ARE CONSUMERS MORE INTERESTED IN FINANCING INCENTIVES OR PRICE REDUCTIONS?

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This paper investigates the difference in consumers' responses to changes in the price of automobiles and changes in the level of the interest rate for automobile loans. Because lower interest rates for automobile loans are essentially equal to a price reduction, consumers should react equally to lower interest rates on automobile loans and to lower prices for automobiles, holding all other factors affecting automobile demand constant. However, many zero percent financing promotions by automobile manufacturers recently have resulted in higher than expected sales, despite the recent recession and low consumer confidence levels. Automobile manufacturers are also offering cash back rebates, but most newspaper articles and industry experts attribute the higher than expected sales to the heavily advertised low financing deals.

Car sales are a large part of the U.S. economy. Approximately one out of every seven jobs in the U.S. is related directly or indirectly to the automobile industry. Due to the large effect of automobile sales on the U.S. economy, many economists have claimed that the recent recession of 2001 would have been much more severe without the high level of automobile sales during that period.

The question whether consumers are more responsive to financing incentives or price incentives is important to anyone trying to market a durable good. If consumers are more responsive to financing incentives, then companies could offer financing incentives instead of cash back rebates and receive a larger response from consumers. Consumers' responsiveness is also an important element of the demand function, which is supposed to be indicative of consumer preferences. A higher response to financing incentives could indicate something about consumers' time preference for money. If consumers would rather have lower monthly payments on a car as opposed to a cash back rebate at the time of purchase, then these consumers must value money in the future more than the current time.

Numerous studies on the demand for automobiles have been performed. These studies have used many different statistical tools and types of analysis to model the demand for automobiles. The studies have resulted in many different elasticities of demand for automobiles and have concluded that automobile demand depends on a variety of different variables. However, no study of the demand for automobiles has focused primarily on the difference between financing incentives and price incentives.

An early study by Daniel B. Suits (1958) accounted for differences in financing terms by dividing the average retail price of a new automobile by the average number of months duration of automobile credit. While dividing the price by the duration of the loan begins to account for financing incentives, it is an unsophisticated method and does not account for changes in interest rates.

A later study by Thomas Dyckman (1965) accounts for different credit terms by giving a dummy variable the value of one in all years in which a substantial easing of credit terms took place. The study period included data from 1929-1962, during which only four years had a credit variable not equal to zero. Although Dyckman's study does improve upon the method used by Suits, it still only considers a few years and does not concentrate sufficiently on the impact of financing incentives on automobile demand. More recent studies continue to include interest rates in the calculations of demand for automobiles but usually equate interest rate changes to price

changes and do not take into account the possibility of consumers preferring interest rate discounts to price discounts. One study by Thomas Noordewier and Patrick Thompson (1992) examines the effects of consumer incentive programs on automobile sales but does not distinguish between price incentives and financing incentives.

Past studies that did account for price and interest rates separately did not include data points from after the events of September 11, 2001. Due to the high level of consumer response to low interest rates since September 11, 2001, including data from that period may demonstrate a larger impact of interest rate deals on the sale of automobiles than previous studies.

Many of the studies have built on other studies by including more variables or different types of variable. Recent studies, such as Sudhir (2001) and Berry et al. (1995), take into account differences in consumer conditions including price, levels of disposable income, and differences in automobiles, such as quality and size. This paper builds on previous studies of automobile demand by distinguishing between consumers' reactions to price changes and interest rates changes and includes the most recent data on automobile sales.

I. THEORY AND PREDICTIONS

In order to demonstrate that consumers prefer financing incentives, the theory of demand will be applied to the sale of new automobiles in the United States. According to the theory of demand, the demand for a certain good is a function of changes in the price of that good, the disposable income of consumers, and consumers' preferences. Increases in the price of a good will decrease the quantity demanded, and increases in income will increase the quantity of a good demanded (unless it is an inferior good, which automobiles are not). The effect of consumers' preferences are harder to measure because they are different for every consumer, but this study tries to account for overall trends in consumers' preferences by using a measure of consumer sentiment. Increases in the measure of consumer sentiment will increase demand because consumers will prefer to purchase more goods when they are confident in the strength of the economy. Because a change in the interest rate on a loan used to pay for a good is effectively equal to a change in the price of a good, the two variables should have the same impact on the sale of new automobiles.

Another element of the theory of demand is that elasticities can be used to compare the effect of different variables on demand. An elasticity of demand is the ratio of the percent change in quantity of the good demanded to the percent change of the variable being investigated. Because elasticities are ratios of percentage changes, elasticities are independent of units. Therefore, a comparison of the price elasticity of demand for new automobiles with the interest rate elasticity of demand for new automobiles will demonstrate which variable has a larger impact on demand. If consumers are more responsive to changes in the interest rate, then the elasticity of demand for the interest rate variable will be larger than the elasticity of demand for the price variable.

Contrary to the theory of demand, I hypothesize that the interest rate elasticity of demand for automobiles will be larger than the price elasticity of demand for automobiles. My hypothesis is based on the recent success of financing incentives in generating sales for automobiles. On the other hand, in accordance with the theory of demand, I predict that the price and rate elasticity of demand for automobiles will be negative and that the income and measure of consumer sentiment elasticity of demand for automobiles will be positive.

II. TEST METHODOLOGY

A regression analysis in log linear form provides results with coefficients (B1, B2, B3, B3) representing elasticities of demand and allows for the isolation of the effects of price and interest rates from the other factors affecting automobile demand. In accordance to the theory of demand, the other factors that influence automobile demand included in the regression are personal disposable income and a measure of consumer sentiment. Thus, my estimated equation is in the following form:

(1) Log(REALSALE) = B_1*Log(PRICE) + B_2*Log(RATE) + B_3*Log(CONSUMERSENTIMENT) + B_4*Log(DPI) + C

The dependent variable *REALSALE* is the personal consumption expenditure on new motor vehicles in billions of chained 1996 dollars. The data were taken from the Bureau of Economic analysis and represent the aggregate level of new automobile sales in the U.S. in real dollars.

The independent variable *PRICE* is one of the variables representing the price of automobiles. A consumer price index for new automobiles was taken from the Bureau of Labor Statistics and used as the *PRICE* variable. The price index has a base of 100 for the year 1984. The variable *PRICE* reflects relative movements in the average aggregate price level for new automobiles. Because the index represents the average price level, it accounts for changes in the number of models offered.

The independent variable *RATE* represents the average interest rate for new car loans at auto finance companies on a 48-month loan. *RATE* is the other variable accounting for the price of automobiles. The finance company data are from the subsidiaries of the three major U.S. automobile manufacturers and are volume-weighted averages covering all loans purchased during the period. Because the variable *RATE* is an average aggregate measure of car loans, comparison with the average aggregate price level of cars shown by the price index is logical.

The independent variable *CONSUMERSENTIMENT* represents the measure of consumer sentiment taken from the University of Michigan's survey of consumers. This variable accounts for changes in consumers' preferences due to the current economic condition, recessions or expansions, that effect consumers' decision to buy a car. Concerning the theory of demand, *CONSUMERSENTIMENT* should be a measure of consumers' preferences.

The independent variable *DPI* stands for personal disposable income and represents per capita disposable personal income in chained 1996 dollars. This variable accounts for changes in consumers' income. The variable *DPI* is another aggregate average that allows for comparison to the *PRICE* and *RATE* variables.

C represents a constant term that accounts for all factors affecting automobile demand that are not captured by the other variables included in the regression equation. The regression includes quarterly time series data from 1987 to the first quarter of 2002 of the variables mentioned above.

III. RESULTS

After running the first Ordinary Least Square regression, the Durbin-Watson statistic demonstrated a high degree of serial or autocorrelation. In order to correct for the autocorrelation, the results from a first order auto regression are shown in table one.

Table 1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.853377	3.772348	-0.491306	0.6252
LOG(*CONSUMERS ENTIMENT*)	0.092303	0.114193	0.808309	0.4225
LOG(*PRICE*)	-2.168814	0.509408	-4.257520	0.0001
LOG(*RATE*)	-0.340631	0.052739	-6.458791	0.0000
LOG(*DP*I)	1.798024	0.409088	4.395202	0.0001
AR(1)	0.748239	0.091012	8.221350	0.0000
R-squared	0.914826	F-statistic	115.9998	
Adjusted R-squared	0.906940	Prob(F-statistic)	0.000000	
Durbin-Watson stat	2.345659			

Estimated Equation:
(2) Log(*REALSALE*) = -2.16 Log(*PRICE*) + -0.34 Log(*RATE*) + .0923 Log(*CONSUMERSENTIMENT*) + 1.79 Log(*DPI*) + *C*

As expected, the coefficients of *PRICE* and *RATE* are negative. The magnitude of the coefficient of *PRICE* is -2.16 and represents a 2.16 percent change in the quantity demanded for every one percent change in the price index for automobiles. As shown in table two below, a price elasticity of 2.16 is larger than any previous estimates. This represents an elastic demand for new automobiles. The t-statistic of -4.25 is below the critical t-score of -1.67 for a one-tail test with 60 degrees of freedom. Thus, the coefficient for *PRICE* is statistically significant but larger than previous estimates.

Table 2: Comparison of Studies

Study	Price Elasticity	Income Elasticity	Rate Elasticity
Beck	-2.168	1.798	-0.34
Suits (1958)	-0.7	1.7	na
Dyckman (1965)	-.98	1.096	.077
Hess (1977)	-1.63	.26	-.33

The magnitude of the coefficient of *RATE* is -0.34. The coefficient represents a 0.34 percent change in quantity demanded for every one percent change in the interest rate for a new car loan. As shown in Table two, a 0.34 estimate for the rate elasticity is in the range of previous research. The t-statistic of -6.45 is significantly lower than the critical t-statistic of -1.67 signifying a statistically significant t-score. Therefore, the coefficient for *RATE* is statistically significantly below zero and reasonable when compared with previous estimates.

DPI's coefficient is 1.79. As expected, the coefficient is positive, demonstrating that when personal disposable income increases, automobile sales also increase. The high income-elasticity of demand for new automobiles is not too alarming, considering new cars are luxury goods. Compared to previous research, an income elasticity of 1.79 is a little large, but is not significantly larger. Thus, a person increasing new car demand by 1.79 percent for every one

percent increase in personal disposable income is plausible. The t-statistic of 2.88 is greater than the critical t-statistic of 1.67, revealing the coefficient is statistically significant. So, the coefficient of *DPI* is both statistically significant and reasonable.

The coefficient for *CONSUMERSENTIMENT* equals 0.09. Unfortunately, the t-score of .116 is below the critical t-statistic of 1.67, so the coefficient is not statistically above zero. Apparently, the consumer sentiment measure was not a good indicator of consumers' preferences of when to buy a new car. Thus, the variable *CONSUMERSENTIMENT* should be excluded from the equation.

The variable AR(1) is a result of the correction for autocorrelation. The coefficient of AR(1) is 0.75 and represents the degree of autocorrelation in the original equation. Because the p-value of the t-statistic is less than the 0.05 level, the t-statistic confirms 0.75 is a statistically significant degree of autocorrelation and needs to be corrected.

The statistics for the overall equation are statistically significant, signifying all of the variables together are a good estimate of the level of automobile sales. The R^2 of 0.914 signifies that 94 percent of the variation of sales from their expected value is explained by the equation. The F-statistic of 115.9 being larger than the critical F of 2.53 affirms that the R^2 is statistically significantly above zero.

One possible problem with the results is multicollinearity. Multicollinearity can affect the sign and magnitude of coefficients, so it could have a serious impact on the results because the coefficients are representing the elasticities and are critical to the analysis of the hypothesis. Multicollinearity might explain the high price elasticity of demand. Table 3 is a correlation matrix demonstrating that multicollinearity might be affecting the coefficients.

Table 3: Correlations

	LOG(*PRICE*)	LOG(*RATE*)	LOG(*DPI*)	LOG(*CONSUMER SENTIMENT*)
LOG(*PRICE*)	1.000000	-0.681477	0.781067	0.431288
LOG(*RATE*)	-0.681477	1.000000	-0.834889	-0.478047
LOG(*DPI*)	0.781067	-0.834889	1.000000	0.520238
LOG(*CONSUMER SENTIMENT*)	0.431288	-0.478047	0.520238	1.000000

Table three shows a high correlation between Log(*RATE*) and Log(*DPI*). However, considering the data are time series and the signs and magnitudes are reasonable, the correlations are not too high. Another consideration is that after running the regression without the highly correlated variable *RATE*, the coefficient of Log(*PRICE*) was still close to the estimated coefficient in the previous regression. Thus, multicollinearity does not appear to be affecting the magnitudes or signs of the coefficients of elasticity.

Because the overall equation is statistically significant and the coefficients for *RATE* and *PRICE* are statistically significant and reasonable estimates, the results can now be applied to the theory of demand. The price elasticity of demand is larger than the interest rate elasticity of demand. Thus, the results refute my hypothesis that interest rates have a greater impact on automobile sales than price changes. However, because the coefficient of *CONSUMERSENTIMENT* was not statistically significant and could be skewing the results, the regression will be examined again without the measure of *CONSUMERSENTIMENT* to ensure

the statistical results are accurate.

The results of the regression without *CONSUMERSENTIMENT* and after being adjusted for autocorrelation errors are shown in table four.

Table 4: Regression without *CONSUMERSENIMENT*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.089268	3.966789	-0.778783	0.4393
LOG(*RATE*)	-0.243969	0.038203	-6.386051	0.0000
LOG(*PRICE*)	-1.755482	0.477659	-3.675174	0.0005
LOG(*DPI*)	1.739366	0.429234	4.052261	0.0002
AR(1)	0.748666	0.094848	7.893363	0.0000
R-squared	0.920626	F-statistic	165.2805	
Adjusted R-squared	0.915056	Prob(F-statistic)	0.000000	
Durbin-Watson stat	2.281515			

The results in table four are similar to the previous results. Once again, all the coefficients for *DPI*, *RATE*, and *PRICE* are statistically significant. The increased R^2 and adjusted R^2 demonstrate this equation as a whole is a better estimation of automobile sales. Another difference between the equations is the magnitude of the coefficient for both *PRICE* and *RATE* decreased. The decrease confirms taking *CONSUMERSENTIMENT* out improved the equation since the original coefficient for *PRICE* was larger than any previous studies. The new price elasticity of -1.75 is closer to estimates of other studies. However, the results still refute the hypothesis that interest rates effect demand more than price changes.

IV. CONCLUSION

The statistical results show that consumers prefer a price reduction to an interest rate discount when purchasing a new automobile. As a result, the recent success of low APR financing on many new cars does not represent a larger trend of consumer preferences towards decreases in the interest rate. There are other possible explanations for the recent success of financing incentives. One explanation may be that consumers only respond to interest rate changes that result in extremely low interest rates, such as the 1.9 percent or zero percent deals that have been offered recently. Before 2000, interest rates were historically above 6 percent. At these higher levels, consumers did not respond to interest rate discounts. Another explanation may be that most consumers do not monitor the interest rates on new car loans as closely as the prices for new cars. Consumers have been aware of the recent low financing rates due to extensive advertising campaigns. The combination of the low financing rates and intense advertising have lead to the high sales of automobiles, not consumers' overall responsiveness to changes in the interest rates on new car loans. A final explanation may be that because consumers are not as familiar with interest rates, they do not understand that impact of changes in the interest rate. Therefore, consumers do not react to interest rate changes because they do not know the effect of the change in the interest rate on the price. Regardless of the possible explanations, the results show that consumers respond to price changes rather than interest rate changes when purchasing a new automobile.

DATA APPENDIX

Date	REALSALE*	RATE**	PRICE***	DPI****	CONUMER SENTIMENT*****
1987:1	149.8000	10.59000	112.8000	18830.00	90.50000
1987:2	164.2000	10.64000	114.5000	18608.00	91.80000
1987:3	177.3000	8.710000	115.5000	18924.00	93.90000
1987:4	158.1000	12.23000	115.7000	19119.00	86.40000
1988:1	176.3000	12.24000	115.5000	19345.00	92.30000
1988:2	172.1000	12.32000	116.6000	19447.00	93.60000
1988:3	165.6000	12.93000	118.5000	19571.00	96.00000
1988:4	172.0000	13.25000	118.2000	19724.00	93.00000
1989:1	170.2000	13.07000	118.9000	19896.00	95.90000
1989:2	169.2000	11.96000	119.2000	19800.00	90.90000
1989:3	181.4000	12.42000	118.7000	19793.00	92.50000
1989:4	155.2000	13.27000	120.9000	19844.00	91.80000
1990:1	173.8000	12.31000	120.7000	20092.00	91.30000
1990:2	162.5000	12.58000	120.4000	20146.00	90.90000
1990:3	157.8000	12.34000	120.7000	20107.00	79.10000
1990:4	145.6000	12.86000	122.6000	19888.00	65.10000
1991:1	126.0000	13.14000	124.6000	19839.00	75.00000
1991:2	127.1000	12.77000	125.4000	19912.00	80.70000
1991:3	132.3000	12.38000	125.7000	19891.00	82.60000
1991:4	130.9000	10.41000	126.8000	19853.00	71.90000
1992:1	138.6000	10.92000	127.4000	20126.00	70.80000
1992:2	139.0000	10.24000	128.3000	20194.00	78.90000
1992:3	141.8000	8.650000	129.1000	20128.00	76.10000
1992:4	145.3000	9.650000	129.7000	20432.00	83.20000
1993:1	139.1000	9.950000	130.1000	20020.00	87.30000
1993:2	148.1000	9.450000	131.1000	20261.00	82.50000
1993:3	149.1000	9.210000	132.2000	20225.00	77.40000
1993:4	158.8000	8.800000	133.4000	20432.00	84.00000
1994:1	156.6000	9.130000	134.6000	20202.00	93.00000
1994:2	156.8000	9.960000	135.8000	20480.00	92.20000
1994:3	154.0000	10.13000	137.7000	20567.00	90.70000
1994:4	157.9000	10.72000	137.2000	20775.00	93.10000
1995:1	149.7000	11.95000	138.3000	20801.00	94.30000
1995:2	148.3000	11.08000	139.2000	20720.00	91.70000
1995:3	147.9000	10.75000	139.2000	20797.00	93.20000
1995:4	152.6000	10.52000	139.9000	20874.00	89.80000
1996:1	153.6000	9.770000	140.8000	20957.00	90.50000
1996:2	151.1000	9.530000	141.4000	21003.00	91.50000
1996:3	147.2000	10.52000	142.4000	21160.00	94.90000
1996:4	148.7000	8.600000	142.2000	21165.00	97.50000
1997:1	151.3000	8.080000	142.2000	21261.00	99.00000
1997:2	144.9000	7.640000	141.8000	21385.00	103.0000
1997:3	159.9000	6.120000	141.3000	21522.00	105.8000
1997:4	162.4000	5.930000	140.7000	21708.00	105.0000
1998:1	160.0000	6.470000	141.0000	22075.00	107.8000
1998:2	179.9000	6.020000	140.1000	22341.00	106.9000
1998:3	169.0000	5.920000	140.7000	22478.00	103.5000
1998:4	189.1000	6.430000	140.5000	22540.00	100.2000

1999:1	186.5000	6.310000	139.6000	22630.00	105.9000
1999:2	196.1000	6.600000	139.2000	22618.00	106.2000
1999:3	201.1000	6.470000	139.5000	22634.00	105.9000
1999:4	200.9000	7.320000	139.3000	22828.00	105.3000
2000:1	216.1000	6.760000	139.4000	23234.00	110.1000
2000:2	206.0000	6.400000	139.8000	23451.00	108.8000
2000:3	212.2000	7.160000	139.6000	23637.00	107.5000
2000:4	198.7000	7.450000	139.6000	23680.00	103.9000
2001:1	213.4000	6.800000	138.9000	23624.00	92.30000
2001:2	216.2000	6.150000	138.7000	23537.00	91.00000
2001:3	219.7000	5.420000	138.4000	24071.00	88.60000
2001:4	267.5000	3.310000	139.6000	23537.00	85.10000
2002:1	239.1000	5.870000	137.6000	24296.00	93.10000
2002:2	234.9000	6.290000	136.7000	24461.00	NA
2002:3	268.4000	2.430000	137.0000	24564.00	NA

* the data for RealSale came from Table 8.9B: Real Motor Vehicle Output of the BEA NIPA tables. It is a measure of vehicle personal consumption expenditures on new motor vehicles in Billions of chained 1996 dollars. The numbers are seasonally adjusted at annual rates. The data can be found at http://www.bea.gov/bea/dn/nipaweb/TableViewFixed.asp?SelectedTable=174&FirstYear=1999&LastYear=2000&Freq=Qtr

** the data for Rate was taken from economagic's table of Terms of Credit: New Car Loans at Auto Finance Companies: Interest Rate; NSA. From the Federal Reserve Board. This data can be found at <http://www.economagic.com/em-cgi/data.exe/frbg19/tc05>

*** The data for price was taken from economagic's Bureau of Labor statistics series of CPI: U.S. city average; New vehicles; 1982-84=100; SA and can be found at <http://www.economagic.com/em-cgi/data.exe/blscu/CUSR0000SETA01>

**** the data for DPI came from the BEA's NIPA Table 8.7. Selected Per Capita Product and Income Series in Current and Chained Dollars. The data used was for chained 1996 dollars of Disposable personal income

***** the data for Consumersentiment came from the University of Michigan's Survey of Consumers and can be found at http://www.sca.isr.umich.edu/documents.php?c=tb

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