MEASURING THE COST TO CONSUMERS OF PRODUCT DEFECTS: THE VALUE OF “LEMON INSURANCE”*

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I. INTRODUCTION

By the end of 1986, forty-one states and the District of Columbia had enacted so-called lemon laws aimed at protecting new-car buyers from automobiles that prove to be “hopelessly defective.” These laws give new-car buyers the right to a new automobile or a full refund if the car turns out to be a lemon.1 According to the Wall Street Journal, “lemon laws are sweeping the country.”2 The expeditious treatment that lemon laws received in state legislatures might indicate that these statutes conferred large benefits on consumers. Alternatively, it may be that these new laws provide little additional protection to the consumer but instead represent “the kind of consumer issue that looks good when legislators go back home.”3 To date, no study has attempted to estimate the value

* We wish to acknowledge the valuable assistance provided by our colleagues: Cheryl Asher, Ron Lafferty, Phil Nelson, Paul Pautler, and Bill Shughart at the Federal Trade Commission; E. W. Eckard, Jr., a member of General Motors’ economics staff during the writing of this article; Hae Shin Hwang, W. J. Lane, and Steven N. Wiggins of Texas A&M University; and Bob Shannon, Joe DeSalvo, and Mark Herander of the University of South Florida. This article was completed while Smithson was an AT&T Fellow at the W. E. Simon Graduate School, University of Rochester.

1 Connecticut was the first state to enact a lemon law, and most states have modeled their lemon laws after Connecticut’s law. Generally, an automobile is declared to be a lemon if either of two conditions is met: (1) the car has been returned to the dealer four times to have the same problem fixed, but the dealer was unable to repair the problem satisfactorily, or (2) the car has been out of service more than 30 days due to one or more defects. Lemon laws typically remain enforceable during the term of the express warranty or for one year following delivery date, whichever is the earlier date. See Mary B. Kegley and Janine S. Hiller, Emerging Lemon Car Laws, 24 Am. Bus. L. J. 87 (1986).


3 This is the opinion of the director of state relations for the Motor Vehicle Manufacturers Association, as reported in the Wall St. J., supra note 2.

[Journal of Law & Economics, vol. XXXI (October 1988)]
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consumers place on lemon protection. This article examines that value by estimating the value to the marginal consumer of a lemon protection plan that was privately supplied by a U.S. automobile manufacturer.

Consumers value lemon insurance if it lowers the expected full price of purchasing an automobile. The expected full price of purchasing the services of an automobile includes not only its acquisition price but also the expected maintenance and operating costs. The value of lemon insurance to a consumer is directly related to (1) the amount by which the lemon insurance reduces the probability of ending up with a lemon and (2) the increase in maintenance and operating costs incurred if the product turns out to be a lemon. Thus, the dollar amount by which a given lemon insurance policy reduces the expected full price is a measure of the expected value to the marginal consumer of the lemon protection provided by that policy.

In 1980 the Chrysler Corporation instituted a program that was unusual in the context of American automobile retailing—a “buy-back” plan.\(^4\) The buy-back program allowed consumers to return their new car for a full refund within thirty days of purchase. The Chrysler buy-back program provided a unique opportunity to measure the consumer’s perceived benefit of lemon insurance. Although the term of Chrysler’s “buy-back” policy was limited, a money-back guarantee certainly provides consumers some degree of lemon protection. Using the limited data that are publicly available, this article estimates the value of the lemon insurance provided by Chrysler’s thirty-day buy-back offer and then uses the estimated value of this thirty-day buy-back plan to examine the value of the one-year buy-back coverage supplied by state lemon laws.

\[ P = V + M(\text{size, lemon}). \]  

(1)

\(^4\) Chrysler’s buy-back program was not unique. Subaru of America experimented with a similar program in three test markets in 1977. General Electric Company is currently intensely advertising a ninety-day buy-back program on its appliances. Whirlpool Corporation has offered a thirty-day buy back on dishwashers since December 1986.

Within a particular size category of automobile (that is, compact, intermediate, or full size), the automobile’s full price can be expressed more simply as

\[ P = V + M + \begin{cases} M_L & \text{if the car is a lemon,} \\ 0 & \text{otherwise,} \end{cases} \]  

(2)

where \( M \) is the normal operation and maintenance cost for a given size category, and \( M_L \) is the additional cost if the car is a “lemon.”

In the empirical analysis that follows, automobile manufacturers are separated into two groups: Chrysler (c) and all other domestic manufacturers (x). Each manufacturer faces a demand function expressed as

\[ Q_c = f_c(P_c, P_x, Z), \quad \text{and} \quad Q_x = f_x(P_c, P_x, Z), \]  

(3)

where \( P_c \) and \( P_x \) are the respective expected full prices, and \( Z \) represents all of the other determinants of demand. The expected full price of an automobile is

\[ \bar{P} = E(P) = V + E(M) + \text{prob}(L) \times M_L, \]  

(4)

where \( \text{prob}(L) \) is the probability that the buyer ends up with a lemon. Within an expected full-price framework, a buy-back program reduces the expected full price by reducing the expected cost of ending up with a lemon \([\text{prob}(L) \times M_L]\). When Chrysler provides lemon protection through its buy-back program, the decrease in Chrysler’s expected full price measures the value of the lemon insurance to the marginal consumer. Using a Cobb-Douglas specification, the demand functions in (3) can be written as

\[ Q_c = A \bar{P}^B \bar{P}^C \ Z^F, \quad \text{and} \quad Q_x = a \bar{P}^b \bar{P}^c \ Z^f, \]  

(5)

and the ratio of Chrysler sales to the sales of all other manufacturers is

\[ q = Q_c/Q_x = (A/a) \bar{P}^{B-b} \bar{P}^{C-c} \ Z^{F-f}. \]  

(6)

Competition in the automobile market forces the expected full price of comparable cars to be equal in equilibrium.\(^6\) Accordingly, market equilibrium exists when

\[ \bar{P}_c = \bar{P}_x = \rho, \]  

(7)

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\(^6\) Although full prices are assumed to be equal (for homogeneous automobiles), the theoretical model could be modified to allow for product differentiation by assuming that (1) the

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where \( p \) is the equilibrium expected full price of comparable cars.

When Chrysler introduced its buy-back plan, the probability that a new-car buyer would end up with a lemon fell, causing the expected full price of a Chrysler to fall. Temporarily, Chrysler's full price declined, a decline that can be modeled as

\[
\bar{P}_c = \rho e^\theta,
\]

where \( \theta \) is negative during the time that Chrysler's full price deviates from the equilibrium full price. Once the buy-back program ends, \( \theta \) equals zero again, and expected full-price equilibrium is restored. The amount by which Chrysler's expected full price falls below \( p \) measures the value of its buy-back program.

The effect of Chrysler's buy-back program on relative sales in time period \( t \) is obtained by substituting equation (8) into equation (6):

\[
q_t = \left( \frac{Q_c}{Q_x} \right)_t = \frac{A \bar{P}_c^{\beta} \bar{P}_x^{\gamma} Z^F}{a \bar{P}_c^{\beta} \bar{P}_x^{\gamma} Z^F} = \left[ \frac{A}{a} \rho^{B + C - b - c} \right] e^{(B - b)\theta D_t} Z_t^{F - f}.
\]

In equation (9), \( D_t \) is a dummy variable equal to one if the buy-back program is in effect during time period \( t \) and zero for all other \( t \). To simplify notation, equation (9) can be rewritten

\[
q_t = Ke^{\alpha D_t} Z_t^{\phi},
\]

where \( q = Q_c/Q_x \), \( K = (A/q)\rho^{B + C - b - c} \), \( \alpha = (B - b)\theta \), and \( \phi = F - f \). Since \( B \) and \( \theta \) are strictly negative and \( b \) is strictly positive, \( \alpha \) must be strictly positive.

Notice that equation (9') presumes that consumers instantly learn of the buy-back plan and immediately react.\(^7\) To allow for possible lags in either the flow of information to consumers or in their reaction to new information, equation (9') is modified as follows:

\[
q_t = Ke^{\alpha D_t} + \alpha D_t Z_t^{\phi},
\]

ratio of expected full prices is constant over the short time period of the study, \( P_c/P_x = \rho \), and (2) consumer utility functions are homothetic. Since these assumptions would also lead to the estimation of eq. (14), product differentiation does not alter the empirical results of this article.

\(^7\) Equation (9') also presumes that consumers do not anticipate either the beginning or the end of the promotion. In practice, manufacturers usually do not give either dealers or consumers advance knowledge of sales promotion plans. Once they announce a new marketing promotion, manufacturers virtually always specify the expiration date.
where $DL_t$ is an additional dummy variable equal to one in the second and all subsequent time periods of the buy-back program. (For example, the first month the buy-back is offered, $D_t = 1$ and $DL_t = 0$; in the second month of the buy-back, both $D_t = 1$ and $DL_t = 1$, and so on.) If there is an information/reaction lag in consumer response to the buy-back, $\alpha_2$ will be nonzero. More specific to the issue at hand, if Chrysler’s buy-back program has value to new-car buyers, then $\alpha_1 + \alpha_2$ will be strictly positive.

In addition to Chrysler’s buy-back offer, two other factors—cash rebates and Chrysler’s financial distress—may have temporarily affected relative prices during the time period examined in this study. Beginning in the late 1970s, car manufacturers (not dealers) began offering cash rebates directly to new-car buyers. A temporary cash rebate lowers the expected full price of an automobile by lowering the acquisition price ($V$). Like the buy-back plan, a cash rebate only changes the expected full-price ratio temporarily. To capture these temporary effects of rebates on relative sales, the following term could be added to equation (10):

$$e^{\sum \beta_i R_{i,t}},$$

(11)

where $R_{i,t}$ is a dummy variable equal to one if the $i$th rebate is in effect during time period $t$ and is zero for all other $t$. If Chrysler offers the rebate, $\beta_i$ is positive; and if Chrysler’s competitors offer the rebate, $\beta_i$ is negative. To allow for a lag in consumer response to a cash rebate, a lag dummy variable ($RL$) can be added to (11) as

$$e^{\sum \beta_i R_{i,t} + \beta_i L R_{i,t}},$$

(12)

where $RL_{i,t}$ equals one in the second and all subsequent time periods of the cash rebate. If Chrysler offers the cash rebate, $\beta_i + \beta_i L$ is expected to be positive; and if Chrysler’s competitors offer the rebate, $\beta_i + \beta_i L$ is expected to be negative.

The data used in this study span a particularly tumultuous time period for Chrysler. That period includes both Chrysler Corporation’s announcement of financial distress with its consequent possibility of bankruptcy and the granting of federal loan guarantees that effectively guaranteed Chrysler’s viability. As suggested by Smith and Stulz, and by Titman,

8 That is, $P_c = \rho e^R$, where $R$ is negative if the rebate is by Chrysler, and $R$ is positive if the rebate is by a competitor.

9 By April 1979 the Wall Street Journal began reporting Chrysler’s financial troubles, and by May it portrayed Chrysler as an “ailing firm.” In August 1979, when Chrysler formally requested federal loan guarantees, the Wall Street Journal was describing the “Crisis at Chrysler.” The loan guarantees were not approved until June 1980, and immediately thereafter the Wall Street Journal reported Lee Iacocca’s barrage of publicity “to reassure potential customers about the firm’s survival.”

10 See Clifford W. Smith and René M. Stulz, Determinants of Firm’s Hedging Policies, 20
the resulting induced expectations about the viability of the manufacturer could have affected expected full price. As the firm experiences financial distress, consumers may perceive that less attention is being given to quality control, thereby increasing the probability of drawing a "lemon."

Or, as the probability of bankruptcy is increased, consumers may anticipate that the service network will shrink or that parts may not be available. In either case, the expected full price would rise (fall) as the firm is subjected to greater (less) financial distress. In the case of the Chrysler Corporation, consumer perceptions changed over time. Consequently, the impact of financial distress on expected full price should be a function of time, \( P_c = \rho e^{\gamma t} \). Since the popular press suggested that public opinion became increasingly pessimistic until the loan guarantees were granted and then became increasingly optimistic, we elected to add a quadratic function to equation (10) to capture the effect of Chrysler's financial distress:

\[
\text{e}^{\gamma_1 t + \gamma_2 t^2}.
\]

If consumer perceptions changed from pessimistic to optimistic, \( \gamma_1 \) would be negative and \( \gamma_2 \) would be positive.

Adding (12) and (13) to equation (10) to incorporate the potential effects on relative prices of cash rebates and Chrysler's financial problems and using per capita income \( (Y) \) and the price of gasoline \( (G) \) as the other determinants of demand \( (Z) \), Chrysler's relative sales in time period \( t \) \( (q_t) \) can be expressed as

\[
q_t = Ke^{\alpha_1 D_t + \alpha_2 DL_t} e^{\beta (R_{t,1} + \beta R_{t,2})} e^{\gamma_1 t + \gamma_2 t^2} Y^{\phi_1} G^{\phi_2}. \tag{14}
\]

Equation (14) is estimated in the next section.

III. THE CHRYSLER EXPERIENCE

The Chrysler buy-back program began January 31, 1980, and effectively ended by April 1, 1980. Within the theoretical framework set forth in the preceding section, the buy-back program would cause the expected full price of a Chrysler to fall below the expected full price of its competitors during the months of February and March 1980. Chrysler sales relative to sales of the other manufacturers should rise. This section of the article examines new-car sales data to see if, in fact, consumers did respond to the Chrysler buy-back plan.

To examine consumer response to Chrysler's lemon insurance pro-

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gram, monthly data on new car deliveries were collected for domestic automobiles by make and model for 1979 and 1980 from *Ward’s Automotive Yearbook*. After sorting monthly sales data into compact, intermediate, and full-size categories, the ratio of Chrysler sales ($Q_c$) to the sales of Ford and General Motors ($Q_m$) was computed. Figures 1–3 plot Chrysler’s relative sales ($q$) for the twenty-four-month period. Notice that for each category, the relative sales data do exhibit a spike during the period of the buy-back program.

During the twenty-four-month time period of this study, several cash rebate programs were offered. Although Chrysler had the most ambitious cash rebate program, other manufacturers also offered cash payments to consumers. Table 1 describes the most significant direct-cash rebate programs offered during the time period of this study. Note that only two of

As noted by one of the referees, the most appropriate sales data for estimating eq. (14) would be off-the-lot purchases and orders rather than deliveries. To the extent that some deliveries occur in months after the order is taken, delivery data may result in an underestimate of the effect of the change in full price via the buy-back program, rebates, or the public’s perception of Chrysler’s financial distress. The only other publicly available data on automobile sales is new-car registrations published by *Automotive News*. Not surprisingly, the estimation of eq. (10) using registration data did not differ qualitatively from the estimation using delivery data. While using delivery data could potentially affect estimates of the effect of the buy-back program and cash rebates, two factors tend to mitigate any bias that might be present. First, the model specification includes a one-month adjustment for lags in consumer response. Only those cars that are delivered at least two months after being ordered go unaccounted for. Second, computation of the dollar value of the buy-back program (Section IV) involves a ratio of the proportionate change in sales during the buy-back to the proportionate change in sales during a particular cash rebate. Given the constant elasticity of demand implied by the Cobb-Douglas demand specification, the ratio of proportionate changes will not be affected if the order-to-delivery lag is constant over the relevant time period.
TABLE 2

ESTIMATION RESULTS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Compacts</th>
<th>Intermediates</th>
<th>Full Size</th>
</tr>
</thead>
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<tr>
<td>Intercept</td>
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<td>37.7199</td>
<td>15.5549</td>
<td>102.7867*</td>
</tr>
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<td></td>
<td></td>
<td>(46.0028)</td>
<td>(39.8834)</td>
<td>(75.7296)</td>
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<tr>
<td>$D$</td>
<td>$\alpha_1$</td>
<td>.1605</td>
<td>.0172</td>
<td>.0191</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(.1707)</td>
<td>(.1619)</td>
<td>(.2935)</td>
</tr>
<tr>
<td>$DL$</td>
<td>$\alpha_2$</td>
<td>.1310</td>
<td>.2689*</td>
<td>.3075</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(.1685)</td>
<td>(.1768)</td>
<td>(.3024)</td>
</tr>
<tr>
<td>$R_1$</td>
<td>$\beta_1$</td>
<td>.6543***</td>
<td>.2959**</td>
<td>.2217</td>
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<tr>
<td></td>
<td></td>
<td>(.1506)</td>
<td>(.1353)</td>
<td>(.2528)</td>
</tr>
<tr>
<td>$R\ell_1$</td>
<td>$\beta_{1,2}$</td>
<td>.2829*</td>
<td>.4515**</td>
<td>.5534**</td>
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<tr>
<td></td>
<td></td>
<td>(.1685)</td>
<td>(.1736)</td>
<td>(.3010)</td>
</tr>
<tr>
<td>$R_2$</td>
<td>$\beta_2$</td>
<td>.2283*</td>
<td>.3712**</td>
<td>-.0235</td>
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<tr>
<td></td>
<td></td>
<td>(.1523)</td>
<td>(.1459)</td>
<td>(.2632)</td>
</tr>
<tr>
<td>$R_3$</td>
<td>$\beta_3$</td>
<td>.5436***</td>
<td>.2159*</td>
<td>.2984</td>
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<tr>
<td></td>
<td></td>
<td>(.1840)</td>
<td>(.1601)</td>
<td>(.3039)</td>
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<td>$R_4$</td>
<td>$\beta_4$</td>
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<td>-.0579</td>
<td>.1636</td>
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<tr>
<td></td>
<td></td>
<td>(.1235)</td>
<td>(.1067)</td>
<td>(.2043)</td>
</tr>
<tr>
<td>$t$</td>
<td>$\gamma_1$</td>
<td>.1098</td>
<td>-.0727</td>
<td>-.1179</td>
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<td></td>
<td></td>
<td>(.1121)</td>
<td>(.0905)</td>
<td>(.1787)</td>
</tr>
<tr>
<td>$t^2$</td>
<td>$\gamma_2$</td>
<td>-.0018</td>
<td>.0022</td>
<td>.0024</td>
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<td></td>
<td></td>
<td>(.0031)</td>
<td>(.0025)</td>
<td>(.0049)</td>
</tr>
<tr>
<td>$\ln Y$</td>
<td>$\phi_1$</td>
<td>-3.1760</td>
<td>-3.1071</td>
<td>-16.2689*</td>
</tr>
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<td></td>
<td></td>
<td>(6.2304)</td>
<td>(5.3774)</td>
<td>(10.2194)</td>
</tr>
<tr>
<td>$\ln G$</td>
<td>$\phi_2$</td>
<td>-5.0710**</td>
<td>.9546</td>
<td>1.5347</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.3708)</td>
<td>(1.9412)</td>
<td>(3.8069)</td>
</tr>
</tbody>
</table>

$R^2$  .9194  .8089  .7606

$F$  12.4438  4.616  3.4659

NOTE.—Values in parentheses are SEs.

a Corrected for autocorrelation.

* Significant at the .10 level in a one-tailed test.

** Significant at the .05 level in a one-tailed test.

*** Significant at the .01 level in a one-tailed test.

the rebates ($R_2$ and $R_4$) extended for more than one month during the sample period (only one month of $R_3$ is contained in the sample period).

Equation (14) was estimated using ordinary least squares (OLS) and correcting for autocorrelation. The estimation results, which are presented in Table 2, are summarized in the following sections.

**Chrysler’s Financial Distress**

Since public opinion cycled from pessimistic to optimistic over the sample period, $\gamma_1$ should be negative and $\gamma_2$ positive. This prediction shows up only for intermediate and full-size autos. In no case, however, were either $\gamma_1$ or $\gamma_2$ significant. Tests of the null hypothesis that $\gamma_1 = \gamma_2 = 0$ could not be rejected for any size category ($F$-statistics were 0.974 for
Figure 1.—Relative sales of compacts
Figure 2.—Relative sales of intermediates
FIGURE 3.—Relative sales of full-size automobiles
compacts, 0.119 for intermediates, and 0.234 for full-size cars). Because the estimates fail to provide support for the contention that Chrysler’s financial distress affected the relative full prices, equation (14) was reestimated without t and t2, and these new estimates are used to examine the effects of the buy-back program and the cash rebates.

The Buy-Back Program

If the buy-back program was effective in increasing the sales of Chrysler relative to its competitors, α₁ + α₂ should be positive. Table 3 gives the new estimates of α₁ and α₂ after dropping t and t² from the estimation equation. The estimates of α₁ + α₂ are positive in all cases, and Table 3 presents the one-tailed tests of significance. Although not significant for compact cars, the estimates support the hypothesis that the buy-back program increased Chrysler’s relative sales: for intermediate and full-size cars, consumers did value the lemon protection provided by a thirty-day buy-back program.

The estimates also suggest that there may be a lag in consumer response to the buy-back. Although significant only for intermediates, the positive estimates of α₂ suggest that the effect of the buy-back program increased over time. Finally, notice that the magnitude of α₁ + α₂ increases with the size category of the car.

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An alternative specification of Chrysler’s financial distress was also examined. In eq. (14) the term $e^{\gamma_D + \gamma_E}$ was replaced with $e^{6(DT_1 + D_T2)}$, where DT₁ equals one when consumers expect Chrysler likely to enter bankruptcy (August 1979–May 1980), and DT₂ is one once the federal loan guarantees were known (June 1980 on). This alternative specification also failed to provide any empirical evidence that financial distress affected Chrysler’s full price.
TABLE 4
ONE-TAILED TESTS OF SIGNIFICANCE

<table>
<thead>
<tr>
<th></th>
<th>Compacts</th>
<th>Intermediates</th>
<th>Full Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate of $\beta_1$</td>
<td>.5410</td>
<td>.2902</td>
<td>.3311</td>
</tr>
<tr>
<td></td>
<td>(2.939)**</td>
<td>(2.345)**</td>
<td>(1.353)*</td>
</tr>
<tr>
<td>Estimate of $\beta_{1,L}$</td>
<td>.2713</td>
<td>.4441</td>
<td>.5471</td>
</tr>
<tr>
<td></td>
<td>(1.283)*</td>
<td>(2.638)**</td>
<td>(1.828)**</td>
</tr>
<tr>
<td>Estimate of $\beta_1 + \beta_{1,L}$</td>
<td>.8123</td>
<td>.7343</td>
<td>.8782</td>
</tr>
<tr>
<td></td>
<td>(4.44)**</td>
<td>(5.897)**</td>
<td>(3.575)**</td>
</tr>
<tr>
<td>Percent significance level on $H_0$</td>
<td>.03</td>
<td>.01</td>
<td>.17</td>
</tr>
</tbody>
</table>

Note.—Values in parentheses are $t$-statistics.
* Significant at the .10 level.
** Significant at the .05 level.
*** Significant at the .01 level.

Cash Rebates

The first Chrysler rebate had the most significant impact of all the rebates. As predicted, $\beta_1 + \beta_{1,L}$ was positive and, as Table 4 indicates, was statistically significant for all three size categories. The parameter estimates for the first Chrysler rebate also provide support for the information/reaction lag indicated in the buy-back program estimates. The positive estimates for $\beta_{1,L}$, which were statistically significant for all size categories, indicate that the effect of the rebate increased over time.

Although important, the impacts of Chrysler's second and third rebates—as indicated by $\beta_2$ and $\beta_3$ in Table 2—were not as strong as those for the first rebate. As noted earlier, each of these rebates was in effect only for one month during the sample period. The impact of the second rebate was significant for both the compact and intermediate categories. The parameter estimate for $\beta_2$ was negative but insignificant for full-size cars. The estimated parameters for the third rebate ($\beta_3$) were all positive as predicted and also significant for both compacts and intermediate size cars.

The Ford rebate had no significant effect on relative sales for any of the size categories. Given this lack of significance, the estimates of the information/reaction lag effect were suppressed (that is, $RL_4$ was set equal to zero for all observations). Dropping $t$ and $t^2$ from the estimation had no qualitative effect on estimates for $\beta_2$, $\beta_3$, or $\beta_4$.

13 When $RL_4$ was included in eq. (14), the parameter estimates and the test of $\beta_4 + \beta_{4,L} < 0$ were

<table>
<thead>
<tr>
<th>$\beta_4 + \beta_{4,L}$</th>
<th>Compacts</th>
<th>Intermediates</th>
<th>Full Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-.066</td>
<td>-.081</td>
<td>-.096</td>
</tr>
<tr>
<td>$t$-statistic</td>
<td>-.468</td>
<td>-.685</td>
<td>-.405</td>
</tr>
</tbody>
</table>
Other Determinants of Demand

While negative in all cases, \( \hat{\phi}_1 \) is significantly negative for full-size cars only, implying that an increase in per-capita income reduces the relative sales of full-size Chryslers. Since \( \phi_1 \) may be interpreted as the difference between the income elasticities for Chryslers and for other U.S. makers (see eq. [6]), this estimate is consistent with either a relatively more income-elastic demand for other U.S. automobiles or Chryslers being an inferior good. Although interesting, our estimates cannot distinguish between the two possibilities.

Gasoline prices were a significant determinant of relative sales only for compacts. The negative estimate for \( \phi_2 \) implies that the elasticity of demand for Chrysler compacts with respect to gasoline prices is larger in magnitude than that for other U.S. automakers. In the case of intermediates and full-size autos, gasoline prices were not a significant determinant of relative sales. Dropping financial distress from the estimation caused gasoline prices to become significant for full-size cars.

IV. Valuation of Chrysler's Lemon Insurance

The estimation results presented in the previous section indicate that buyers of intermediate and full-size cars did value the thirty-day lemon protection offered by Chrysler. This leads us to the principle question of the article: what value did the marginal consumer place on the Chrysler lemon insurance? As explained in Section II, the value of the lemon insurance provided by Chrysler's buy-back program can be measured by the change in the expected full price of a Chrysler resulting from the buy-back offer. This section measures the dollar value of lemon protection by comparing the consumer response to a cash rebate with that of the buy-back plan.

Recall that the demand specification in Section II implies constant elasticity of demand with respect to expected full price. Consequently, the elasticity of relative sales with respect to a change in Chrysler's acquisition price (via a cash rebate) equals the elasticity of relative sales with respect to a change in expected maintenance costs (via the buy-back plan). Using subscripts \( CR \) and \( BB \) to denote the time period of a cash rebate and the buy-back program, it follows that

\[
\left( \frac{\Delta q}{q} \right)_{CR} \left( \frac{\bar{P}_c}{\Delta \bar{P}_c} \right)_{CR} = \left( \frac{\Delta q}{q} \right)_{BB} \left( \frac{\bar{P}_c}{\Delta \bar{P}_c} \right)_{BB}. \tag{15}
\]

Noting that the proportionate change in \( q \) measures the change in actual sales relative to the level of sales that would have occurred in the absence of either a cash rebate or buy-back plan, equation (15) can be rewritten as
\[(\Delta \tilde{P}_c)_{BB} = \left(\frac{q_{BB} - \hat{q}_{BB}}{\hat{q}_{BB}}\right) \left(\frac{\hat{q}_{CR}}{q_{CR} - \hat{q}_{CR}}\right) (\Delta \tilde{P}_c)_{CR} \frac{(\bar{P}_c)_{BB}}{(\bar{P}_c)_{CR}}, \quad (16)\]

where \(q_{BB}\) is actual relative sales during the buy-back program, and \(\hat{q}_{BB}\) is relative sales predicted from the regression results assuming the buy back had not been offered.\(^{14}\) The variables \(q_{CR}\) and \(\hat{q}_{CR}\) are similarly defined for cash rebates. The term \((\Delta \tilde{P}_c)_{CR}\) measures the change in Chrysler's full price after a cash rebate is offered and is equal to the amount of the rebate.\(^{15}\) The final term in equation (16) measures the relation of the full price just prior to a cash rebate. Had Chrysler's financial distress been a significant determinant of relative sales, this ratio of full prices would be a function of time.\(^{16}\) Since the estimation results presented in Table 2 offer no evidence of a time effect, \(\partial q/\partial t\) is treated as zero, and \((\bar{P}_c)_{BB}/(\bar{P}_c)_{CR} = 1\). That is, prior to the temporary changes induced by either a cash rebate or a buy-back, competition would have equalized full prices.\(^{17}\)

To obtain estimates of the value consumers placed on Chrysler's thirty-day lemon insurance, we compared the response to the buy back to the response to Chrysler's August-September 1979 cash rebate.\(^{18}\) Our methodology was straightforward. We used our estimates of equation (14) with \(t\) and \(t^2\) omitted to obtain predicted relative sales in the absence of the buy back (\(\hat{q}_{BB}\)) and a rebate (\(\hat{q}_{CR}\)). Then, using actual relative sales data for the buy-back (\(q_{BB}\)) and rebate periods (\(q_{CR}\)) and setting \((\Delta \tilde{P}_c)_{CR}\) equal to $400, the value of the lemon insurance was calculated using equation (16). Table 5 presents the estimates and their asymptotic standard errors.\(^{19}\) Given the estimates for \(\alpha_1 + \alpha_2\) in Table 3, it is not surpris-

\(^{14}\) Predicted relative sales for January, February, and March 1980 are obtained using the estimates of eq. (14), setting \(\alpha_1\) and \(\alpha_2\) equal to zero.

\(^{15}\) While buyer-seller haggling determines the distribution of the cash rebate between the inframarginal car buyers and the auto dealer, the marginal buyers must capture the entire amount of the cash rebate in order to buy a new car.

\(^{16}\) From eq. (13), the relation between the full price prior to the buy-back and full price prior to a cash rebate would be

\[ (P_c)_{BB}/(P_c)_{CR} = \exp[\gamma_1 (t_{CR} - t_{BB}) + \gamma_2 (t_{CR}^2 - t_{BB}^2)], \]

where \(t_{BB}\) is the time period just prior to the buy back (January 1980) and \(t_{CR}\) is the time period just prior to the cash rebate.

\(^{17}\) The marginal cost for an automobile is reasonably constant over a given model year. Widespread contracting for inputs coupled with fixity of production techniques and product design substantially reduce the variability in production costs during the model year. Hence, over a model year—or over seven months of a model year, as will be necessary in our estimation—constant expected full cost is not unreasonable.

\(^{18}\) The August-September rebate was chosen because \(R_t\) proved to be the most significant of all the rebates (see Table 2).

\(^{19}\) To determine the sensitivity of the value estimates to variations in the econometric specification, we considered several alternative models by (1) eliminating the information/
TABLE 5
CONSUMERS' VALUATION OF CHRYSLER'S THIRTY-DAY BUY-BACK PLAN

<table>
<thead>
<tr>
<th>Value of lemon insurance ($)</th>
<th>Compact</th>
<th>Intermediate</th>
<th>Full Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.19</td>
<td>138.24</td>
<td>218.24</td>
<td></td>
</tr>
</tbody>
</table>

Asymptotic SE*  
34.62 21.24 46.34

* Calculated as described by L. R. Klein in Textbook of Econometrics (1953).

ing that the value of lemon insurance increases with the size of the car. Consider, for example, one-standard-error confidence intervals for the estimates:

<table>
<thead>
<tr>
<th>Compacts</th>
<th>Intermediates</th>
<th>Full Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>(- $32.43)–$36.81</td>
<td>$117.00–$159.48</td>
<td>$171.90–$264.58</td>
</tr>
</tbody>
</table>

If consumers believe that the increase in maintenance and operating costs for a "large lemon" exceeds the increase for a "small lemon," then it follows that the value of lemon insurance varies directly with the size of the automobile.

V. IMPLICATIONS FOR STATE LEMON LAWS

So far we have examined the value to consumers of a thirty-day money-back guarantee that allowed new-car buyers to return a car for any reason during the first month of ownership. Now we wish to compare the value of this thirty-day buy-back plan to that of a state lemon law that gives the consumer the right to a new car or full refund during the first year of ownership. The two insurance policies are compared along three dimensions of insurance quality: term of coverage, comprehensiveness of coverage, and the transaction costs of using the policy.

First consider term of coverage. To the extent that consumers believe

reaction lag (that is, setting DL and RL equal to zero), (2) modifying the specification of Chrysler’s financial distress (see note 12 supra), and (3) lagging both Y and G one period. The four estimates for each size category are summarized below.

<table>
<thead>
<tr>
<th>Size</th>
<th>Minimum Value ($)</th>
<th>Maximum Value ($)</th>
<th>Mean ($)</th>
<th>Standard Deviation</th>
<th>Percent of Car's Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact</td>
<td>2.19</td>
<td>120.11</td>
<td>73.19</td>
<td>51.53</td>
<td>1.32</td>
</tr>
<tr>
<td>Intermediate</td>
<td>41.91</td>
<td>138.24</td>
<td>104.02</td>
<td>44.62</td>
<td>1.29</td>
</tr>
<tr>
<td>Full Size</td>
<td>111.09</td>
<td>218.24</td>
<td>185.77</td>
<td>50.46</td>
<td>1.95</td>
</tr>
</tbody>
</table>

* Computed as (mean value of lemon insurance)/(list price of average car in size category). The average list price was obtained from The 1980 Cars: List Price vs. Dealer Cost, 45, no. 4 Consumer Reports 233–237 (April 1980).
LEMON INSURANCE

that most major defects occurring in the first year are detectable within the first month of ownership, then, ceterus paribus, consumers will perceive little difference between the thirty-day policy provided by Chrysler and a one-year policy. In the literature concerned with auto lemons, every consumer complaint sufficiently sensational to reach the popular press involved defects that were detected within the first month of ownership.20 Beyond this anecdotal evidence, the opinions of experts within the industry and at the regulatory authorities suggest that most major defects that occur in the first year of ownership are discovered during the first month of ownership, with the notable exception of transmission defects.21

With respect to comprehensiveness of coverage and transaction costs of using a policy, Chrysler’s thirty-day buy-back policy unambiguously dominates the one-year state lemon laws. Chrysler’s money-back promise covered any complaint while the state lemon laws only cover those defects during the first year that “substantially impair the use and value” of the new car.22 Furthermore, the cost of obtaining relief under state lemon laws is significantly higher than that associated with using the buy-back. Virtually all lemon laws stipulate that the consumer resort to arbitration before a new car is replaced or the money refunded.23 In contrast, the Chrysler plan only required the buyer to inform the dealer of his or her dissatisfaction; Chrysler did not require the buyer to prove that there was anything wrong with the car.

Hence, it seems likely that for most consumers the lemon protection provided by Chrysler’s 30-day buy-back plan was viewed as equivalent to (if not better than) the coverage contained in state-provided lemon laws. Consequently, the value estimates presented in Table 5 provide upper-bound estimates of the marginal value of state lemon laws.

VI. SUMMARY AND CONCLUSIONS

Using the limited data that are publicly available, this article addresses two questions: (1) do consumers value lemon insurance? and (2) what

20 Obviously those consumer complaints reported in the press will be the most nightmarish ones. Nevertheless, consumer perceptions about the expected cost of buying a lemon are formed in part by the press. Indeed, it is for the very worst cases that consumers most seek lemon protection. Major defects occurring after the express warranty expires can be insured against by buying extended service contracts.

21 Transmission defects have constituted a significant portion of the regulatory concerns. However, these cases involved defects that were detected after the expiration of the warranty. Consequently, these defects would not have been covered by either a thirty-day or a one-year lemon insurance policy.

22 See Kegley and Hiller, supra note 1, at 97.

23 Id. at 99; and Bridgett Davis, Car Buyers Discover “Lemon Laws” Often Fail to Prevent Court Trip, Wall St. J., October 21, 1986, at 35.
value does the marginal consumer place on lemon insurance? By examining the market's reaction to the Chrysler Corporation's 1980 buy-back program, a thirty-day lemon insurance policy, we find that consumers do value protection against the possibility of buying a lemon. Furthermore, the larger the car, the greater the value placed on lemon protection: estimates for the value of the thirty-day lemon insurance policy to the marginal consumer ranged from $2 for compacts to $138 for intermediates and $218 for full-size automobiles. Since the coverage provided by Chrysler's buy-back plan was more comprehensive than state lemon law coverage, and since the available evidence suggests that most major first-year defects are quickly discovered by new car buyers, the protection provided by the newly created state lemon laws is likely to be less valuable than the protection provided by Chrysler's thirty-day coverage.

Although consumer advocates initially greeted lemon laws with enthusiasm, consumers have not used the new laws extensively. In fact, during the first thirteen months that Connecticut's lemon law was in effect, only forty automobiles were returned out of 113,000 registered. The fact that consumers do not frequently use lemon laws and that they place relatively small value on the lemon protection provided by the laws indicates that new-car buyers do not believe it is very likely they will end up with a lemon during the first year of ownership, even if unlucky enough to buy one. One reason that consumers may not place a high value on lemon insurance is that auto makers have substantially upgraded and streamlined their arbitration mechanisms. According to a recent study, "Consumer arbitration mechanisms are now well established in the automobile industry. . . . For the majority of consumers, automobile industry arbitration has been relatively quick, inexpensive, and informal." Because lemon laws require arbitration before allowing consumers to proceed with litigation, it may be the case that the state lemon laws have not provided much relief that was not already available in the marketplace.


25 See Richard Widdows, Consumer Arbitration as a Dispute Resolution Mechanism in Customer-Seller Disputes over Automobile Purchases, 42 Consumer Arb. 17 (March 1987).