Modeling the Response of the Domestic Automobile Industry to Mandates for Increased Fuel Economy

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Fuel economy mandates for new automobiles sold in the United States were legislated in the Energy Policy and Conservation Act of 1975. A number of studies have estimated the technical feasibility of the firms producing cars that comply with the mandates, and several studies have investigated a few of the direct economic effects resulting from full compliance by such firms. This paper systematically analyzes the economic incentives the mandates provide to the firms and the alternative responses the firms may make. A behavioral model of joint profit maximization for the domestic automobile industry is initially geared to 1976 market data when no mandates were in effect. The parameters of the model are then used to estimate the equilibrium changes in prices, costs, sales, profits, individual and aggregate fuel economies, and governmental revenues when various levels of fuel economy mandates are imposed for 1985. The model indicates that domestic automobile manufacturers will react to fuel economy mandates by downsizing and adopting new but currently available fuel-saving technologies rather than forcing major changes in the mix of cars sold. This strategy should allow them to produce cars with sales-weighted-average gasoline consumption of less than 8.55 L/100 km (greater than 27½ mpg) by 1985.

Predicting the effects of taxes on the price-quantity response of profit-maximizing firms is a problem frequently encountered in economic analysis. This paper deals with the response of the domestic automobile industry, a multiproduct industry, to mandates for increased new-car fuel economy as legislated in the Energy Policy and Conservation Act of 1975. The law requires the sales-weighted-average of new-automobile fuel economy for each major manufacturer to increase on a prescribed schedule from 1978 through 1985.

The relationship among automobile prices, the price of gasoline, and the national consumption of gasoline has been analyzed by a number of groups, especially since the energy crises of 1973-1974 (1,2,3,4,5). The feasibility and costs of increasing new-automobile fuel economy have also been studied (6,7). Only two of the major studies, however, have dealt with the question of fuel economy mandates (8,9; see also 10,11,12).

This paper projects the full long-range response of the domestic automobile industry to fuel economy mandates by using a rather simple industry model. This approach assumes that the domestic automobile industry acts as if it were a single entity maximizing the joint profits of its members. The monopoly assumption, although clearly not doing full justice to the price leadership form of oligopoly that exists in the domestic market, provides insights that are obscured in most other studies by the usually implicit assumption of purely competitive markets. Three sizes of cars are modeled as representative of the output of the industry, and the industry is assumed to select the prices and fuel economies of these cars in a way that maximizes long-term profits. This model is initially fitted to 1976 market information when there were no mandates in effect. The parameters of the model are then used to estimate the equilibrium changes in prices, costs, sales, profits, individual and aggregate fuel economies, and governmental revenues when various levels of fuel economy mandates are imposed for 1985.

INDUSTRY SIMULATION MODEL

Model Structure

The model assumes that the domestic automobile industry acts as a single giant firm maximizing the joint profits of its members. The industry produces and sells three types of cars: large cars (representing the standard and luxury models), midsize cars, and small cars (representing the current subcompact, compact, and luxury compact models).

The model consists of 12 basic equations. There is a profit function that is treated as the industry's basic objective function and is maximized. There are three demand equations—one for each type of car—and three cost equations. Finally, there is a fine function and four other definitional equations. These equations are

$$\Pi = (R - C)(1 - \gamma) - F \qquad (1)$$

$$R = P^b Q^b + P^m Q^m + P^s Q^s \qquad (2)$$

$$Q^b = \alpha_0^b \; P^{b^{\alpha_1^b}} \; P^{m^{\alpha_2^b}} \; P^{s^{\alpha_3^b}} \; E^{b^{\alpha_4^b}} \; E^{m^{\alpha_5^b}} \; E^{s^{\alpha_6^b}} \qquad (3)$$

$$Q^m = \alpha_0^m \; P^{b^{\alpha_1^m}} \; P^{m^{\alpha_2^m}} \; P^{s^{\alpha_3^m}} \; E^{b^{\alpha_4^m}} \; E^{m^{\alpha_5^m}} \; E^{s^{\alpha_6^m}} \qquad (4)$$

$$Q^s = \alpha_0^s \; P^{b^{\alpha_1^s}} \; P^{m^{\alpha_2^s}} \; P^{s^{\alpha_3^s}} \; E^{b^{\alpha_4^s}} \; E^{m^{\alpha_5^s}} \; E^{s^{\alpha_6^s}} \qquad (5)$$

$$C = C^b + C^m + C^s \qquad (6)$$

$$C^b = \beta_0^b + (\beta_1^b + \beta_2^b E^b) Q^b \qquad (7)$$

$$C^m = \beta_0^m + (\beta_1^m + \beta_2^m E^m) Q^m \qquad (8)$$

$$C^s = \beta_0^s + (\beta_1^s + \beta_2^s E^s) Q^s \qquad (9)$$

$$F = T(M - E)Q \qquad (10)$$

$$Q = Q^b + Q^m + Q^s \qquad (11)$$

$$E = Q(Q^b/E^b + Q^m/E^m + Q^s/E^s)^{-1} \qquad (12)$$

where

- Π = industry profits,
- R = revenue,
- C = costs (production and selling),
- F = fuel economy fine,
- P = new automobile prices,
- Q = new automobile sales,
- E = new automobile fuel economy,
- T = fuel economy tax rate ($ per km/L or mpg),
- M = fuel economy mandate,
- b = large automobiles,
- m = midsize automobiles,
- s = small automobiles,
- α_j^i = demand elasticities,
- β_j^i = cost parameters, and
- γ = corporate income tax rate.

The profit function recognizes that the fuel economy fine cannot be deducted from industry revenue for income tax purposes. This approximately doubles the impact of any level of fine on the industry over what it would be if it were deductible. The demand functions are assumed to be log-linear in prices and fuel economy. This permits the use of any of the constant value elasticities that have been estimated recently for the industry. The cost functions are designed so that input information on the levels of average and marginal costs for the several sizes of automobiles to derive values for the structural parameters may be used in the calibration procedure. The fine function uses the harmonic mean in calculating the sales-weighted-average fuel economy for the industry.

Calibrating the Model

Calibrating the model on the 1976 market values implies an assumption that the industry was within reasonable proximity of long-range equilibrium at that time—a most unrealistic and potentially dangerous assumption. It can be justified only if our projections and conclusions display a large degree of robustness and insensitivity to changes in parameter values. A major portion of our plans for future research is concerned with developing a reliable statistical basis for the model's parameter.

$$\partial\Pi/\partial P^b = Q^b + \alpha_1^b[(P^b - \beta_1^b - \beta_2^b E^b)Q^b/P^b] + \alpha_1^m[(P^m - \beta_1^m - \beta_2^m E^m)Q^m/P^b] + \alpha_1^s[(P^s - \beta_1^s - \beta_2^s E^s)Q^s/P^b] = 0 \qquad (13)$$

$$\partial\Pi/\partial P^m = Q^m + \alpha_2^b[(P^b - \beta_1^b - \beta_2^b E^b)Q^b/P^m] + \alpha_2^m[(P^m - \beta_1^m - \beta_2^m E^m)Q^m/P^m] + \alpha_2^s[(P^s - \beta_1^s - \beta_2^s E^s)Q^s/P^m] = 0 \qquad (14)$$

$$\partial\Pi/\partial P^s = Q^s + \alpha_3^b[(P^b - \beta_1^b - \beta_2^b E^b)Q^b/P^s] + \alpha_3^m[(P^m - \beta_1^m - \beta_2^m E^m)Q^m/P^s] + \alpha_3^s[(P^s - \beta_1^s - \beta_2^s E^s)Q^s/P^s] = 0 \qquad (15)$$

$$\partial\Pi/\partial E^b = \alpha_4^b[(P^b - \beta_1^b - \beta_2^b E^b)Q^b/E^b] + \alpha_4^m[(P^m - \beta_1^m - \beta_2^m E^m)Q^m/E^b] + \alpha_4^s[(P^s - \beta_1^s - \beta_2^s E^s)Q^s/E^b] - \beta_2^b Q^b = 0 \qquad (16)$$

$$\partial\Pi/\partial E^m = \alpha_5^b[(P^b - \beta_1^b - \beta_2^b E^b)Q^b/E^m] + \alpha_5^m[(P^m - \beta_1^m - \beta_2^m E^m)Q^m/E^m] + \alpha_5^s[(P^s - \beta_1^s - \beta_2^s E^s)Q^s/E^m] - \beta_2^m Q^m = 0 \qquad (17)$$

$$\partial\Pi/\partial E^s = \alpha_6^b[(P^b - \beta_1^b - \beta_2^b E^b)Q^b/E^s] + \alpha_6^m[(P^m - \beta_1^m - \beta_2^m E^m)Q^m/E^s] + \alpha_6^s[(P^s - \beta_1^s - \beta_2^s E^s)Q^s/E^s] - \beta_2^s Q^s = 0 \qquad (18)$$

These equations and Equations 1-12 provide a total of 18 equations relating the variables and parameters of our model.

To calibrate the model to the 1976 market equilibrium, values for the variables are specified below:

Exogenous			Endogenous		
Variables	Parameters		Variables	Parameters	
P^b	α_2^b	α_1^s	Π	α_0^b	β_1^b
P^m	α_3^b	α_2^s	R	α_0^m	β_1^m
P^s	α_4^b	α_4^s	C	α_0^s	β_1^s
Q^b	α_5^b	α_5^s	E		β_2^b
Q^m	α_6^b	α_6^s	Q	α_1^b	β_2^m
Q^s	α_1^m			α_2^m	β_2^s
E^b	α_3^m	$\partial C/\partial Q^b$		α_3^s	
E^m	α_4^m	$\partial C/\partial Q^m$		β_0^b	
E^s	α_5^m	$\partial C/\partial Q^s$		β_0^m	
C^b	α_6^m			β_0^s	
C^m					
C^s					

Values for the 20 endogenously determined variables and parameters are then derived using the values for the input variables and a total of 20 independent equations—11 structural equations (Equations 1-12 less Equation 10, the fine function assumed inoperative for 1976); 6 profit-maximizing relations (Equations 13-18); and 3 marginal cost definitions:

$$\partial C^b/\partial Q^b = \beta_1^b + \beta_2^b E^b \qquad (19)$$

$$\partial C^m/\partial Q^m = \beta_1^m + \beta_2^m E^m \qquad (20)$$

$$\partial C^s/\partial Q^s = \beta_1^s + \beta_2^s E^s \qquad (21)$$

Values of Exogenous Variables and Parameters

The input base period values for the variables and parameters that are exogenously determined for the calibration procedure are presented in Tables 1 and 2.

The 1976 values for the input variables were gathered from a variety of sources. Sales data were taken from Automotive News (January 10, 1977). The fuel economy values are unweighted averages computed from the Environmental Protection Agency's estimates of combined city and highway fuel economy for all of the 1976 domestic models. The price and cost figures are derived primarily from information released by the Council on Wage and Price Stability. Several adjustments were made to these price and cost figures to better reflect the actual market situation (13). The corporate income tax is assumed to apply to all operations and is a flat 48 percent of revenue less costs.

There are two types of input demand elasticities. The direct fuel economy elasticities represent our impression of the average values empirically estimated during the last few years. Values for the cross elasticities of both price and fuel economy were specified to be zero for the initial simulation runs. This was done to simplify the computations involved in both the calibration and simulation procedures.

Values for Endogenous Variables and Parameters

The outputs of the calibration procedure that are of primary interest are the direct price elasticities and the cost parameters associated with increasing fuel economy. The other endogenously determined values are of much less importance. The variables are simple functions of the exogenous variables, and the remaining demand and cost parameters are constants used in scaling the demand, cost, and marginal cost functions.

Values for the fuel economy cost parameters (the β_2^i) are determined from Equations 16-18. With the assumptions and specifications discussed here, these equations reduce to

$$\beta_2^b = \alpha_4^b\{[P_0^b - (\partial C^b/\partial Q^b)_0]/E_0^b\} = 0.5[(6190 - 4460)/14] = \$61.79 \qquad (22)$$

$$\beta_2^m = \alpha_5^m\{[P_0^m - (\partial C^m/\partial Q^m)_0]/E_0^m\} = 0.5[(4740 - 3280)/18] = \$40.56 \qquad (23)$$

$$\beta_2^s = \alpha_6^s\{[P_0^s - (\partial C^s/\partial Q^s)_0]/E_0^s\} = 0.6[(4100 - 2700)/22] = \$38.18 \qquad (24)$$

Table 1. Variable values input to calibration.

	Variables				
				Cost ($)	
Car Size	Q	E	P ($)	Average	Marginal (Q)
Large	2.3×10^6	14	6190	5390	4460
Midsize	2.9×10^6	18	4740	4170	3280
Small	3.4×10^6	22	4100	3625	2700

Table 2. Demand elasticities input to calibration.

	Demand Elasticities					
Car Size	P^b	P^m	P^s	E^b	E^m	E^s
Large	X[a]	0.0	0.0	0.5	0.0	0.0
Midsize	0.0	X[a]	0.0	0.0	0.5	0.0
Small	0.0	0.0	X[a]	0.0	0.0	0.6

[a]X represents a value determined endogenously.

That is, assuming there is no change in the quantity sold, the cost of increasing fuel economy by 0.4 km/L (1 mpg) implied by the actual market data is about $62 for large cars, $41 for midsize cars, and $38 for small cars. These figures, derived from assumptions concerning average cost levels and the behavior of the industry, appear to be of reasonable magnitude.

Using the derived values of β_2^i, the direct price elasticities can now be estimated using Equations 13-15. These equations simplify to

$$\alpha_1^b = -\{[P_0^b - (\partial C^b/\partial Q^b)]/P_0^b\}^{-1} = -[(6190 - 4460)/6190]^{-1} = -3.58 \quad (25)$$

$$\alpha_2^m = -\{[P_0^m - (\partial C^m/\partial Q^m)_0]/P_0^m\}^{-1} = -[(4740 - 3280)/4740]^{-1} = -3.25 \quad (26)$$

$$\alpha_3^s = -\{[P_0^s - (\partial C^s/\partial Q^s)_0]/P_0^s\}^{-1} = -[(4100 - 2700)/4100]^{-1} = -2.93 \quad (27)$$

Note that the values of the direct price elasticities depend only on the relation of price to marginal cost. If price should be equal to marginal cost, a condition usually considered to be an attribute of a competitive firm, the price elasticity for the firm's product would be infinite. Any increase in the firm's price would result in a total loss of sales. Market, or monopoly, power, is represented by an increasing markup of price over cost and by a smaller simplicity.

These price elasticities, derived from price and cost estimates and the assumption of joint profit maximization, are somewhat greater in magnitude than many of the elasticities recently estimated in other studies. This difference is not due to the lack of cross elasticities in our model. Nor does it appear to be caused by our current assumption of joint profit maximization for the industry. It is probably due to our explicit modeling of the long-range adjustments in the market for new automobiles, rather than focusing on the year-to-year changes in sales.

PROJECTING INDUSTRY RESPONSE

Having calibrated the model to the 1976 market conditions, the fuel economy fine function is made operational and the changes in industry sales, prices, revenues, fuel economies, costs, and profits may be observed. Our assumptions condition this to be a long-range analysis. Each solution of the model represents the industry's behavior by and for the year 1985, assuming that it can start its adjustments, plans, and processes immediately. This study is concerned only with the final equilibrium, not with the year-to-year changes required to attain that position, although all of the inputs have been designed to ensure that all implied year-to-year changes are feasible. All dollar values reported are in constant 1976 dollars.

Base Case Results

All of the simulations use the model specified earlier in this paper. The only additional information required is the maximum feasible level of fuel economy for each size class of automobiles that is consistent with our cost conditions. Our cost review and analysis indicate that it is quite probable that diesel-powered automobiles with advanced transmissions can be in full production by 1985 and that large cars with this technology can average fuel consumption of 9.80 L/100 km (24 mpg); midsize cars, 8.11 L/100 km (29 mpg), and small cars 6.19 L/100 km (38 mpg). Less fuel consumption does not appear feasible at any reasonable price. This is our base case.

Figure 1 illustrates the results of the base case runs. We have solved the industry model for the profit maximizing behavior associated with fuel consumption mandates of 13 through 7.8 L/100 km (fuel economy mandates 18 through 30 mpg). As the 1976 sales-weighted-average fuel consumption of the industry was about 13 L/100 km, the points associated with a 13 L/100 km (18 mpg) mandate represent the nominal, or no change, position of the industry. The fine function uses a tax rate of $12.50 for each 0.4 km/L ($50 for each mile per gallon) that the sales-weighted-average fuel economy falls short of the mandate. This is the tax rate specified in the present law.

The upper left segment of Figure 1 shows the fuel economy that 1985 cars are expected to display plotted against the levels of the fuel economy mandate inducing them. The model projects that any level of consumption down to about 8 L/100 km (29 mpg) will be met. Midsize cars reach their minimum feasible level of fuel consumption with a mandate of 8.4 L/100 km (28 mpg). Large-car fuel consumption is at its minimum when the mandate is 8 L/100 km (29 mpg). Small cars never reach their fuel economy limits.

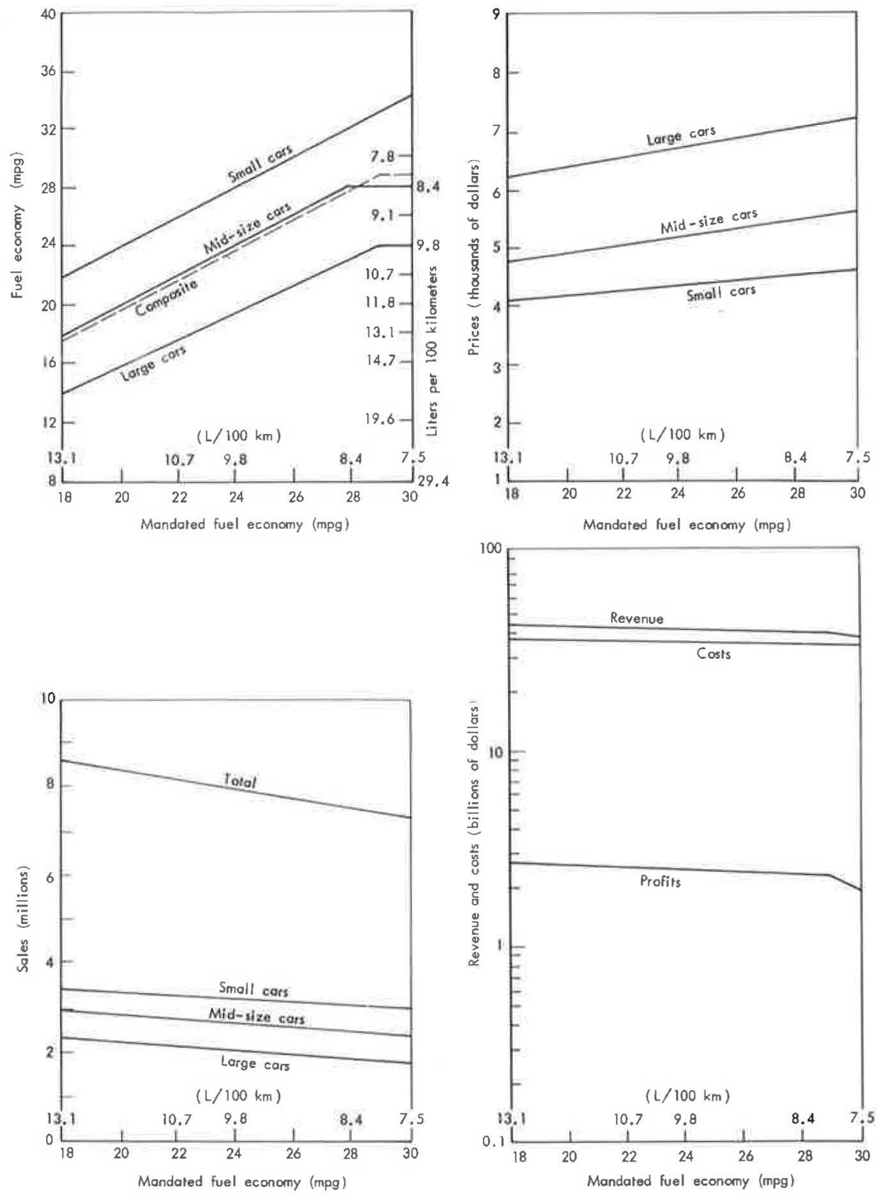
These results indicate that for mandates down to 8 L/100 km (29 mpg), it is worthwhile for the industry to incur the additional costs associated with increasing the fuel economy of all the cars it produces rather than paying the fine. These results are implied by the present profitability of the industry, the costs of $15 or less per 1 L/100 km ($60 or less per mpg) for increasing fuel economy, and the sales effects of increasing both fuel economy and price.

New-car prices are plotted in the upper right segment of Figure 1 for the different mandates. They rise slowly but steadily as the level of the mandated fuel economy increases. With a mandate of 8.5 L/100 km (27.5 mpg) large-car prices are about 13 percent above the nominal level. Midsize-car prices and small-car prices are up about 12 percent for that level of mandate.

The consequences of these fuel economy and price changes on industry sales are shown in the lower left segment of Figure 1. Total sales drop slightly but steadily as mandated fuel economy is increased. The effects are roughly equal for the three types of cars. Comparing a mandate of 8.5 L/100 km (27.5 mpg) to the nominal case, sales of each size class fall by about 0.4 million vehicles. This translates into an 18 percent sales decline for large cars, 14 percent for midsize cars, and 12 percent for small cars.

Industry revenue, costs, and profits are illustrated in the lower right segment of Figure 1. Revenues and costs behave quite similarly for most levels of the mandate so that profits decline rather slowly up to the 8

Figure 1. Market projections for 1985—effects of alternative mandates, base case technology.



L/100 km (29 mpg) mandate level. Above that, profits decrease sharply. A mandate of 8.5 L/100 km (27.5 mpg) decreases industry profits about 19 percent below the nominal level.

Perhaps the most significant aspect of these results is that they contain nothing surprising. The use of reasonable inputs produces reasonable outputs. Our analysis suggests that a fuel consumption standard of 8.5 L/100 km (a fuel economy mandate of 27.5 mpg) will induce a new car sales-weighted-average fuel consumption of 8.5 L/100 km (fuel economy of 27.5 mpg) in 1985, a decrease of about 35 percent from the nominal level. Such a standard will also cause new-car prices to rise by about 12 percent, sales to fall by about 15 percent, and industry profits to decline by about 10 percent.

When industry profits decline as the level of the fuel consumption mandate is decreased, it is in the interest of the automobile industry to have the mandate set as high as possible. It appears that each 1 L/100 km decrease in the mandate is associated with about a $50 million decrease in profits for most of the range. The final steps of the mandate are associated with much larger reductions. Thus, it is clearly to the advantage of the industry to lobby for a high mandate.

Sensitivity of Results to Cost Estimates

The automobile industry is assumed to balance the costs of decreasing new-car fuel consumption against the revenue effects and against the fines associated with not meeting the mandated levels. Therefore, a simple method of assessing sensitivity to the cost levels estimated to apply to fuel economy improvement is to vary the tax rate in the fine function. The legislated tax rate is currently $12.50/0.4 km/L ($50/mpg) that actual fuel economy is below the mandate. If a slight lowering of the tax rate will change the predicted behavior of the industry, particularly if it will cause the industry to incur some level of fine rather than fully meeting the mandate, then our results are also probably quite sensitive to the fuel economy improvement costs.

To test this sensitivity we set the fuel economy mandate at 8.5 L/100 km (27.5 mpg) and lowered the tax rate in $5 increments. It was not until the fine was less than $2.50 per 0.4 L/100 km ($10/mpg) that the behavior of the industry was affected in any way. Thus our base-case results may be consistent with fuel economy improvement costs of up to perhaps $25/0.4 km/L ($100/mpg).

The lower limit for our general results can also be estimated. If we simplify the model slightly by assuming the fuel economy fine is based on the simple average of new-car fuel economy rather than the harmonic mean it can be solved analytically. In particular, we can solve for the level of fuel economy improvement costs that just equate the individual new-car fuel economies with their technical limits. These values are \$39 for large cars, \$27 for midsize cars, and \$29 for small cars. If the fuel economy improvement costs, β_2^1, are less than this, the full marginal costs of increasing fuel economy, dC/dE, will be less than the associated marginal revenue, dR/dE, and it will be in the industry's best interests to maximize fuel economy for their new cars even if there are no fines or taxes.

RESTRICTED TECHNOLOGY CASE

In our base case we assume that diesel-powered cars are technologically feasible in the 1980s and that they will meet the standards of the Clean Air Act of 1967.

Either or both of these assumptions may not prove to be true, so we have also simulated a restrictive technology case. In this case we assume that the diesel models are not available—for whatever reason—and that we are restricted to less advanced technologies. Maximum fuel economy for 1985 is now achieved with a stratified charge engine and advanced transmission. With this technology, fuel consumption levels may be as low as 10.7 L/100 km (22 mpg) for large cars, 9 L/100 km (26 mpg) for midsize cars, and 7.1 L/100 km (33 mpg) for small cars.

The output for this case is shown in Figure 2. In general, the results of these runs are quite similar to the base case runs except that the critical point, the point at which it is no longer profitable for the automobile industry to achieve the mandated level of fuel economy, is now at a mandate of about 8.5 L/100 km (27.5 mpg). A mandate of 8.5 L/100 km will be met, while a mandate of 8.4 L/100 km (28 mpg) will not be achieved with the \$50 tax rate. A fuel economy mandate of 8.5 L/100 km (27 mpg) is projected to increase new-car average fuel economy to that level, an increase of over 50 percent from the nominal case; to increase prices and decrease sales by nearly 10 percent; and to decrease profits by about 12 percent. Profits appear to be quite sensitive to the reduced technology.

Sensitivity of Results to Cost Estimates

Because this restrictive technology case implies that the automobile industry will not meet fuel economy mandates of less than 8.5 L/100 km (27 mpg), it is again of in-

Figure 2. Market projections for 1985—effects of alternative mandates, restricted technology.

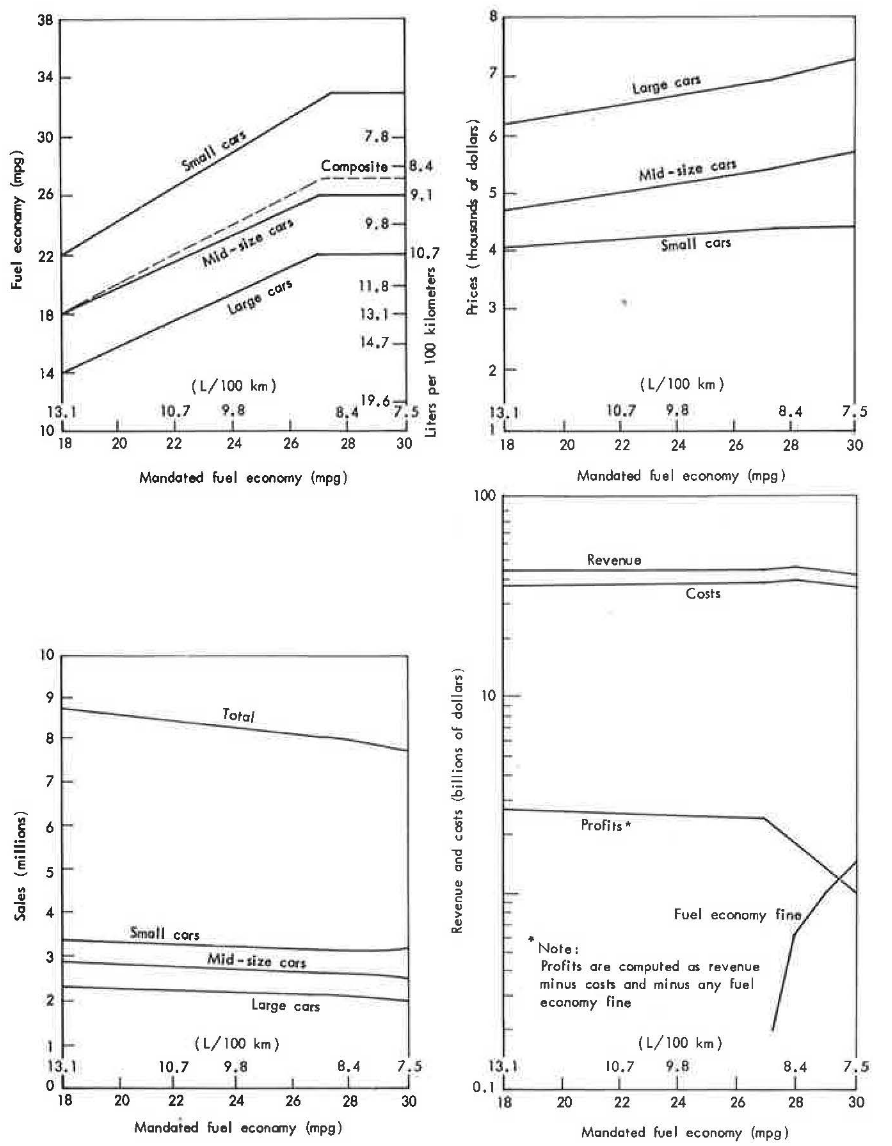
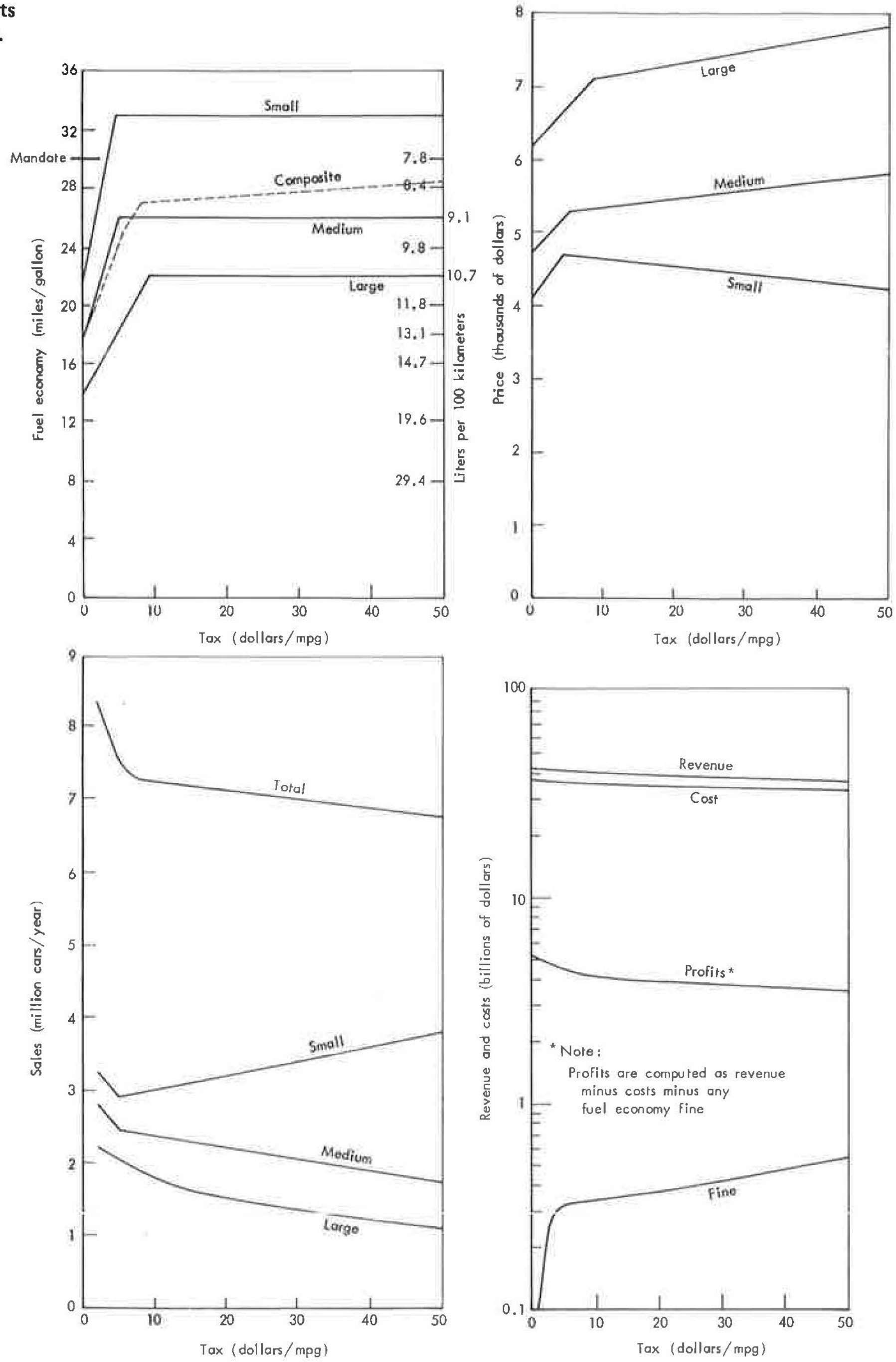


Figure 3. Market projections for 1985–effects of alternative tax rates, restricted technology.



terest to test the sensitivity of the results to the tax rate used in the fine function.

Figure 3 displays the results of this analysis. The mandate is set at 7.8 L/100 km (30 mpg) and the tax rate varied from \$0 to \$50. The results are consistent with our previous findings; a tax rate of as little as \$5/0.4 km/L (\$20/mpg) causes all fuel economy improvements for each size class of car to be adopted. Further increases in composite fuel economy can be achieved only by changing the mix of cars sold; and as the large cars are still much more profitable than the smaller cars, it takes a very large tax rate to bring about any substantial change in the sales mix. The mandate is not met, so the fine increases as the tax rate is increased and profits steadily decrease. These figures indicate the structure of the price changes and shifts in the sales mix that occur when technical responses alone are not sufficient to achieve the mandated level of fuel economy.

SUMMARY AND CONCLUSIONS

These analyses have provided some valuable insights into the mechanics and implications of fuel economy taxation of the type legislated by the Energy Policy and Conservation Act of 1975.

Basic Industry Responses

1. The response of the automobile industry to government policies designed to induce greater fuel economy in new automobiles requires two separate and distinct actions: technical actions to improve the fuel economy of all the cars they produce and pricing actions de-

signed to promote the sale of small fuel-efficient cars and to slow the sale of large inefficient ones.

2. Using our demand and cost parameters, very little incentive is required to induce the industry to implement all of the available technology and weight-saving methods for increasing fuel economy.

3. The current industry profit and demand structures are weighted so heavily in favor of larger cars that large incentives would be required to cause any significant sales shift from large to small cars.

Implications for Public Policy

1. The tax rate and the mandate level are both powerful policy tools and the relationship of the mandated fuel economy to the available technology is especially sensitive.

2. Fuel economy mandates that are within the available technology will be met.

3. The automobile industry has no incentive to produce cars with composite fuel economy greater than the mandated level. Consequently, a desire for gasoline conservation implies that the mandate should be set near the technological limit.

4. Fuel economy taxation is a constraint on the behavior of the automobile industry. A positive tax rate associated with any fuel economy mandate greater than the present unregulated level will decrease industry profits.

5. Modest tax rates will cause the implementation of all available technology. Higher tax rates accomplish nothing—if the mandate can be met with the available technology—or increase the level of the fine, driving prices up and sales and industry profits down if the mandate is not met.

6. Therefore, the mandate should be set close to the estimated limits of technology and a low tax rate should be chosen. The mandate should be set there because the industry has no incentive to surpass whatever level is set. The tax rate should be low to avoid impacting heavily on industry profits if the technology or demand predictions are wrong and the mandated level of fuel economy cannot be achieved.

Need for Further Research

We hope this paper gives some indication of the wealth of insights into the effects of fuel economy taxation that can be suggested by even the simplest type of industry model. The formulation of a sound public policy for energy conservation, however, requires information and analyses that are as accurate and current as possible. To contribute to this policy formulation, the methodology of this paper should be expanded and improved. The industry model in particular needs to be replaced by a model that more accurately reflects the oligopolistic nature of the domestic automobile industry, and the parameters of the model need to be based on time-series information that captures at least some of the dynamic adjustments continually taking place in the various markets.

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