may at least potentially accrue to motorists who take their cars in for inspection. Generally, automobiles subject to a regular regime of inspection and maintenance will be better maintained and tuned, and thus should experience both improved fuel economy (FEG) and less need for major engine repairs (EMB). These may be considered benefits of an inspection/maintenance program directly realized by the motoring public, as distant from the more generalized benefits of improved air quality enjoyed by the entire population.

State Government

The costs of the emissions inspection/maintenance program directly incident to the budget of the state government include all expenditures related to the design, operation and administration of the program. Because New Jersey has required automobile safety inspections since 1937, the existing facilities and labor force were already in place when the emissions test was added to the inspection program. Therefore, an accurate accounting of the cost of the emissions program to the state must include only those costs which can be reasonably charged to the emissions program; that is, those costs which should not be incurred were it not for the fact of the emissions inspection/maintenance program. This study did not try to estimate the total cost of the entire inspection/maintenance system.

The study distinguished between: a) capital and start-up costs, and b) operating and maintenance costs. The first category reflects all costs of a non-recurring nature incurred during preliminary planning and decision-making and initial program implementation. The operating and maintenance costs include the annually recurring costs necessary to operate and maintain the emissions inspection program. To sum up and compare costs, it is necessary that they be presented in common dimensions. A commonly accepted procedure is to calculate the annualized value of the capital costs; by doing so, they can then be compared or added to the annual operating and maintenance costs.

State Government: capital cost model

Total Capital Costs (TCC) are summarized in the following Equation (2):

(2) TCC = ETCC + PRCC + ACC

Where:

ETCC = capital costs associated with emissions testing
PRCC = capital and start-up costs associated with the private reinspection system
ACC = general program and planning start-up costs

The capital costs of emissions testing include the costs of equipment purchase and installation, the expansion of facilities, and the initial training of emissions testing personnel. The costs of the private reinspection system include the purchase of equipment, the training of inspectors for and calibration of emissions testing equipment and the training of garage mechanics in emissions testing and emissions repairs. Those costs not directly attributable to either the emissions testing activity or private reinspection monitoring but to general program administration and planning, include expenditures on analysis of alternative standards and alternative abatement controls, initial public education activities and initial training of administrative personnel.

State Government: operating and maintenance cost model

Total annual Operating and Maintenance Costs (TOMC) are summarized in Equation (3):

(2) TOMC = ETOMC + PROMC + AOMC

Where:

ETOMC = emissions total operating and maintenance costs
PROMC = private reinspection operating and maintenance costs
AOMC = administration operating and maintenance costs

The term ETOMC includes labor, equipment maintenance and repair and recurrent training costs. The PROMC category also includes recurring labor, equipment maintenance and employee training costs as well as the training of private garage mechanics. Administration costs again include labor and recurrent supply and equipment costs in addition to public education and administrative training expenses.

RESULTS

Cost to the Motoring Public

The cost of repairs and reinspection (out-of-pocket money payments) accounted for 70 percent of the total cost while just over 20 percent is attributable to the time required for traveling and waiting for repairs and reinspection (Table 1). The total cost of $16,799,200 averages out to $4.57 per vehicle going through the inspection system.[4] The money payment costs of repairs (but not reinspection) account for about 66 percent of the total cost.

The total cost estimate above did not include any estimate of the fuel economy gains that may be derived from the program. These benefits are due primarily to the fact that some proportion of the population of vehicle owners would, in the absence of the emissions

[2]Since the objective of the study is to estimate the incremental costs of adopting the emissions inspection program, only the value of the additional time spent by the driver at the initial inspection which is attributable to emissions testing is included. The other costs of time and travel for the initial inspection are not included because they would be incurred for the safety inspection regardless of whether the emissions inspection program was adopted.

[3]The opportunity cost of time was taken to be equal to the average wage of production workers in the state, while recognizing that many people who take their family vehicles in for inspection may be unemployed or doing so on their off time.

[4]The number of vehicles required to undergo inspection in 1977 was 3,675,598, approximately 17 percent of which failed the initial emissions inspection.

testing program, keep their vehicles in such poor state of repair that they would suffer from very poor fuel mileage. The argument is that the emissions testing and repair program forces this subset of drivers to get their cars tuned up at least once a year, thus forcing upon them the benefit of improved fuel economy. A literature review suggested that an estimate of an average 0.40 percent gain (Panzer; Bayler and Eder; Rubenstein, *et al.*, U.S. Environmental Protection Agency, 1979; Becker and Rutherford). Using this estimate and an average price of gas in 1977 of 63 cents per gallon,[5] the estimated value of fuel economy gains (VFEG) was $7,319,700 resulting in a net annual cost to the motoring public (NACMP) of $9,479,500.[6]

A sensitivity analysis was performed on the model. Since the values of some variables and parameters possess some margin of uncertainty, a number of them were allowed to vary by as much as 20 percent to estimate what effect such variations might have on the total cost estimate. The two variables found to have substantial effects were the average hourly wage of New Jersey production workers and the average cost of emissions repairs at private repair stations. A 20 percent increase in the hourly wage value increased the total cost estimate by 4.4 percent or by $743,700. A 20 percent increase in the average cost of vehicle repairs increased the total cost estimate by 11.6 percent or by $1,949,900.

Two other variables—the average price of gasoline and the percentage gain in fuel economy resulting from increased maintenance—were found to have substantial effects on the value of fuel economy gains and therefore net costs. An increase in the price of gasoline to $1.00 per gallon increased FEG by 58.7 percent or by $4,296,700. An increase in the percentage gain in fuel economy to 1 percent increased FEG by 150.0 percent or by $10,979,600.

An effort was made to approximate the results for 1979 by indexing upwards four important variables: The price of gas, the average cost of repairs at private repair stations, the average hourly wage and the number of registered cars. Total cost was estimated to have risen by 56.1 percent, four-fifths of which was attributable to rise in the cost of repairs. The rise in the price of gas to just over a dollar a gallon largely accounted for a 67.1 percent increase in the value of fuel economy gains. Net costs would increase by 47.3 percent or by $4,535,700.

Table 1.
Cost to the Motoring Public, 1977

Cost Category	Estimated Dollar Value	Percent of Total Cost	Average Cost per Vehicle
Value of time: initial inspection	$ 180,600	1.1	$0.05
Value of time: repairs and reinspection	3,550,600	21.1	0.97
Travel cost: repair and reinspection	1,070,100	6.4	0.29
Money payments: repair and reinspection	11,904,200	70.9	3.24
Total fine costs	93,700	0.5	0.02
Total costs	$16,799,200	100.0	$4.57

[5]These figures were updated to provide an estimate of the costs to the motoring public for 1979 as will be described later in the paper.

[6]While engine maintenance benefits are recognized as potential benefits from the inspection/maintenance system, there is no empirical basis for determining what the value of these benefits might be. Therefore, no estimates are offered.

Cost to State Government

Total annual cost is the sum of annualized capital and start-up costs and annual operating and maintenance costs. These costs are presented by program components rather than by agency involvement. Unpublished data from the files of DEP and DMV were made available to estimate program costs to these agencies. The cost estimates are presented in Table 2.

The capital costs of emissions testing and private reinspection accounted for only one-third of the capital and start-up costs of the program. The administration and planning costs of personnel time, materials and equipment occurred over several years prior to the actual start of the emissions testing program and for several years after it. These costs are responsible for two-thirds of the capital cost total.

It should be noted that this capital cost estimate is probably an underestimate. Information on the cost of training DMV employees was not available and information on the expenditures devoted to preliminary planning efforts and public education were incomplete.

The cost of the initial emissions testing program is responsible for just under one-half of the total operating and maintenance costs while planning and administration accounts for slightly more than one-third of the operating and maintenance total. The private reinspection program accounts for only 15 percent of the operating and maintenance expenditures and 14 percent of the total budgetary expenditures on the emissions inspection/maintenance program. Labor expenses accounted for 85 percent of the operating and maintenance costs of the emissions testing and private reinspection components of the total program. Only ten percent of O&M costs were devoted to equipment and maintenance and repair. Again, as with the capital cost estimates, these figures should be regarded as underestimates of the true 1977 costs; some information, especially on training and public education activities, was not available or was incomplete.

Table 2.
Program Costs to State Government, 1977

Annualized Capital Costs:		
Emissions Testing Program	$ 49,400	
Private Reinspection Program	21,700	
Program Administration and Planning	145,500	
		$ 216,600
Annual Operating and Maintenance Costs:		
Emissions Testing Program	399,800	
Private Reinspection Program	129,600	
Program Administration and Planning	311,400	
		$ 840,800
Total Annual Costs		$1,057,400

Net Total Program Costs

Net total program costs are calculated by adding together the costs to the motoring public and to the state government. Table 3 presents the cost estimates for 1977. It will be noted immediately that 90 percent of the net total program cost is borne not by the state government but by the motoring public. Excluding the somewhat speculative fuel economy gains, the total program cost in 1977 was $17,856,600 of which the part directly borne by the motoring public accounted for 94 percent.

Cost Effectiveness

Reductions in emissions of hydrocarbons (HC) and carbon monoxide (CO) resulting from the New Jersey inspection/maintenance program were estimated using the U.S. EPA's MOBILE 1 computer simulation model. The program costs can then be expressed in terms of cost per unit reduction as shown in Table 4.

This table shows the cost per ton of reductions as the total expenditure on emissions control per ton of reduction in hydrocarbon and carbon monoxide emissions. Strictly speaking, the total expenditures should be allocated between the portion that contributes to reducing hydrocarbons and the portion that contributes to reducing carbon monoxide emissions. In fact, the necessary data are not available and there is no generally acceptable method for allocating the estimated costs between the reductions in the two pollutants. Perhaps the single best measure, given this state of affairs, is simply the costs per total ton of pollutant reduction as shown in the last column.

Table 3.
Annual Emissions Inspection/Maintenance Program Costs, 1977

	Aggregate Value	*Cost/ Vehicle*
Cost to Motoring Public		
Total Cost	$16,799,200	$4.57
Less: Value of Fuel Economy Gains	−7,319,700	−1.99
Net Annual Cost to Motoring Public	9,479,500	2.58
Cost to State Government		
Annualized Capital Costs	216,600	0.06
Annual Operating and Maintenance	840,800	0.23
Total Cost	1,057,400	0.29
Net Total Program Cost	$10,536,900	$2.86

Table 4.
Cost of Inspection/Maintenance per Unit Reduction in Emissions

	Cost per Ton Reduction		
Cost Item	Hydrocarbons	Carbon Monoxide	Total Pollutants
Cost to Motoring Public			
Total Cost	$543.66	$27.86	$26.50
Net Cost	306.77	15.72	14.95
Cost to State Government	34.22	1.75	1.69
Total Program Cost	577.88	29.61	28.17
Net Program Cost	341.00	17.47	16.62

CONCLUSIONS

It is worth noting that while public discussions of the costs of various government programs very often focus solely on the budgetary costs to the government agencies having responsibility for the program, these government budgetary costs may often be the lesser fraction of the total social costs of the program. In the case of the emissions inspection program in New Jersey, the government budgetary component accounted for only about six percent of the total social cost (exclusive of fuel economy gains) while the less visible and often ignored costs borne by the motoring public apart from the government budget are by far, in this case, the more important burden of the program. In other words, an adequate social accounting of the costs of the program should take into consideration the full cost of the program, whether the cost shows up in the government budget or simply is widely dispersed among the private household budgets of the many individuals affected by the program. Focusing only on the budgetary costs to government may result in misleading conclusions and wrong policy decisions.

REFERENCES

Bayler, T. and L. Eder, *Fuel Economy Improvement Through Diagnostic Inspection*, U.S. Department of Transportation, National Highway Traffic Safety Administration, Traffic Safety Programs, Office of State Vehicle Programs, Report No. DOT HS-802 284, 1977.

Becker, J. P. and J. A. Rutherford, "Analysis of Oregon's Inspection and Maintenance Program," U.S. Environmental Protection Agency, Inspection/Maintenance Staff, Ann Arbor, Michigan. Paper No. 79-73, presented at 72nd Annual Meeting of Air Pollution Control Association, June 25, 1977.

Lave, L. and E. Seskin, *Air Pollution and Human Health*, Baltimore: Johns Hopkins Press, 1977.

New Jersey, *Motor Vehicle Inspection System Study Commission, Final Report*, 1978.

New Jersey, Department of Environmental Protection, *State Implementation Plan Revision—Public Participation Meetings*, 1978.

New Jersey, Department of Environmental Protection, *New Jersey Motor Vehicle Emission Inspection Program, Summary and Report—Phase I*, 1976.

Panzer, J., "Fuel Economy Improvements Through Emissions Inspection Maintenance," Society of Automotive Engineers Report No. 76003, presented to the Automotive Engineering Congress and Exposition in Detroit, Michigan, February 23-27, 1976.

Rubenstein, G., *et al.*, "Vehicle Inspection and Maintenance—The California Program," Society of Automotive Engineers Report No. 760557, presented at the Fuels and Lubricants Meeting in St. Louis, Missouri, June 7-10, 1976.

Seneca, J. and P. Asch, *The Benefits of Air Pollution Control in New Jersey*, Center for Coastal and Environmental Studies, Rutgers University, New Brunswick, New Jersey, 1979.

U.S. Environmental Protection Agency, *I/M Update*, Mobile Source Air Pollution Control, Ann Arbor, Michigan, 1979a.

U.S. Environmental Protection Agency, "Portland Study Interim Analysis: Observations on Six Months of Vehicle Operation," Office of Air, Noise and Radiation, Office of Mobile Source Air Pollution Control, Emission Control Technology Division, Inspection/Maintenance Staff, 1979b.