Analysis of the Effects of Deregulation on Intrastate Trucking Prices in Florida

Jesus Donate

STAT 510: Linear Regression and Analysis

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Abstract

This report analyzes the effect of Florida's 1980 intrastate trucking deregulation on shipping prices using shipment data from before and after deregulation. Two regression models were created to address the impact of deregulation on prices. Model 1 included all predictors and indicated a 63.4% price decrease following deregulation, while explaining 85.30% of price variation. Diagnostics revealed a nonlinear relationship between distance and price, leading to Model 2, which incorporated a quadratic distance term and removed non-significant predictors. Model 2 improved explanatory power (R^2=0.9137) and estimated a 62.4% price reduction due to deregulation. It is shown that both models satisfied regression assumptions. The results provide strong evidence that deregulation significantly lowered trucking prices in Florida and offer an accurate regression model for predicting future shipping costs in a post-regulatory environment.

Introduction

The trucking industry has been the backbone of the U.S. supply chain since the inception of interstate highways, delivering commodities all across the country. Before the 1980s, intrastate trucking in many states operated under strict regulatory policies. Those regulatory policies give state officials the authority to set entry restrictions (carriers had to be given the authority to transport a commodity on a specific route), set freight rates, and determine the types of goods that can be transported. These policies made the process of getting approval for new routes or new rate changes slow and cumbersome, which stifled innovation and competition. In July 1980, Florida became the first state to pass a deregulation policy, which allowed carriers to set their own prices based on market conditions. This regularization provides a unique case study to examine how regulatory changes affect transportation pricing.

The objectives of this report are the following: first, to assess the impact of deregulation on the prices charged for motor transport services in Florida, and second, to develop a regression model that gives reliable predictions of prices for future forecasting. Using shipment observations from both before and after deregulation, this report applies multiple regression analysis to make inferences on the effects of deregulation while at the same time creating a practical model for predicting shipping costs.

Methods

I. Data Description/Preparation

The analysis is based on a dataset that contains 134 observations collected from a population of more than 27,000 intrastate trucking shipments in Florida. Data were collected before and after Florida's deregulation policy took effect on July 1, 1980, from a single major carrier operating out of Jacksonville (JAX) and Miami (MIA). The dataset does not contain any missing values for any variable in any observation.

Each observation consists of 10 variables:

Variable	Type	Description
Distance	Quantitative	Miles traveled (in hundreds)
WEIGHT	Quantitative	Weight of product shipped (in 1,000 pounds)
PCTLOAD	Quantitative	Percent of truck load capacity (0-100%)
PRODUCT	Categorical	Product classification (100, 150, 200), reflecting value-to-weight ratio
ORIGIN	Categorical	City of origin (JAX or MIA)
MARKET	Categorical	Destination market size (LARGE or SMALL)
DEREG	Categorical	Deregulation indicator (YES or NO)
PRICPTM	Quantitative	Price per ton-mile (in 1980 USD)
CARRIER	Categorical	Carrier identifier
LNPRICE	Quantititiative	Natural log of price per ton-mile (in 1980)

Note: Two variables were excluded from the report:

- PRICPTM was omitted because the dependent variable LNPRICE is its natural logarithm. Including both would introduce redundancy and potential multicollinearity.
- CARRIER was removed because it contains only one level ("B") within all observations, providing no useful information for modeling.

There are 67 samples that were taken during the regulation period and another 67 samples that were taken in the deregulation period, creating a balanced set of samples from both periods. To prepare the qualitative variables for regression analysis, each was converted into indicator variables. DEREG, ORIGIN, and MARKET consist of binary categories, and therefore can be simply converted into one indicator variable. However, the PRODUCT variable, which has three levels (100, 150, 200), required two indicator variables. Using PRODUCT = 100 as the base category, indicator variables were created for PRODUCT = 150 and PRODUCT = 200.

Categorical variables will be encoded into the following:

- DEREG: 1 = YES (post-deregulation), 0 = NO (pre-deregulation)
- ORIGIN: 1 = MIA, 0 = JAX
- MARKET: 1 = LARGE, 0 = SMALL
- PRODUCT: Consists of two indicator variables (the original PRODUCT predictor is dropped):
    - PRODUCT_150 = 1 if PRODUCT = 150, otherwise 0
    - PRODUCT_200 = 1 if PRODUCT = 200, otherwise 0
    - If PRODUCT = 100, this becomes our base level. β_1 = mean for the base level

II. Key Inferences

One of the core objectives in this report is to assess the impact of deregulation on trucking prices. To make a formal statistical inference about this impact, it is critical to look at the regression coefficient of the DEREG variable (β_{DEREG}) in our regression model. The interpretation of the regression coefficient $\beta_{DEREG} = \mu_{Regulated} - \mu_{Deregulated}$ is the estimated difference in the mean of LNPRICE between the deregulated and regulated periods, holding all other variables in the model constant. The following hypothesis tests can be done to determine if there is any significant difference between the deregulated and regulated periods on LNPRICE.

(Hypo. Test 1)

$$H_0 : \beta_{DEREG} = 0$$
$$H_A : \beta_{DEREG} \neq 0$$

Failing to reject H_0 statistically implies that deregulation had no effect on the price per ton-mile, holding other variables constant. If H_0 is rejected, then deregulation had a statistically significant effect on the price per ton-mile. If H_0 was rejected, looking at β_{DEREG} can indicate the difference between the two periods. Since the dependent variable is the natural log of price, a significant β_{DEREG} will be interpreted as an approximate percentage change in price. The decision rule will be H_0 is rejected if the p-value associated with β_{DEREG} is less than the significance level $\alpha = 0.05$. Else, H_0 has not been rejected.

While Hypo. Test 1 is a significantly important test to investigate, it is also important to report significance tests (t-test) for all other predictors coefficients in order to understand their roles in predicting future prices. For the model comparison step, the model comparison F-test will be used to determine whether adding new predictors to the reduced (previous) model will provide significant explanatory power beyond the reduced model.

III. Model Diagnostics and Assumptions

After fitting our regression models, it is important to assess the assumptions of Ordinary Least Squares (OLS) by checking linearity in parameters, independence, normality, homoscedasticity (equal variance), multicollinearity, and the existence of outliers or influential points.

- The linearity assumption for each quantitative predictor can be assessed by examining residual-by-regressor plots. A random scatter of points around zero will support the assumption of linearity. If a systemic pattern (such as a U-shape trend) appears in the plot, this can be an indication that there is a potential violation in linearity. This, at times, can be fixed by introducing a non-linear relation to the model, such as a quadratic term.
- For the trucking dataset, the 134 shipments were randomly selected from a large population, and the sample data are cross-sectional (meaning each observation represents a distinct shipment at a specific point). Therefore, it is safe to assume that the errors ϵ_i are independently distributed.
- The normality of errors will be evaluated using a normal Q-Q plot of the studentized residuals. If the residuals are normally distributed, then the points will follow closely to the diagonal line. If there is a deviation from the diagonal line, this shows that there is a loss of normality.
- Homoscedasticity can be examined using residuals vs the fitted values. A random scatter plot with no pattern supports the assumption that the variance of the errors is constant across all levels of fitted values. If heteroscedasticity is detected, we can transform the response LNPRICE to a more appropriate response. This is a trial-and-error approach.
- To detect multicollinearity, the Variance Inflation Factor (VIF) can be used for each predictor after fitting the model. A VIF greater than 10 is a common cutoff for indicating that there might be a problematic multicollinearity. We can also check if there are any contradictions where the overall model F-test is significant while all the individual t-tests are not significant. This is a symptom of multicollinearity.
    - Note that WEIGHT and PCTLOAD are highly correlated (look at Table Correlation Matrix 1). Having these variables together can cause multicollinearity problems.
- Outliers can be detected using studentized deleted residuals (RStudent), t_i. If $\left|t_i\right| > t(1 - \frac{\alpha}{2n};\ n - p - 1)$ where n = # of observations and p = # of parameters in model, then the *i*th observation can be identified as a possible outlier.
- For this report, influential points will be identified using two metrics: Cook's distance and DFBETAS.
    - Using DFBETAS will help identify any observations that unduly influence our primary estimate of the deregulation effect. Since the DEREG coefficient is the most important in our model, it is important to identify any observation that could meaningfully affect this key parameter. An observation will be considered potentially influential if:

$$\left|DFBETAS_{DEREG}\right| > \frac{2}{\sqrt{n}}, \text{ where n = \# of samples}$$

$$\text{Hence, } \left|DFBETAS_{DEREG}\right| > 0.1728$$

Results

I. Model 1: First-Order Multi-linear Regression

The first model to be fitted consists of all predictors from the dataset. Let Y be the values of LNPRICE, X_{DIST} be the values for DISTANCE, X_{PRO150} be the values for PRODUCT_150, and X_{PRO200} be the values for PRODUCT_200.

(Model 1)

$$E(Y) = \beta_0 + \beta_{DIST}X_{DIST} + \beta_{WEIGHT}X_{WEIGHT} + \beta_{PCTLOAD}X_{PCTLOAD} + \beta_{DEREG}X_{DEREG} + \beta_{ORIGIN}X_{ORIGIN} + \beta_{MARKET}X_{MARKET} + \beta_{PRO150}X_{PRO150} + \beta_{PRO200}X_{PRO200}$$

Inferences:

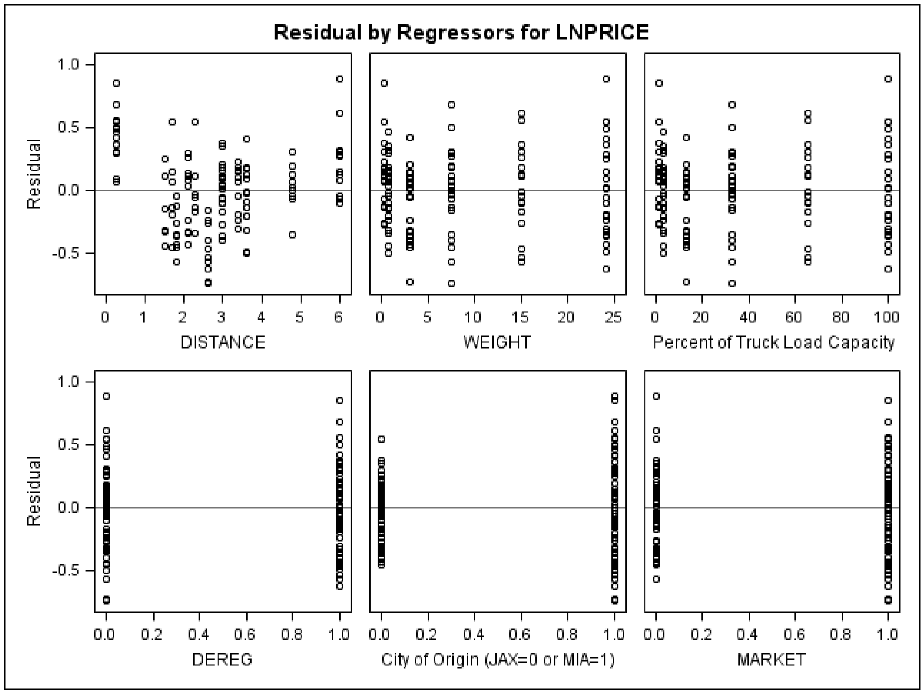
The output produced after fitting Model 1 is located at Table TA1. Overall, Model 1 was highly significant (p-value < .0001). This means that at least one predictor within model 1 significantly contributes to explain the variation of our response variable, LNPRICE. Looking at the coefficient of multiple determination, $R^2 = 0.8530$, we can say that model 1 explains 85.30% of the variability of the response variable, indicating a strong fit. Our adjusted R^2, $R_a^{\ 2} = 0.8436$, also suggests a strong fit, even after penalizing the number of predictors within the model.

Looking at the β_{DEREG} estimate, we see $b_{DEREG} =- 1.005$ and the p-value is less than .0001, so we have significant evidence that the DEREG variable contributes significantly to the response LNPRICE. The estimated coefficient is -1.005, which means that the deregulation period was $e^{-1.005} \approx 0.366$ times the prices per ton-mile before deregulation. This means that there was a 63.4% decrease in price per ton-mile during the deregulation period, holding distance, weight, capacity, origin, market, and product type constant.

Other significant predictors include DISTANCE, ORIGIN, and PRODUCT_150 / PRODUCT_200, all having a p-value of less than 0.05. We interpret the coefficients as follows: (DISTANCE) For each additional hundred mile, LNPRICE decreases by $(1 - e^{-.305}) * 100\% \approx 26.9\%$, holding all other variables constant. (ORIGIN) For shipments originating from Miami are $(e^{.305} - 1) * 100\% \approx 35.7\%$ higher in price than those from Jacksonville. (PRODUCT) The estimated coefficient for $b_{PRO150} = 0.189$ indicates PRODUCTS with the value 150 are $(e^{.189} - 1) * 100\% \approx 20.8\%$ more expensive than PRODUCTS that are of value 100. The estimated coefficient for $b_{PRO200} = 0.256$ indicates PRODUCTS with the value 200 are $(e^{.256} - 1) * 100\% \approx 29.2\%$ more expensive than PRODUCTS that are of value 100.

For the non-significant variables, we can create another model that omits the non-significant variables from the model and compare the reduced model with the original full model. Before creating the next model, it is important to check that assumptions of our model are held true.

Assumptions and Diagnostics:



Looking at our residual by regressor plots (figure on the right), most plots appear to be randomly scattered around 0. However, for Residuals vs. DISTANCE, we see some signs of non-linearity. The plot has a pattern that resembles a quadratic function. For the second model, it would be of interest to add a quadratic term to the DISTANCE variable and analyze its results. Another assumption to verify is normality. This can be done using Graphs G1.1. There is also a strong indication of normality in our model since the QQ-plot (in the output plot is called Residual Quantile plot) has points close to the diagonal line. Checking for homoscedasticity can be done by looking at the residual vs. predicted value plot on in Graphs G1.1. There is no pattern around the 0 line, which supports the assumption that the variance of the errors is constant across all levels of fitted values. In Tables TA1, variables WEIGHT and PCTLOAD are highly correlated, based on VIF. Therefore, these two predictors can be creating a multicollinearity problem. To fix this issue, we can simply drop one of the two predictors. For model 2, we will use the PCTLOAD as one of the independent variables.

Using software to look for outliers and influential observations, it was found that there are not outliers for the model, that is no absolute RStudent value was greater than $t(1 - \frac{0.05}{2(134)}; 134 - 8 - 1) \approx 3.58$. However, there are several observations that are considered influential using Cook's distance. For simplicity, if the observations' $Cook's\ D > 4/n = 0.032$, then that observation is potentially influential. Graphs G1.2 provide a snippet of some observations that are considered influential and the SAS Code in Appendix gives us 6 potential influential points (2, 3, 21, 25, 116, 117). For DFBETAS, the DEREG coefficient is the coefficient of interest, as stated in Model Diagnostics and Assumptions subsection. We identify observations that are influential to β_{DEREG} if $\left|DFBETAS_{DEREG}\right| > 0.1728$ is true. In Tables DFBETAS 1, observation 2 is potentially influential since 0.1773 > 0.1728. Looking into all observations, we find that observations 2, 93, 94, 96, and 117 are influential to β_{DEREG}.

II. Model 2: Second-Order Reduced Multi-linear Regression

The second regression model being introduced has a quadratic term for DISTANCE predictor and has omitted WEIGHT and MARKET predictors. DISTANCE was centered ($DISTANCE - \overline{DISTANCE}$) and multiplied by itself to get DISTANCE2. This was done to reduce correlation between DISTANCE and DISTANCE2 as shown in Table Correlation Matrix 2.

(Model 2)

$$E(Y) = \beta_0 + \beta_{DIST}X_{DIST} + \beta_{DIST2}X^2_{DIST2} + \beta_{PCTLOAD}X_{PCTLOAD} + \beta_{DEREG}X_{DEREG} + \beta_{ORIGIN}X_{ORIGIN} + \beta_{PRO150}X_{PRO150} + \beta_{PRO200}X_{PRO200}$$

Inferences:

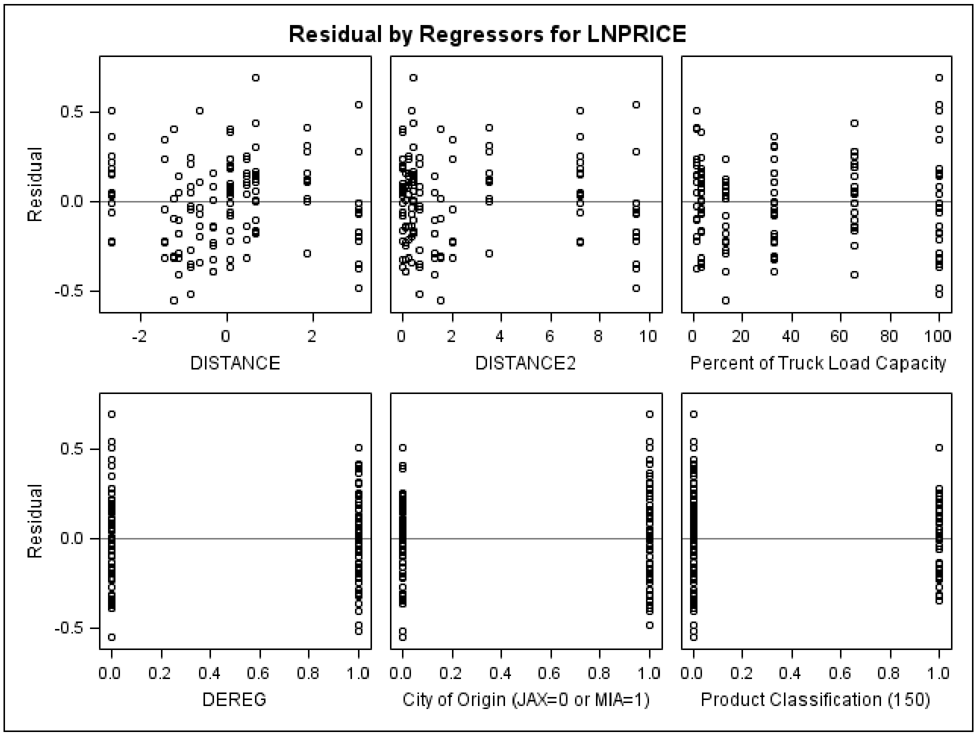
The output produced after fitting Model 2 is located at Table TA2. Once again, Model 2 was highly significant (p-value < .0001) in predicting LNPRICE. This indicates that the set of all predictors collectively explain the variation of our response variable, LNPRICE. Looking at the coefficient of multiple determination, $R^2 = 0.9137$, we can say that model 2 explains 91.37% of the variability of the response variable, indicating a strong fit. Our adjusted R^2, $R_a^2 = 0.9089$, also suggests a strong fit, even after penalizing the number of predictors within the model. It is important to note that model 2 explains the variability of LNPRICE better than model 1. Specifically, there is a $R^2_{model\,2} - R^2_{model\,1} = 0.0607$ difference between both models, and thus model 2 explains 6.07% more of the variability for LNPRICE compared to model 1.

The β_{DEREG} estimate, b_{DEREG}, is equal to -0.979 and its p-value is less than .0001. Again, we have significant evidence that the DEREG variable contributes significantly to the response LNPRICE at significant level 0.05. The estimated coefficient is -0.979, which means that the deregulation period was $e^{-0.979} \approx 0.376$ times the prices per ton-mile before deregulation. This means that there was a 62.4% decrease in price per ton-mile during the deregulation period, holding distance, capacity, origin, and product type constant. Model 2 had a 63.4% decrease in price per ton-mile. Both models have similar substantive effects. Therefore, it is likely that the true impact deregulation had on price per ton-mile is a substantial reduction of approximately 62–63%. The consistency of b_{DEREG} across both significant models provides strong evidence that deregulation led to dramatically lower shipping prices in Florida.

Other significant predictors, those having a p-value of less than 0.05, include DISTANCE, ORIGIN, PCTLOAD, and PRODUCT_150 / PRODUCT_200. For model 2, PCTLOAD has become a significant predictor which contributes to the prediction of LNPRICE. Since WEIGHT was removed from model 2, the multicollinearity issue was resolved and PCTLOAD has now become a significant predictor.

Note that ORIGIN became insignificant when fitted to model 2. This could be due to added DISTANCE2 to the model. DISTANCE2 could now properly capture the relationship between distance and price that was previously being partially attributed to ORIGIN. Further analysis would be required to make this conclusion.

Assumptions and Diagnostics:



Looking at our residual by regressor plots (figure on the right), all plots appear to be randomly scattered around 0. Notice that DISTANCE no longer has a U-shaped pattern compared to its residual by regressor plot for model 1. This is an indication that the quadratic term helped explain the variation better compared to the original linear function. Another assumption to verify is normality. This can be done using Graphs G2.1. Since the point within the QQ-plot lands close to the diagonal line, this is a strong indicator that our residuals are normally distributed along the regression model. Checking for homoscedasticity can be done by looking at the residual vs. predicted value plot in Graphs G2.1. There is no pattern around the 0 line, which supports the assumption that the variance of the errors is constant across all levels of fitted values. In Tables TA2, there are no variables that have a VIF greater than 10. Therefore, there is very little evidence of a problematic multicollinearity.

Using software to look for outliers and influential observations, it was found that there are not outliers for the model, that is no absolute RStudent value was greater than $t(1 - \frac{0.05}{2(134)}; 134 - 7 - 1) \approx 3.58$. However, there are several observations that are considered influential using Cook's distance. Once again, for simplicity, if the observations' $Cook's\ D > 4/n = 0.032$, then that observation is potentially influential. Graphs G2.2 provide a snippet of some observations that are considered influential and Tables Cook's 2 gives us 7 potential influential points (21, 53, 67, 76, 112, 117, 132). For DFBETAS, the DEREG coefficient is the coefficient of interest, as stated in Model Diagnostics and Assumptions subsection. We identify observations that are influential to β_{DEREG} if $\left|DFBETAS_{DEREG}\right| > 0.1728$ is true. In Tables DFBETAS 2, observation 10 is potentially influential since 0.1767 > 0.1728. Looking into all observations from the output of SAS Code, we find that observations 10, 53, 67, 82, 111, 112, 117, and 132 are influential to β_{DEREG}.

Conclusions

This analysis examined the impact of Florida's 1980 intrastate trucking deregulation on shipping prices using shipments from before and after deregulation as observations. Though this report only contains two models (due to time constraints), these models nevertheless provide meaningful and statistically supported insights into the research questions. The first model establishes a baseline for understanding how the predictors can be used to predict LNPRIICE and find flaws that will be resolved with improved models. The second model was created from the insights from the first model. Omitting predictors that had no significant effect in predicting the response and introducing a quadratic term for DISTANCE improved the explanatory power.

Both regression models provide significant evidence that deregulation led to a substantial reduction in shipping prices. Holding all predictors constant, such as distance, load capacity, and product type, the estimated effect of deregulation, $\widehat{\beta}_{DEREG} = b_{DEREG}$, was a price decrease of around 63% in Model 1 and 62% in Model 2. This finding strongly supports the conclusion that the removal of regulatory price controls resulted in markedly lower per-ton-mile costs for intrastate trucking in Florida.

This report has also created a regression model (model 2) that explains 91.37% of the variation in LNPRICE and which also meets all the regression assumptions. This model can be used for forecasting shipping costs in Florida's deregulated market. There can be models that capture the variation better with the use of interaction terms, but for this report's purpose, this model is effective enough.

Appendix

Table Correlation Matrix 1:

Pearson Correlation Coefficients, N = 134 Prob > |r| under H0: Rho=0	DISTANCE	WEIGHT	PCTLOAD	LNPRICE	DEREG	ORIGIN	MARKET	PRODUCT_150	PRODUCT_200
DISTANCE Distance Traveled (hundreds of miles)	1.00000	0.06964 0.4240	0.06798 0.4351	-0.54490 <.0001	-0.05898 0.4984	0.08887 0.3072	-0.21937 0.0109	-0.00796 0.9272	0.04980 0.5677
WEIGHT Weight of Shipment (thousands of pounds)	0.06964 0.4240	1.00000	0.99967 <.0001	-0.44407 <.0001	-0.05374 0.5374	0.01301 0.8814	0.04699 0.5897	-0.09624 0.2687	0.02016 0.8172
PCTLOAD Percent of Truck Load Capacity	0.06798 0.4351	0.99967 <.0001	1.00000	-0.44217 <.0001	-0.05414 0.5344	0.01484 0.8649	0.04656 0.5932	-0.09461 0.2769	0.02072 0.8122
LNPRICE Natural Log of Price per Ton-Mile	-0.54490 <.0001	-0.44407 <.0001	-0.44217 <.0001	1.00000	-0.52605 <.0001	0.07303 0.4017	0.09755 0.2621	0.07704 0.3763	0.02638 0.7622
DEREG Deregulation in Effect (YES=1 or NO=0)	-0.05898 0.4984	-0.05374 0.5374	-0.05414 0.5344	-0.52605 <.0001	1.00000	0.10466 0.2288	0.03012 0.7297	0.03262 0.7083	0.04611 0.5968
ORIGIN City of Origin (JAX=0 or MIA=1)	0.08887 0.3072	0.01301 0.8814	0.01484 0.8649	0.07303 0.4017	0.10466 0.2288	1.00000	0.08243 0.3437	0.12436 0.1522	-0.03148 0.7180
MARKET Destination Market Size (LARGE=1 or SMALL=0)	-0.21937 0.0109	0.04699 0.5897	0.04656 0.5932	0.09755 0.2621	0.03012 0.7297	0.08243 0.3437	1.00000	0.04323 0.6199	-0.05973 0.4930
PRODUCT_150 Product Classification (150)	-0.00796 0.9272	-0.09624 0.2687	-0.09461 0.2769	0.07704 0.3763	0.03262 0.7083	0.12436 0.1522	0.04323 0.6199	1.00000	-0.51134 <.0001
PRODUCT_200 Product Classification (200)	0.04980 0.5677	0.02016 0.8172	0.02072 0.8122	0.02638 0.7622	0.04611 0.5968	-0.03148 0.7180	-0.05973 0.4930	-0.51134 <.0001	1.00000

Table Correlation Matrix 2:

Pearson Correlation Coefficients, N = 134 Prob > |r| under H0: Rho=0	DISTANCE	DISTANCE2
DISTANCE	1.00000	0.23687 0.0059
DISTANCE2	0.23687 0.0059	1.00000

Tables TA1:

First Model

The REG Procedure
Model: MODEL1
Dependent Variable: LNPRICE Natural Log of Price per Ton-Mile

Number of Observations Read	134
Number of Observations Used	134

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	76.79237	9.59905	90.66	<.0001
Error	125	13.23477	0.10588		
Corrected Total	133	90.02713			

Root MSE	0.32539	R-Square	0.8530
Dependent Mean	10.57621	Adj R-Sq	0.8436
Coeff Var	3.07661		

Parameter Estimates							
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	Intercept	1	12.02346	0.09613	125.08	<.0001	0
DISTANCE	Distance Traveled (hundreds of miles)	1	-0.30498	0.01896	-16.08	<.0001	1.08445
WEIGHT	Weight of Shipment (thousands of pounds)	1	-0.03523	0.12532	-0.28	0.7791	1545.31693
PCTLOAD	Percent of Truck Load Capacity	1	-0.00119	0.02992	-0.04	0.9685	1544.31317
DEREG	Deregulation in Effect (YES=1 or NO=0)	1	-1.00497	0.05692	-17.65	<.0001	1.02528
ORIGIN	City of Origin (JAX=0 or MIA=1)	1	0.30491	0.05781	5.27	<.0001	1.05350
MARKET	Destination Market Size (LARGE=1 or SMALL=0)	1	-0.00079598	0.05871	-0.01	0.9892	1.07099
PRODUCT_150	Product Classification (150)	1	0.18891	0.07278	2.60	0.0106	1.40359
PRODUCT_200	Product Classification (200)	1	0.25616	0.06791	3.77	0.0002	1.37600

Tables TA2:

Model 2

The REG Procedure
Model: MODEL1
Dependent Variable: LNPRICE Natural Log of Price per Ton-Mile

Number of Observations Read	134
Number of Observations Used	134

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	82.25931	11.75133	190.62	<.0001
Error	126	7.76782	0.06165		
Corrected Total	133	90.02713			

Root MSE	0.24829	R-Square	0.9137
Dependent Mean	10.57621	Adj R-Sq	0.9089
Coeff Var	2.34766		

Parameter Estimates							
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	Intercept	1	11.06862	0.05315	208.25	<.0001	0
DISTANCE		1	-0.33650	0.01442	-23.33	<.0001	1.07697
DISTANCE2		1	0.08036	0.00853	9.42	<.0001	1.63745
PCTLOAD	Percent of Truck Load Capacity	1	-0.00979	0.00058654	-16.70	<.0001	1.01907
DEREG	Deregulation in Effect (YES=1 or NO=0)	1	-0.97913	0.04350	-22.51	<.0001	1.02833
ORIGIN	City of Origin (JAX=0 or MIA=1)	1	0.00922	0.05392	0.17	0.8646	1.57435
PRODUCT_150	Product Classification (150)	1	0.20261	0.05535	3.66	0.0004	1.39433
PRODUCT_200	Product Classification (200)	1	0.31218	0.05200	6.00	<.0001	1.38550

Tables Cook's 1

Influential Points based on Cook's D for Model 1

cookd	obs_n
0.036733	2
0.036349	3
0.060237	21
0.037795	25
0.043630	116
0.092668	117

Tables Cook's 2

Influential Points based on Cook's D for Model 2

cookd	obs_n
0.052022	21
0.057609	53
0.038006	67
0.032603	76
0.084982	112
0.070489	117
0.033961	132

Tables DFBETAS 1

The REG Procedure
Model: MODEL1
Dependent Variable: LNPRICE Natural Log of Price per Ton-Mile

Output Statistics

						DFBETAS								
Obs	Residual	RStudent	Hat Diag H	Cov Ratio	DFFITS	Intercept	DISTANCE	WEIGHT	PCTLOAD	DEREG	ORIGIN	MARKET	PRODUCT_150	PRODUCT_200
1	-0.0212	-0.0667	0.0525	1.1341	-0.0157	0.0019	-0.0044	0.0046	-0.0046	-0.0062	-0.0046	-0.0054	0.0089	0.0086
2	0.6842	2.2084	0.0653	0.8127	0.5838	0.2080	-0.2981	-0.1173	0.1164	0.1773	0.2067	0.0783	-0.2837	-0.2641
3	0.5571	1.8132	0.0920	0.9355	0.5772	0.0914	-0.2421	-0.3040	0.3070	0.1614	0.1538	0.0642	-0.2390	-0.2292
4	0.3604	1.1662	0.0952	1.0769	0.3782	0.0949	-0.1914	0.1315	-0.1269	0.0983	0.1214	0.0214	-0.1167	-0.1228
5	-0.1612	-0.5063	0.0483	1.1088	-0.1141	-0.0038	-0.0033	0.0327	-0.0323	-0.0451	-0.0385	-0.0342	0.0665	0.0638
6	0.1162	0.3696	0.0728	1.1479	0.1035	0.0640	-0.0393	0.0205	-0.0213	0.0297	0.0420	-0.0494	-0.0469	-0.0463
7	0.3066	0.9784	0.0725	1.0815	0.2736	-0.0303	0.1337	0.0303	-0.0331	0.0899	0.0693	0.0977	-0.1326	-0.1270
8	0.1912	0.6065	0.0664	1.1212	0.1618	-0.0447	0.0845	-0.0463	0.0457	0.0599	0.0370	0.0600	-0.0827	-0.0814
9	0.1505	0.4863	0.1011	1.1756	0.1631	-0.0250	0.0704	0.0443	-0.0425	0.0536	0.0397	-0.0439	-0.0522	-0.0634
10	0.3720	1.1803	0.0589	1.0330	0.2953	0.1662	0.0074	0.0399	-0.0426	0.1244	-0.0958	-0.1101	-0.1275	-0.1472
11	0.3512	1.1128	0.0575	1.0430	0.2749	0.1527	0.0075	0.0265	-0.0289	0.1178	-0.0912	-0.1037	-0.1205	-0.1392
12	0.1990	0.6271	0.0538	1.1042	0.1496	0.0785	0.0044	-0.0013	0.0003	0.0675	-0.0528	-0.0586	-0.0676	-0.0789
13	0.1859	0.5864	0.0557	1.1103	0.1424	0.0575	0.0055	-0.0427	0.0425	0.0659	-0.0531	-0.0550	-0.0640	-0.0758
14	-0.1048	-0.3345	0.0803	1.1594	-0.0989	-0.0285	0.0057	-0.0307	0.0293	-0.0390	0.0277	0.0376	0.0269	0.0384
15	0.1423	0.4476	0.0520	1.1175	0.1048	0.0410	-0.0125	-0.0014	0.0006	0.0450	-0.0419	0.0331	-0.0486	-0.0518
16	-0.2002	-0.6386	0.0759	1.1293	-0.1830	-0.0326	0.0335	-0.0577	0.0553	-0.0696	0.0589	-0.0365	0.0517	0.0666
17	0.1171	0.3693	0.0566	1.1282	0.0904	0.0457	-0.0120	-0.0256	0.0255	0.0405	-0.0316	-0.0382	-0.0399	-0.0469
18	0.2982	0.9424	0.0551	1.0669	0.2276	0.0838	-0.0041	0.0196	-0.0218	0.0945	-0.0888	0.0755	-0.1033	-0.1095

Tables DFBETAS 2

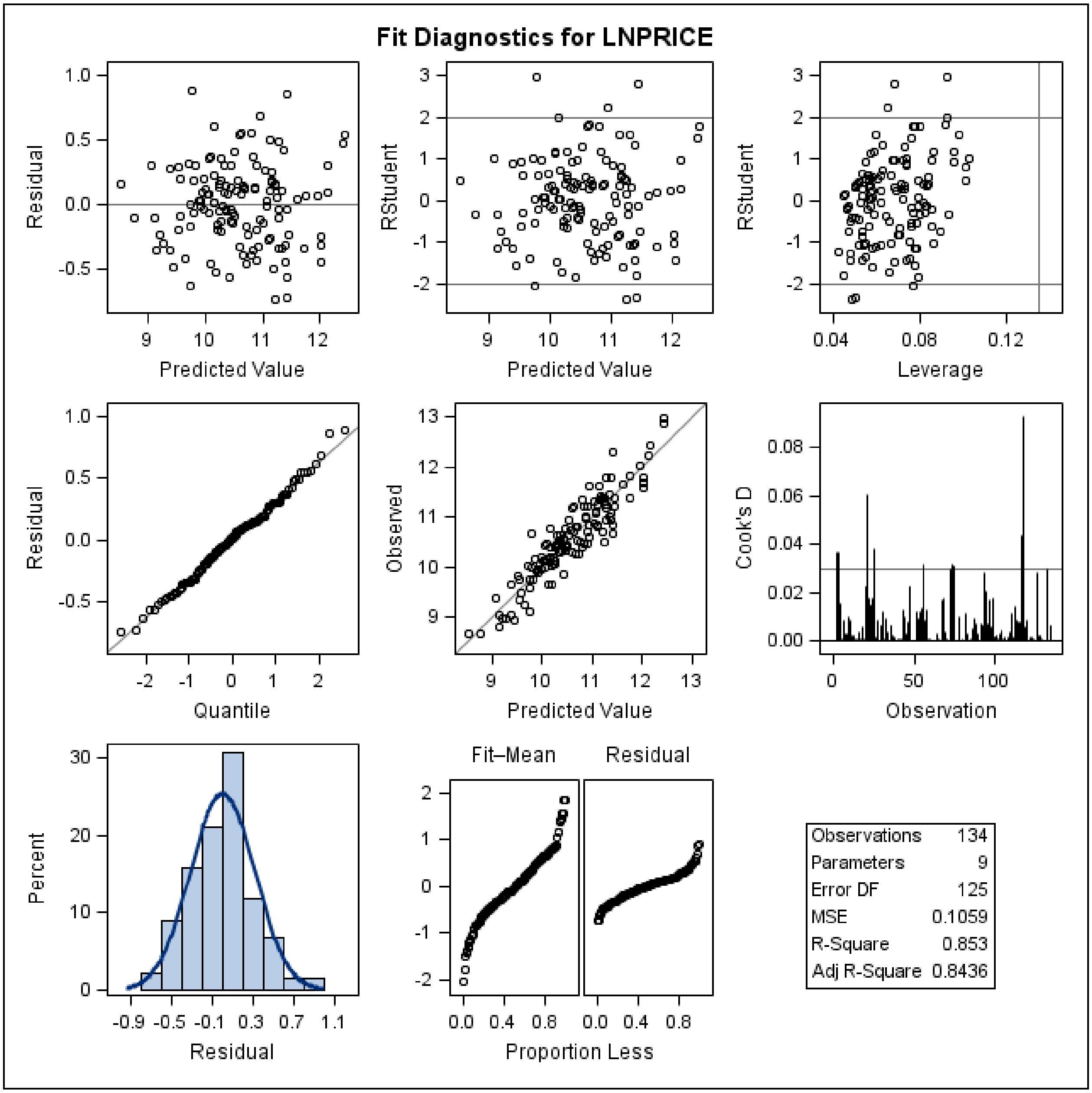
Model 2

The REG Procedure
Model: MODEL1
Dependent Variable: LNPRICE Natural Log of Price per Ton-Mile

Output Statistics

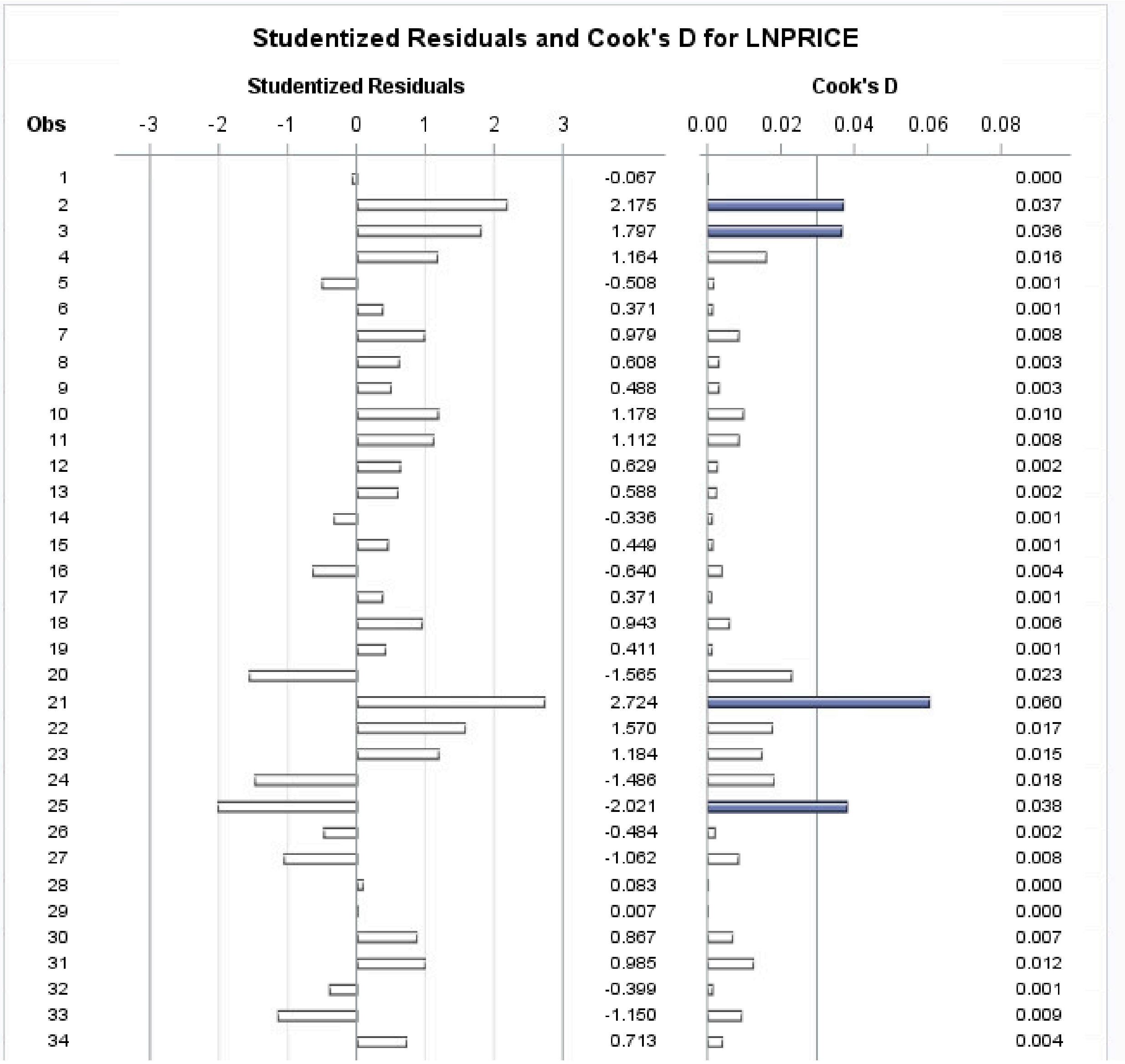
						DFBETAS							
Obs	Residual	RStudent	Hat Diag H	Cov Ratio	DFFITS	Intercept	DISTANCE	DISTANCE2	PCTLOAD	DEREG	ORIGIN	PRODUCT_150	PRODUCT_200
1	0.3103	1.2933	0.0614	1.0210	0.3307	0.1011	0.0982	-0.1859	-0.0253	0.1072	0.1958	-0.1692	-0.1858
2	0.3685	1.5561	0.0804	0.9941	0.4600	0.0449	-0.2825	0.2220	-0.0272	0.1379	-0.0003	-0.1895	-0.1584
3	0.2578	1.0854	0.0837	1.0791	0.3281	-0.0098	-0.2021	0.1520	0.0683	0.1003	-0.0003	-0.1238	-0.1082
4	0.0436	0.1843	0.1004	1.1822	0.0615	-0.0092	-0.0355	0.0255	0.0277	0.0179	-0.0001	-0.0197	-0.0181
5	0.1659	0.6877	0.0593	1.0993	0.1726	0.0509	0.0129	-0.0975	-0.0109	0.0542	0.1063	-0.0891	-0.0963
6	0.2380	0.9868	0.0568	1.0620	0.2421	0.0938	-0.0579	-0.0546	-0.0902	0.0753	0.1091	-0.1319	-0.1274
7	0.4155	1.7439	0.0644	0.9399	0.4576	0.1875	0.2223	-0.0866	-0.1819	0.1574	0.1620	-0.2403	-0.2440
8	0.3157	1.3117	0.0550	1.0110	0.3163	0.0930	0.1609	-0.0684	-0.0357	0.1224	0.1211	-0.1700	-0.1797
9	-0.1637	-0.6951	0.1042	1.1536	-0.2370	0.0189	-0.0982	-0.0963	-0.0894	-0.0842	0.0184	0.0789	0.0818
10	0.4095	1.7051	0.0502	0.9336	0.3919	0.2663	0.0581	-0.0298	-0.1587	0.1767	-0.1113	-0.1914	-0.2127
11	0.3901	1.6216	0.0493	0.9491	0.3691	0.2490	0.0548	-0.0286	-0.1422	0.1684	-0.1058	-0.1811	-0.2019
12	0.2421	0.9980	0.0459	1.0483	0.2188	0.1419	0.0324	-0.0184	-0.0640	0.1045	-0.0650	-0.1090	-0.1234
13	0.2392	0.9842	0.0422	1.0461	0.2066	0.1177	0.0294	-0.0198	-0.0164	0.1050	-0.0641	-0.1027	-0.1201
14	-0.0526	-0.2180	0.0624	1.1333	-0.0562	-0.0094	-0.0046	0.0057	-0.0322	-0.0251	0.0144	0.0195	0.0258
15	0.0222	0.0914	0.0494	1.1206	0.0208	0.0117	-0.0052	0.0048	-0.0057	0.0095	-0.0092	-0.0097	-0.0102
16	-0.3112	-1.3012	0.0668	1.0256	-0.3481	-0.0379	0.0899	-0.0590	-0.1955	-0.1494	0.1330	0.1125	0.1386
17	0.1167	0.4787	0.0414	1.0957	0.0995	0.0545	-0.0071	0.0015	-0.0071	0.0504	-0.0362	-0.0493	-0.0560
18	0.2528	1.0444	0.0489	1.0453	0.2367	0.1518	-0.0265	0.0196	-0.0895	0.1071	-0.0862	-0.1147	-0.1227

Graphs G1.1

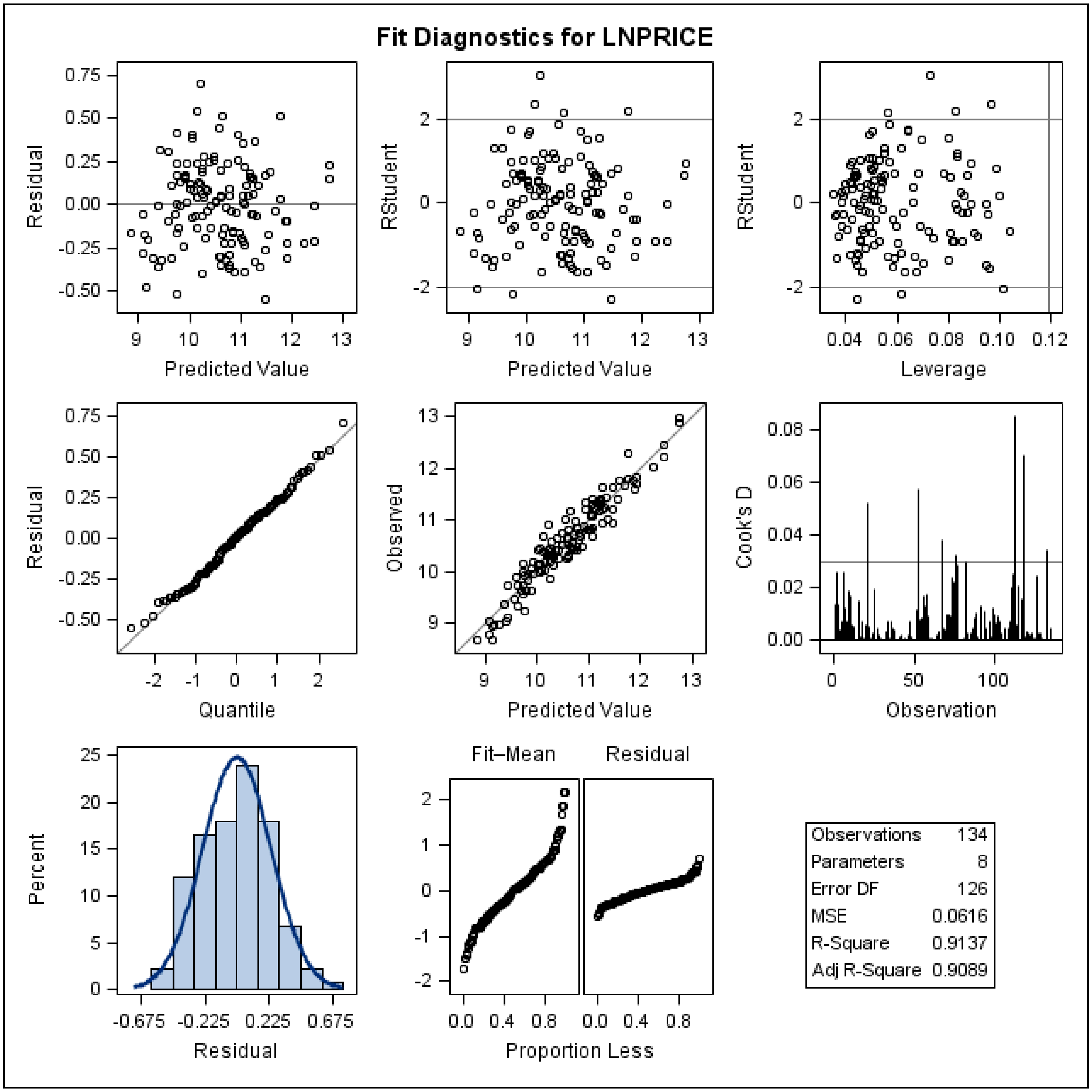


Fit Diagnostics for LNPRICE
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
Observed
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 134
Parameters 9
Error DF 125
MSE 0.1059
R-Square 0.853
Adj R-Square 0.8436

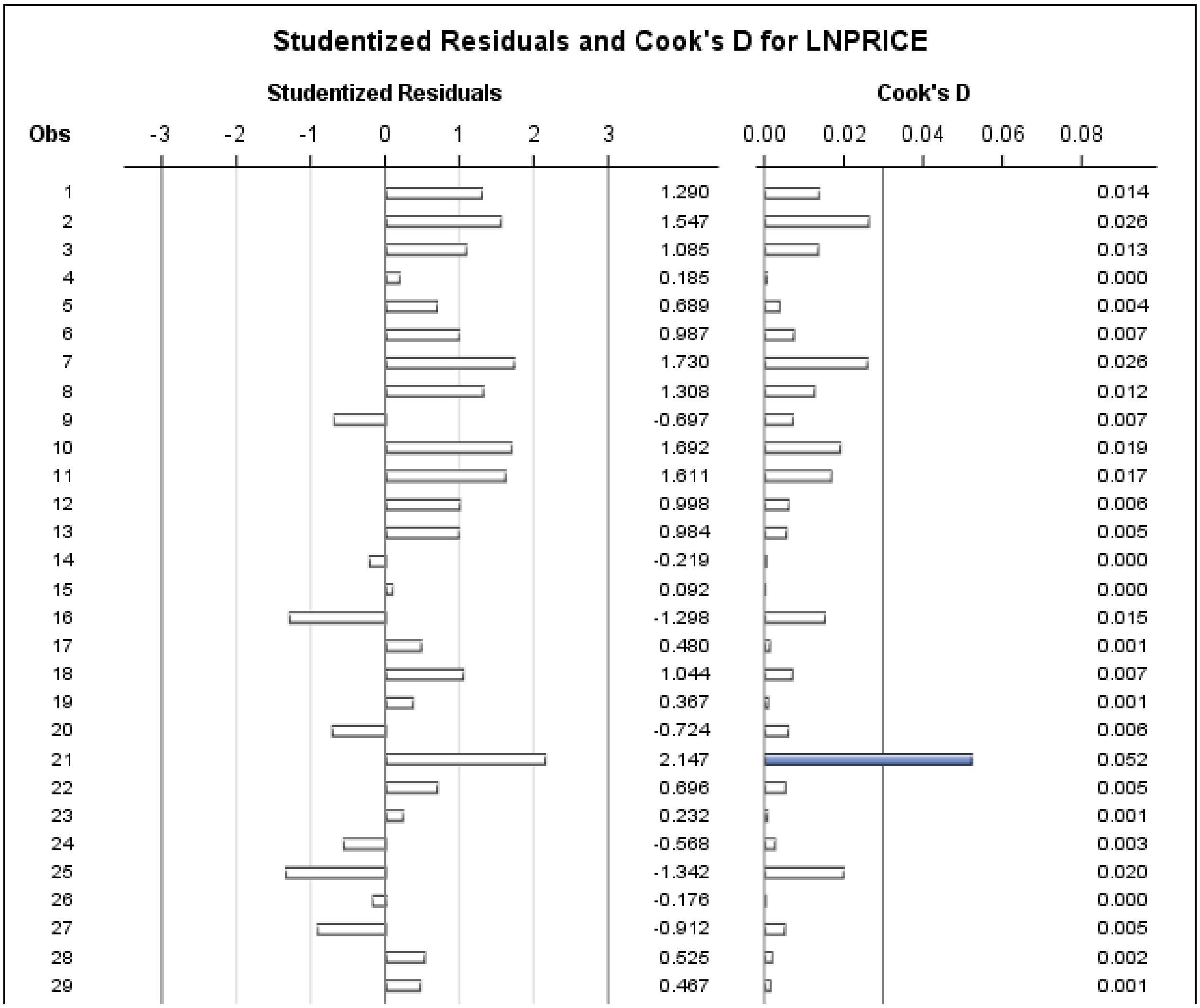
Graphs G1.2


Studentized Residuals and Cook's D for LNPRICE
Studentized Residuals
Cook's D
Obs
-3 -2 -1 0 1 2 3
0.00 0.02 0.04 0.06 0.08
1 -0.067 0.000
2 2.175 0.037
3 1.797 0.036
4 1.164 0.016
5 -0.508 0.001
6 0.371 0.001
7 0.979 0.008
8 0.608 0.003
9 0.488 0.003
10 1.178 0.010
11 1.112 0.008
12 0.629 0.002
13 0.588 0.002
14 -0.336 0.001
15 0.449 0.001
16 -0.640 0.004
17 0.371 0.001
18 0.943 0.006
19 0.411 0.001
20 -1.565 0.023
21 2.724 0.060
22 1.570 0.017
23 1.184 0.015
24 -1.486 0.018
25 -2.021 0.038
26 -0.484 0.002
27 -1.062 0.008
28 0.083 0.000
29 0.007 0.000
30 0.867 0.007
31 0.985 0.012
32 -0.399 0.001
33 -1.150 0.009
34 0.713 0.004

Graphs G2.1


Fit Diagnostics for LNPRICE
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
Observed
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 134
Parameters 8
Error DF 126
MSE 0.0616
R-Square 0.9137
Adj R-Square 0.9089

Graphs G2.2


Studentized Residuals and Cook's D for LNPRICE
Studentized Residuals
Cook's D
Obs
-3 -2 -1 0 1 2 3
0.00 0.02 0.04 0.06 0.08
1 1.290 0.014
2 1.547 0.026
3 1.085 0.013
4 0.185 0.000
5 0.689 0.004
6 0.987 0.007
7 1.730 0.026
8 1.308 0.012
9 -0.697 0.007
10 1.692 0.019
11 1.611 0.017
12 0.998 0.006
13 0.984 0.005
14 -0.219 0.000
15 0.092 0.000
16 -1.298 0.015
17 0.480 0.001
18 1.044 0.007
19 0.367 0.001
20 -0.724 0.006
21 2.147 0.052
22 0.696 0.005
23 0.232 0.001
24 -0.568 0.003
25 -1.342 0.020
26 -0.176 0.000
27 -0.912 0.005
28 0.525 0.002
29 0.467 0.001