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Econ 482
Project Paper Rough Draft

**Executive Summery:**

Since 1908, when Henry Ford rolled the first Model T off the production line automobiles have gotten more reliable, efficient, and most importantly, safer. To some the automobile is a tool breed from human ingenuity, a testament to mass manufacturing, but to most the automobile is just a form of convenient transportation, one's ride from place A to place B. Some consumers, however, simply demand more, they demand tire blistering power, spine bending acceleration, and exotic mind numbing styling. For this, they pay a premium. What is it that they are actually paying for? I sampled 71 2004 model year sports cars. I took sports car to mean that if the manufacture advertised it as their sports car in 2004 it was a sports car and subsequently included. Two regressions where run resulting in:

**(1) Price = 449.028HP – 578.033SIXTY – 5188.322QUARTER + 6660.207ORIGIN**

**(2) Price = 451.499HP – 5478.89QUARTER + 6637.738ORIGIN**

With the little change in the coefficients when removing SIXTY, I decided to leave it in when evaluating the model. I choose 3 cars at random from the 2005 model year to test the model. I found that the model predicted the price of the Lamborghini almost exactly, the price of the Porsche fairly close, and the price of the BMW was way off. I suspect the model, being based purely on performance doesn't entirely capture this recent innovation in superior engine design coupled with relatively low cost. When all is said and done, I am fairly confident that his model can predict the prices of sports car relatively well. It seems to do very well model high priced super sports cars, but fails to accurately model the newly emerging cars with high performance numbers and relatively low pricing.

**An Introduction:**

Zero to sixty in 3.3 seconds, Zero to on hundred in 6.6 seconds, and 660 Horse Power at a mere 7800 RPM. To most these are just numbers. To some, they might be recognized automobile related. To a select few they scream: Ferrari Enzo. Would you pay $652,830 for an automobile that seats only two, has the most uncomfortable interior available, constructed from shatter proned carbon fiber, doesn't offer a heater, air conditioning or radio? No? All 399 planned production models are spoken for and have a current resale value in the neighborhood of 1.3 million dollars. Since 1908, when Henry Ford rolled the first Model T off the production line automobiles have gotten more reliable, efficient, and most importantly, safer. To some the automobile is a tool breed from human ingenuity, a testament to mass manufacturing, but to most the automobile is just a form of convenient transportation, one's ride from place A to place B. Thus reliability, safety, and fuel efficiency are the average consumer's utmost concern. This class of consumer automobiles is priced accordingly. Some consumers, however, simply demand more, they demand tire blistering power, spine bending acceleration, and exotic mind numbing styling. For this, they pay a premium. What is it that they are actually paying for?

**The Purpose:**

The purpose of this model is to provide a guide to this subset of automobile buyers. I wish to take the available data from automobiles produced in the 2004 model year and use linear regression techniques to model four variables that weigh heavily in determining price. I will judge success of the model on whether it accurately predicts the price of 3 randomly selected vehicles in the 2005 model year.

**Data & Variable Selection:**

I have to admit, I took some discretion when making selections for variables to test. Logic would suggest, from looking at the Ferrari Enzo, sports car consumers for the most part are not paying these high prices for cushy leather seats, computer navigation or climate control. They are paying for gut wrenching performance and the attention associated with uber exotic styling. For the first category, pure performance, I selected the three universally accepted measures of basic sports car performance: the engines performance and efficiency: horse power (hp), its acceleration from zero to sixty (sixty), and the time elapsed traversing one quarter mile from a stop (quarter). Horse power figures ranged form the Ferrari Enzo's 660 HP to the Toyota MR2 Spyder's 138 HP. Unlike the large range encompassed by the horse power statistics zero to sixty and quarter mile times where much more tightly clustered with Ferrari Enzo and Mitsubishi Lancer Sport Pack setting the spread. Secondly, I had the variable of styling to consider. Since there is no "judge" of cars styling, I choose a proxy variable. I have come to notice that styling certain styling cues are indicative to certain areas of the world. For example, Eastern European companies like Lamborghini and Ferrari styling brings about the graceful and balanced lines of a mid-engine rear wheel drive layout, while Western European styling wraps a sedan in harden aggressive lines like BMW and Lotus. In steep contrast Japanese styling is considered by most to be somewhat bland, much like their westernized teriyaki: It's still damned good, but could be much better if they didn't water it down to avoid offending some consumers. I coded this in a variable called origin representing the country of the car's origin: 1 = Japan, 2 = Germany, UK = 3, USA = 4, Italy = 5, and finally Sweden = 6. I sampled 71 2004 model year sports cars. I took sports car to mean that if the manufacture advertised it as their sports car in 2004 it was a sports car and subsequently included. I also took the best trim available if it didn't have any performance differences, however if increased trim included performance changes I included all trims. Performance and country of origin data was recorded from the December 2004 issue of Motor Trend and prices where taken from www.carpoint.com.

**The Model:**

The first regression I ran included all the variables: HP, SIXTY, QUARTER, and ORIGIN and resulted in the following (Eviews Regression: Appendix 1)

In the form: $\mathbf{Y = \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3 + \beta_4 X_4}$:

**(1) Price = 449.028HP – 578.033SIXTY – 5188.322QUARTER + 6660.207ORIGIN**

Most of equation (1) makes logical and intuitive sense. High horse power, low 0-60, and low quarter miles times tend to yield a higher price. The base price is $\beta_1$ times $X_1$ and $\beta_4$ times $X_4$. Logically lower zero to sixty and lower quarter mile times should result in a higher price. - $\beta_2$ times $X_2$ and -$\beta_{3t}$ times $X_3$ reflect this intuition. My R-Squared statistic is about .6, which is not great, yet not horrible either. I think it is about right for this data. The data had no clear trend, as in the past few years, some very low priced, high performance sports sedans have come out of Germany and Japan. HP had high significance (.00 probability of being 0), QUARTER and ORIGIN, hand much lower significance of .15 and .32 respectively, and SIXTY had extremely low significance of .93. I attribute this to the volatility of zero to sixty times. These statistics can be largely affected by driver skill, weather conditions and altitude. QUARTER statistics are affected by these conditions also, but to a lesser extent. I decided to remove SIXTY and re-regress the data (Eviews Regression: Appendix 1B):

**(2) Price = 451.499HP – 5478.89QUARTER + 6637.738ORIGIN**

Equation (2) also makes a lot of intuitive sense. With these changes my R-Squared fit didn't change much, still hovering about .6. Significance for HP and QUARTER went up and the resulting probability of .00. ORIGIN significant level stayed about the same at about .31. After more in-depth thought and debate I concluded that the t-test, while in most cases a wonderful tool, does not tell us whether or not to leave the variable in. It merely gives us an idea of whether or not it maybe statistically significant. The only real advantage to removing the variable is increasing efficiency. I would rather sacrifice a little efficiency then risk the chance of having biases Betas. I decided to leave it in when evaluating the model.

**The Results:**

I choose 3 cars at random from the 2005 model year to test the model. The cars chosen where the German built 2005 M3 from BMW, the 2005 Italian built Gallardo from Lamborghini, and the 2005 German built Porsche 911 GT3. I have summed up a table of results below (Calculations Appendix 2A):

| Automobile | Actual Price | Modeled Price | Difference | %Difference |
|---|---|---|---|---|
| 2005 BMW M3 | $ 55,600.00 | $ 90,606.00 | $41,606.00 | 43% |
| 2005 Lamborghini Gallardo | $ 190,000.00 | $ 187,332.00 | $ 2,668.00 | 1% |
| 2005 Porsche 1991 GT3 | $ 100,900.00 | $ 114,536.00 | $13,636.00 | 12% |

We can see that the model predicted the price of the Lamborghini almost exactly, the price of the Porsche fairly close, and the price of the BMW was way off. Both the Lamborghini and the Porsche are considered super sports cars and have very low 0-60 and quarter mile times. The M3 is a sedan, but performs spectacularly well. It is said to be the misnomer of the sports car club. Numerous very high performing, yet low priced sports cars have been appearing in the market in last few years. They are few, and do not follow the general pricing trends that most of the other sports cars do. I suspect the model, being based purely on performance doesn't entirely capture this recent innovation in this new category of superior engine design and relatively low cost. I suspect that sports cars from Japan in this category like the Subaru STi and the Lancer Evolution RS would also be extremely over priced by the model as well (Appendix 2B):

| Automobile | Actual Price | Modeled Price | Difference | %Difference |
|---|---|---|---|---|
| 2005 Subaru WRX STi | $ 34,900.00 | $ 69,647.00 | $34,747.00 | 49% |
| 2005 Mitsubishi Lancer RS | $ 26,435.00 | $ 56,279.00 | $29,844.00 | 53% |

The model confirms my suspicion. The model predicts very well for vast majority of the more expensive super sports cars. These cars make up majority of the data and show the general trend: high hp, low 0-60, low quarter mile times, and high MSRP prices. The model is much weaker when predicting these lower priced sports cars with relative high performance numbers.

**Conclusions:**

When all is said and done, I am fairly confident that his model can predict the prices of sports car relatively well. It seems to do very well model high priced super sports cars, but fails to accurately model the newly emerging cars with high performance numbers and relatively low pricing. If I where to remodel this project, I would add a variable, that coded 1 for two wheel drive and 0 for all wheel drive. This would even out the performance statistics as well as price. All wheel drive tends to decrease zero to sixty times vastly, decrease quarter miles times slightly and add a hefty price hike to the cars MSRP price. I think this would give better results for the lower priced, but high performing cars like the Subaru WRX STi, the Mitsubishi Evo Lancer RS, and the BMW M3 since two the three are all wheel drive.

## Appendix 1A: (Eviews Regression, All Variables)

Dependent Variable: PRICE
Method: Least Squares
Date: 11/09/04 Time: 12:52
Sample: 1 71
Included observations: 70

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| HP | 449.0283 | 72.44200 | 6.198453 | 0.0000 |
| SIXTY | -578.0338 | 6692.473 | -0.086371 | 0.9314 |
| QUARTER | -5188.322 | 3566.233 | -1.454847 | 0.1505 |
| ORIGIN | 6660.207 | 6661.310 | 0.999835 | 0.3210 |

| | | | |
|---|---|---|---|
| R-squared | 0.563312 | Mean dependent var | 75388.21 |
| Adjusted R-squared | 0.543463 | S.D. dependent var | 93158.87 |
| S.E. of regression | 62945.16 | Akaike info criterion | 24.99336 |
| Sum squared resid | 2.61E+11 | Schwarz criterion | 25.12185 |
| Log likelihood | -870.7676 | Durbin-Watson stat | 1.625664 |

## Appendix 1A: (Eviews Regression, Excluding SIXTY)

Dependent Variable: PRICE
Method: Least Squares
Date: 11/09/04 Time: 13:21
Sample: 1 71
Included observations: 70

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| HP | 451.4995 | 66.05805 | 6.834889 | 0.0000 |
| QUARTER | -5478.897 | 1174.264 | -4.665815 | 0.0000 |
| ORIGINORG | 6637.738 | 6606.741 | 1.004692 | 0.3187 |

| | | | |
|---|---|---|---|
| R-squared | 0.563263 | Mean dependent var | 75388.21 |
| Adjusted R-squared | 0.550226 | S.D. dependent var | 93158.87 |

| | | | |
|---|---|---|---|
| S.E. of regression | 62477.19 | Akaike info criterion | 24.96490 |
| Sum squared resid | 2.62E+11 | Schwarz criterion | 25.06127 |
| Log likelihood | -870.7716 | Durbin-Watson stat | 1.628665 |

## Appendix 2A:

| Year | Make | Model | Price:MSRP | HP | 0-60 | 1/4 Mile | CO |
|---|---|---|---|---|---|---|---|
| 2004 | BMW | M3 | 55600 | 333 | 4.7 | 13.4 | Germany (2) |
| 2004 | Lamborghini | Gallardo | 187959 | 493 | 4.3 | 12.5 | Italy (6) |
| 2004 | Porsche | 911 GT3 | 99900 | 380 | 4.3 | 12.9 | Germany (2) |

$PRICE_{BMW}$ \$90,606.00 = 449.028(333) – 578.033(4.7) – 5188.322(13.4) + 6660.207(2)

$PRICE_{LAMBO}$ \$187,332.00 = 449.028(493) – 578.033(4.3) – 5188.322(12.5) + 6660.207(6)

$PRICE_{PORSCHE}$ \$114,536.00 = 449.028(380) – 578.033(4.3) – 5188.322(12.9) + 6660.207(2)

## Appendix 2B:

| Year | Make | Model | Price:MSRP | HP | 0-60 | 1/4 Mile | CO |
|---|---|---|---|---|---|---|---|
| 2004 | Subaru | Impreza WRXSTi | 33698 | 300 | 4.7 | 13.3 | Japan (1) |
| 2004 | Mitsubishi | Lancer Evo RS | 27095 | 271 | 4.4 | 13.2 | Japan (1) |

$PRICE_{SUBARU}$ \$69,647.00 = 449.028(300) – 578.033(4.7) – 5188.322(13.3) + 6660.207(1)

$PRICE_{MITSU}$ \$56,279.00 = 449.028(271) – 578.033(4.4) – 5188.322(13.2) + 6660.207(1)