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Estimating a Transaction Price for New Automobiles

Researchers in analyzing the demand for automobiles have assumed that the price is fixed by the manufacturer and therefore can be considered to be exogenous in market studies. This assumption contradicts earlier findings that transaction prices and list prices differed significantly. This paper develops a model estimating the transaction prices of new automobiles. It is argued that transaction prices for new automobiles are market determined. Transaction prices are found to be a function of dealer inventories and several other variables. Dealer inventories measured in terms of daily selling rates are used in the model as a proxy for market conditions.

I. Introduction

For over 2 decades researchers have analyzed the overall demand for automobiles (Brems 1956; Chow 1957; Stone and Rowe 1957; Houthakker and Taylor 1966; Smith 1975; Johnson 1978). While several researchers have begun to disaggregate automobile demand in response to the development of distinct submarkets (Blomqvist and Haessel 1978; Carlson 1978; Lave and Train 1979), they, in a manner similar to earlier aggregate studies, continue to assume that price is exogenous. For instance, Smith, in modeling the demand for new cars, assumes "the supply of new cars is perfectly elastic at a price exogenously fixed by the manufacturer" (Smith 1975, p. 14).

Yet over 2 decades ago, Jung (1959, 1960) reported the survey results of Chicago automobile dealers indicating that transactions prices and list prices differed significantly. The degree of concentration in automobile manufacturing may have led previous researchers to ignore the fact that the transaction price for new automobiles is not set by the manufacturer, but, as Jung reported, is determined in a (monopolistically) competitive dealer market where the "monopoly" element is a consequence of less than perfect information (Arrow 1975). In a recent article in this *Journal*, Carlson (1978) recognizes that list price and transaction price may

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differ, but he assumes, ad hoc, that consumers always are able to bargain away one-half of the dealer's potential gross new car profit regardless of market conditions, that is, the discount is 50% of the markup. These treatments of price represent a shortcoming of previous research, since the implicit assumption is that market forces have little or no effect on the transaction price.

It is the purpose of this paper to develop a model estimating the transactions prices of new automobiles. It is argued that transactions prices for new automobiles are market determined. Transactions prices are modeled to be a function of dealer inventories, list prices adjusted for factory installed options, dealer advertising expenditures, and manufacturer cash incentives to dealers (rebates). One of the advantages of this model is that after the equation is estimated, transactions prices can be simulated readily, since the values of the significant independent variables are available in published sources such as *Automotive News*. Therefore, if one wished to estimate automobile demand for (say) compact cars, one would not have to consider price as exogenous, but could estimate a "market determined" transaction price utilizing this type of simulation. In the next section of the paper, the model is developed. The results are analyzed in Section III, and conclusions are drawn in Section IV.

II. The Model

Virtually all new automobiles are purchased at retail from authorized new-car dealers, who are franchised by the manufacturer(s) that they represent. However, it is important to emphasize that they are not agents of the manufacturer but independent firms. While domestic automobiles are manufactured under highly concentrated conditions, they are sold generally in markets which are (monopolistically) competitive.[1] Information costs may allow new-car dealers to engage in extensive price discrimination.

While federal statute dictates that a new automobile have the manufacturer's suggested list price posted on its window, this price is a suggested price only. However, this is the primary information "shared" by both buyer and seller. Dealers can sell the car for higher than the list price by tying high-profit, dealer-installed accessories[2] to the car, or, more directly, by explicitly raising the transaction price. Observations of transactions prices for fuel efficient cars above list prices in 1974 and 1980 provide examples. More commonly, new cars

1. These markets are monopolistically competitive because consumer and dealer information is costly, that is, there are significant search costs, allowing dealers, in the limit, to negotiate a different price for each consumer.

2. These accessories would include such items as protective exterior finishes, interior fabric shields, and extra dealer-preparation charges.

are retailed below their posted list prices. In either case, the transaction price should be reflective of dealer inventories relative to sales, with the latter being a proxy for market conditions.[3] In addition to inventories, several other variables can be expected to influence the market-determined price, a priori. These variables include manufacturer rebates to dealers, dealer advertising expenditures, and the vehicle list price (or dealer cost).

Inventories

Dealer inventories can be considered a proxy for actual market forces. A traditional notion in the literature is that dealers aim for an optimal inventory of double their monthly sales rate. However, this rule of thumb ignores the effect of inventory costs, primarily the prime interest rate, on the dealer's desired inventories. Greater than optimal inventories are costly in terms of carrying (floor plan) costs, while less than optimal inventories are costly in terms of lost sales, especially in light of the 60–90-day wait for automobiles ordered from the manufacturer. We define $I^s_{i,t}$ to be the dealer inventories of the ith model car (Mercury Zephyr, Lincoln Continental, etc.) in terms of daily selling rates in period $t - 1$. Thus $I^s_{i,t} = (I_{i,t})/(S_{t-1})$, where $I_{i,t}$ represents the inventories of the ith model on the first day of period t and S_{t-1} represents sales of the ith model in period $t - 1$. When desired inventories, I^*, which are a function of expected sales and floor planning costs, differ from actual inventories, I, dealers adjust by varying the discount offered, ceteris paribus. If $I > I^*$, the dealer lowers price, that is, increases the discount, to increase the firm's sales rate until $I = I^*$. If $I^* > I$, the dealer lowers the discount, at times selling the car above the manufacturer's suggested price. Note that the dealer discounts are not a function of the absolute level of inventories, but rather of the difference between those desired and actual, in terms of selling rates. Thus, in a period when actual sales are less than anticipated sales ($I > I^*$), larger discounts will be offered. Similarly, in periods of excess demand ($I^* > I$), discounts will not be forthcoming and transactions prices may exceed list. In other words, dealers price adjust when their inventories are in disequilibrium.[4]

3. Throughout this paper inventories will be considered in terms of daily selling rates.

4. A priori, desired inventories should be an inverse function of interest rates. However, our data are ex post actual dealer inventories. An attempt to model actual inventories as a function of the prime interest rate in either the same period, lagged one period, or lagged two periods was unsuccessful. The inability to confirm this relationship is explained by the fact that expected or desired and actual inventories are often divergent. If such were not the case, then desired inventories should always equal actual inventories, and therefore inventories should have no effect on the transaction price. For if dealers' expectations of sales were always correct, they could adjust I^* to reflect the demand changes rather than use price adjustments to attain the optimal inventory level. See equation (3) for evidence that inventories do affect transactions prices. Also see Weiss (1963).

It is recognized that the relationship between inventories and market adjustment is not as simple as modeled here. Recent work on inventory modeling has demonstrated the complexity of this relationship (De Vany 1976; Gould 1978; Carlton 1979). Gould (1978) has addressed the problem of equilibrium in a competitive industry with demand uncertainty arising from the absence of a central market to match buyers and sellers. He has shown that when consumers have differing preferences for product availability, a multiplicity of prices can exist (p. 21), with those wishing a greater certainty of availability (availability being a function of inventory) willing to pay a higher price.

De Vany (1976) seeks to explain how the time cost of consumption is determined in market equilibrium under monopoly. He argues that since customers balk at excessive queues, the demand for the firm's product will be influenced by both price and the firm's ability to deliver (p. 254). Therefore, inventories as well as excess capacity serve an economic function to the firm. These models add to our theoretical understanding of the role of inventories, but the complexity of them limits their empirical application. For the purposes of this paper, the need for simplicity and empirical relevance has led us to proffer a less complex relationship between inventories and price.

Monthly dealer inventories in terms of daily selling rates by car line were obtained from *Automotive News*. While these data represent national averages, they can be assumed to reflect regional conditions, for regional imbalances, if any, in a particular line of new or used motor vehicle tend to be narrowed through organized markets. For instance, see "Cars Wanted," "Cars for Sale," and "National New Car Exchange" in *Automotive News*. Since $I_{i,t}$ represents total new-car inventories of the ith line, I^*, ceteris paribus, would be constant over the calendar year. As new model introduction approached, $I_{i,t}$ would include an increasing proportion of the new model year's autos.

Dealer Advertising

It is a characteristic of all markets where information is costly that firms engage in extensive advertising and promotions. In the retail automobile market, these expenditures are primarily to provide price information, promote dealer recognition and loyalty, and to differentiate the dealer from others in the market. Given the standard model of monopolistic competition, one would expect that advertising expenditures would raise transaction price by increasing dealer costs. However, if one recognizes that consumers must incur costs in obtaining price and location information, the increase in transaction price may be offset by a reduction in search costs. That is, while the pecuniary price increases, the full price, which includes search costs, may decrease (Becker 1965; Crafton 1979). Because of the inability to estimate search

costs, the model developed here, however, can only capture the effect on the transaction price.

List Price

Use of the manufacturer's base suggested list price as the price variable in models of automobile demand misrepresents transaction price because of the omission of manufacturer-installed optional equipment. For instance, during the 1978 model year, the average Mercury Marquis was equipped with over $1,500 in factory-installed optional equipment (*Automotive News: Market Data Book Issue* 1979). Use of the base list price would have understated the actual list price by over 25%.

The manufacturer's suggested list price, $L_{i,t}$, was calculated as:

$$L_{i,t} = F_{i,t} + \sum_{j=1}^{n} (O_{i,t}) f_{i,t}; \tag{1}$$

$F_{i,t}$ represents the list price of the base care exclusive of any freight charges for the ith-size car in period t and $O_{i,t}$ the list prices for major manufacturer-installed optional accessories on the ith-size car during the model year. The variable $f_{i,t}$ represents the percentage of the ith model car in period t equipped with the jth accessory. Prices were obtained from *Automotive News,* while optional equipment installations by model year were obtained from the annual *Automotive News Market Data* issues. While the Bureau of Labor Statistics has a new car component of its Consumer Price Index, it does not publish indexes for specific size categories, nor does it measure the prices of vehicles as actually equipped.

It is argued that list price rather than dealer cost is the better explanatory variable to be utilized for estimating transaction price. Both the dealer and the consumer know the list price when negotiating. Only well-informed consumers know the discount structure and therefore dealer cost. Further, as discussed below, while rebates frequently are used to reduce dealer cost, only consumers who regularly read the automotive trade literature would have knowledge of such.[5] All specifications tested using dealer cost had less explanatory power. Therefore, for econometric and theoretical reasons, we believe list price is the better explanatory variable.

Price Incentives

In the absence of a permanent price change, dealer invoice costs do not vary within the model year. That is, cars ordered late in the model year have the same potential profit margin (list minus cost) as those ordered

5. The GM and Ford dealer rebates during August and December 1979 were the first such rebates to be widely advertised.

at new-model introduction. However, manufacturers at times make temporary price adjustments for particular models. Such cost adjustments, generally dubbed rebates, are of several types.

Within the model year during periods of excess dealer inventories, auto manufacturers frequently offer temporary price incentives. The vast majority of incentives are to the dealer in the form of rebates, which effectively lower the dealer's vehicle cost. At times the size of the rebate is a function of the firm meeting certain sales objectives within predetermined time constraints.

Although less frequent, consumer rebates by manufacturers have been more highly publicized. Here the manufacturer lowers the transaction price by making rebates directly to the consumer and bypassing the dealer. During periods of extreme inventory imbalance, such as that faced by Chrysler late in the 1979 model year, the manufacturer may use both types simultaneously.

At the end of the model year, manufacturers traditionally have given their dealers a 5% rebate on leftover models. With the exception of Chrysler, manufacturers in recent years have applied this rebate to all lines, independent of dealer sales performance.[6] Thus, after new-model introduction, the dealer's unit cost on leftover models declines by 5%.

Transactions Prices and Data Sources

Data on gross vehicle profit and dealer advertising promotion expenditures were obtained from *Lincoln-Mercury Dealer Guide Group Averages,* a monthly publication distributed to dealers by the Dealer Business Management Department of the Lincoln-Mercury Division of the Ford Motor Company. The data represent the monthly performance averages of approximately 75 medium-sized (new-car planning potential of 200–400 units per year) Lincoln-Mercury dealers in four mid-Atlantic states (Ford Motor Company 1977–79).

Obtained from this publication were average vehicle gross profits for seven of the division's car lines[7] for 9 months over a period incorporating the 1977–79 model years (January 1977–March 1979). Transactions prices for each car line were calculated by summing dealer costs and gross dealer profits.[8] For transactions involving a used car trade-in, the used car trade-in was valued at wholesale, with the difference treated as a discount off the list price of the new car (or vice versa).

6. Commencing with the 1980 model year closeout, additional domestic manufacturers altered the terms of this type rebate.

7. Each division car line was modeled except the Lincoln Versailles and the Capri.

8. For the ith line, dealer cost, exclusive of rebates, can be expressed $C_{i,t} = aL_{i,t} + bO_{i,t}$, where $C_{i,t}$ = dealer cost inclusive of holdbacks, $L_{i,t}$ = manufacturer's base car list price, a = (1 − percentage markup for the ith car), $O_{i,t}$ = manufacturer's list price for factory-installed optional equipment, b = (1 − percentage accessory markup for the ith car).

Utilizing these pooled time-series cross-sectional data, we tested the relationship in double logarithmic form between the transaction price of the ith line of cars and that line's dealer inventories, manufacturer price incentives to dealers (rebates), dealer advertising and promotional expenditures, and list price (including accessories). The equation was estimated utilizing generalized least squares with the data corrected for autocorrelated disturbances and heteroscedasticity (Pindyck and Rubinfeld 1976, pp. 202–11, 94–125). This specification is presented in (2) with a priori expected signs in parentheses above the variables:

$$P_{i,t} = \underset{(-)}{a_1 I^s_{i,t}} + \underset{(-)}{a_2 R_{i,t}} + \underset{(+)}{a_3 A_t} + \underset{(+)}{a_4 L_{i,t}} + a_5, \tag{2}$$

where $P_{i,t}$ = the transaction price in dollars of the ith line, including all major manufacturer-installed optional accessories in period t (exclusive of freight charges); $I^s_{i,t}$ = dealer inventories of the ith line on the first day of period t in terms of daily selling rates in period $t-1$; $R_{i,t}$ = manufacturer cash incentives to dealers in dollars for the ith line in period t including intra- and intermodel year rebates; A_t = dealer advertising and promotional expenditures in dollars per vehicle in period t; and $L_{i,t}$ = the list price in dollars of the ith line including all major manufacturer-installed optional accessories in period t. The results of the specification are:

$$P_{i,t} = \underset{(-1.84)^*}{-.0244\, I^s_{i,t}} - \underset{(-2.09)^*}{.227 R_{i,t}} + \underset{(0.90)}{.013 A_t} + \underset{(28.79)^*}{.098 L_{i,t}} + 8.012, \tag{3}$$

where $R^2 = .94$, df = 57, and D-W = 1.93 (after time series were adjusted for autocorrelative disturbances);[9] t-statistics are in parentheses, and asterisk denotes significant at the 5% level (one tail).

III. The Empirical Results

As shown in (3), each variable except dealer advertising proved to be significant, with the a priori determined sign. It is interesting to note that inventory in terms of daily selling rate, the proxy variable for market forces, was highly significant. This confirms the hypothesis that market forces are important in determining transaction price, which was found, as expected, to be inversely related to the inventory measure. That is, the higher the actual inventory level in terms of daily selling rates, the greater the discount from the list price. These greater

9. The equation estimated using ordinary least squares, unadjusted for autocorrelative disturbances, was

$$P_{i,t} = \underset{(-3.37)^*}{-.0647 I^s_{i,t}}\ \underset{(-2.01)^*}{.23 R_{i,t}} + \underset{(1.53)}{.0351 A_t} + \underset{(40.22)^*}{.103 L_{i,t}} + 8.01,$$

$R^2 = .97$, D-W = .55, asterisk denotes significant at the 5% level.

discounts were found despite the fact that given floor planning costs, the dealer has (on average) a higher unit cost on "high" inventory vehicles. This result, namely, that transaction price and inventory levels are inversely related, is contrary to the result predicted by the "average-cost pricing" model (Davisson and Taggart 1974, pp. 174–211). According to this model, if dealers offer prices based on unit costs, and since unit costs increase as inventories rise, ceteris paribus, discounts would decrease, not rise, as our results indicate.[10] Hypotheses based on this type of "average-price" model seem to assume that market forces (supply and demand) are irrelevant.

Of further interest is the rebate coefficient. This coefficient was negative and significant at the 5% level. That is, as manufacturer rebates to dealers increased, the dealer discounts on the vehicles eligible for the rebates increased. Since (3) is in logarithmic form, we can read directly that approximately 23% of the manufacturer's rebates to its dealers were passed forward to the new-car purchaser.

Manufacturers make extensive use of temporary rebates to dealers as a means of adjusting price to reflect market weaknesses in particular car lines or across all car lines. In making these temporary price adjustments, manufacturers anticipate that dealers lower their normal gross profit margins, with the rebate making the difference.

The fact that less than 24% of the manufacturer's rebate is passed forward to the consumer is not overly surprising, as dealers use portions of the remainder to finance shift variables such as increased levels of dealer promotion activity and increased salesperson compensation on the models subject to manufacturer rebates. The rebate is used to finance price reductions as well as shift variables.[11]

As of mid-1980, the direct consumer rebate has been used extensively by the industry in 1975, 1979, and 1980.[12] In the two earlier instances, the programs were initiated by Chrysler Corporation in response to excessive factory and dealer inventories. The direct consumer rebate tends to be more expensive to the manufacturer than the dealer rebate in that no specific dealer sales performance is required for the consumer to obtain the price reduction. Furthermore, the rebate applies to every unit sold, preventing the manufacturer and the dealer from pricing at the margin.

Since the Lincoln-Mercury Division did not have a direct consumer rebate program during the observation period, the model cannot di-

10. It is recognized that the "average-cost pricing" model treats inventories as a stock, while this paper treats inventories in terms of selling rates (flow). Yet is is argued that our results do contradict the essential thesis of this model.

11. Conversation with Central Virginia Ford Motor Company dealers ("casual empiricism") seems to confirm this analysis. Several dealers stated that manufacturer rebates were used not only to reduce the transaction price, but also to try to stimulate demand.

12. Several smaller or selective rebate programs should be noted. In the 1960s, Studebaker and American Motors had several programs whereby they rebated relatively small amounts ($25) to particular groups such as shareholders or senior citizens.

rectly compare the efficacy of the two rebate types. Although the rebate coefficient is significant, it is quite small if interpreted in dollars. From (3) it is estimated that if a $500 rebate were given to dealers consumer transactions prices would decline by less than $114. Three aspects of this finding are noteworthy. First, the observation that a marginal dealer rebate of $1.00 lowers the average price by $0.23 can be explained by the fact that the marginal price is less than the average price. Second, and significant from an economic perspective, is the issue of information costs. Few consumers would be aware of the existence or size of dealer rebate programs. Furthermore, consumers must negotiate to share in these cost reductions, while no negotiation is necessary to obtain the consumer rebate. Finally, as discussed above, a portion of the dealer rebate is used as a demand stimulus.

These results can be interpreted as supportive of the Chrysler decision to undertake consumer rebates late in the 1979 model year (summer), in lieu of an enlarged dealer rebate program.[13] Chrysler's increased sales and market penetration during the period it used consumer rebates (while Ford and General Motors continued to use dealer rebates) are reflective of the relative, as well as absolute, lower transactions prices for Chrysler cars vis-à-vis the vehicles of other domestic firms. While part of the Chrysler performance reflects absolute and relative increases in advertising and promotion expenditures, it would be difficult to attribute this increased sales and market share solely to advertising, since General Motors and Ford simultaneously increased advertising expenditures to promote their dealer rebate programs (Bohn 1979). The fact that AMC, Ford, and GM also choose to adopt consumer rebate programs throughout the 1980 model year in lieu of enlarged dealer rebate programs is consistent with our findings.

Additionally, dealer advertising and promotion expenditures were found not to be a significant determinant of transaction price in (3). However, it is possible that advertising may reduce search costs and therefore the "full price," that is, pecuniary price plus search cost. Data limitations precluded a test of this interesting hypothesis.

Finally, for each division car line, the manufacturer's suggested list price, adjusted to include factory-installed options, was highly significant. This is expected since list price is the starting point for bargaining between consumers and dealers. Further, it is the only price information to which both parties have equal access.

IV. Summary

Postulating that the transaction price for new automobiles is determined in a competitive new-car dealer market, rather than being set

13. During most of the 1979 model year, Chrysler had dealer rebate programs on other than its four-cylinder lines.

exogenously in the more highly concentrated automobile manufacturing sector, this paper develops a model to estimate the transaction price of new automobiles. Dealer new-car inventories in terms of daily selling rates are used in the model as a proxy for market conditions (supply and demand). The transaction price is modeled to be a function of inventories, manufacturer price incentives to dealers, advertising, and vehicle list price. Each variable except advertising was found to be significant with the a priori determined sign. Most important, and consistent with a market model, transaction price was found to be inversely related to the measure of dealer inventories. It was determined that manufacturer rebates to dealers had a statistically significant effect on the transaction price, although the effect was small in magnitude. Finally, list prices, adjusted to include actual-factory-installed, optional accessories, were a significant determinant.

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