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Consumer Preference of Semi-Professional Trumpet Players

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Consumer Preference of (somewhat) Professional Trumpet Players

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Abstract

This project has taken data on the performance and price of trumpet players in the USU Caine college of performing arts. We analyzed this to see the instrument prefferences of aspiring professional trumpet players. We have chosen two primary variables to determine this from. First, we find the sound signiture produced by the instrument and the player. Second, we look at the type of music that the player is interested in. This is a seemingly simple relationship, but we have found it to be frought with complication.

1 Introduction

We show that (within a 95 percent confidence interval) there is little statistical significance in the type of trumpet purchased by those playing classical music compared to those playing jazz music. There also does not appear to be a clear correlation between changes in sound signiture with increases in price. ($R^2 = 57\%$)

We took recordings of 17 students in the Caine School of Performing Arts who played the trumpet as their major instrument (major in this case will mean academic major). All of these students had fairly nice instruments and were able to fill in information about their respective instruments to great detail. It was interesting to note that all of them used Bb trumpets with a .459 inch bore, most of the musicians said that color was not a point that they considered in purchasing their instrument, quality and price were the key factors. We attempted to take this into consideration as we performed the experiment.

We suspect that the modestly inconclusive results stem primarily to the amount of random variation in the player themselves. We have also made some assumptions (see section 2: Heroic Assumptions) that causes our model to lose its accuracy. We do suspect however that if we were able to control for assumption 2, and had enough data to expand on assumption 1, we could make a better fit based on more clear and accurate data.

By "we" in this paper, I am reffering to myself.

2 Heroic Assumptions

Our first assumption is that all trumpet players play classical or Jazz genres of music. It is easy to see when talking to trumpet players that they fall primarily into these two schools of thought: Mozart or Louis Armstrong. I suspect that this is primarily attributed to the fact that they don't really have any other options. One of the major questions that this analysis attempted to explain is the difference in prefference of the classical player as opposed to the Jazz musician.

The second heroic assumption that this paper makes (however inaccurate it is of a measure of reality) is that the musician did not face a budget constraint when purchasing his/her instrument. We are going to labor under the thought that everyone picked his/her ideal instrument. This allows us to see if price is correlated with the sound signiture without taking into account that there may be a better suited or preffered instrument.

The third and final assumption that we choose to make in this study is that the sound signiture of the instrument can be expressed soley by the slope of the regression line that relates wave to pressure. This is not perhaps the best way to describe the relation because higher priced trumpets appears to have some common discrepencies in the harmonic series that can be attributed to the more refined metal used in construction of the instrument (like gold plating). However, as the length of the instrument is the same, the harmonic series still obeys the harmonic oscillator equations (to the second order anyways) and behaves the same in the aggregate. (In other words, this is not a physics class so I cut this corner a little bit.)

3 Fourier Analysis

The key variable in this project (and for the musicians) is the sound quality. In talking with them, they used ethereal terms such as "rich" or "deep" and "sharp" or "cutting" respective to the genre. Hearing the musicians describing the sound that they wished to hear made it seem like it would be easy to see a difference in quality.

Unlike musicians, we chose not to describe sound in ethereal ways but in mathematical ways. We chose to take the Fourier transform of the wave functions and analyze the sound in the frequency domain and regressed it against the sound pressure (in Decibels). Please see the appendix for a graph, original graphs of the initial data can be made available upon request but I am refraining from putting in too much math in this report.

I used the following Fourier Transform below to find the discrete values of the harmonic series:

$(\mathrm{S}_{2N}f)(x) = \frac{1}{\pi}\int_0^{\pi} \frac{sin(2N+1/2)(x-t)}{2sin(\frac{x-t}{2})}dt - \frac{1}{\pi}\int_{-\pi}^{0} \frac{sin(2N+1/2()x-t)}{2sin(\frac{x-t}{2})}dt$

This derivation was long and tedious (actually probably the second most time consuming aspect of this project, the first being accrument of the data).

This yeilded the desired values, each of the trumpets overtones were analyzed until they dropped below a threshold line (-65 Db) where human ears really can't register a sound anymore. I did not think that any higher order harmonics were relevant than what could be easily discerned.

4 Analysis Procedures

While it was easy to calibrate for the right note (initial frequency) for each of the players being recorded. It was hard to calibrate for the sound intensity (Decibels). We have chosen to analyze both the actual sound levels of the harmonic series as well as the change in intensity of the harmonic series (these are denoted as Decibels and Delta (Del.) Decibels). The 17 trumpet players' sound quality is denoted entirely by their slope coefficients of the regressions.

This was indexed against a binary variable (what genre the play) and what the price of that instrument was provided by the player or at a reputable music store (most people knew the price of their instrument). We hoped to see a correlation.

The programs used were: LaTex (as can be obviously seen) C++ Compiler MathCad (formal derivation of this wave function transform)

5 Statistical Results

For a formal tour of the results, we urge the reader (you) to glance at the appendix.

We find that the following holds true: 1) The classical players and jazz players appears to have statistically similar sound patterns in their trumpets. Using a two sample t-test on adjusted data to verify shows the following: T=1.63 N=15

There was also a major outlier in the price data (go figure, someone has to have a trumpet worth five times that of everyone else's) that changed the slope of the analysis line in the jazz group. Our I-MR control chart showed that this was more than three standard deviations from the mean and we have chosen to classify this trumpet as a "high performance" trumpet and struck it from the record, although the calculations using it are available for perusal in the appendix. (using the outlier trumpet gave us a result with a R squared value of 6 percent)

Ultimately, for the jazz musicians group we achieved the following regression function:

(Decibels / Frequency) = -0.0362 + 0.00001*(Price)

R Squared value of 57.7 percent

Again for the Classical musicians group we find the following:

(Decibels / Frequency) = -0.0241 + 0.000003*(Price)

R Squared value of 27.8 percent

6 The Interpretation, and Logical Next Steps

This seems to indicate that price (and subsequent material composition) is not the only factor that influences the sound quality of a trumpet. Rather, it is fairly difficult to give any conclusive interpretation as we have such a low confidence in our findings.

However, we can say that there is a increasing realationship between price and sound quality. The more expensive the instrument becomes, the overtones get louder compared to the intitial note. Even though there is a very slight relationship, the sign of the slope is positive on all accounts.

We suspect that this will be easier to prove with further work in the future. We will first need a larger sample size, prefferably one that does not have a budget constraint. Either we need to do a double blind study of musicians and unmarked trumpets, or we can find actual performing professionals and assess their trumpets. I suspect that once people are making a career out of their trumpet, it becomes very important to find that instrument that makes the sound you want.

Regression Analysis: Decibel versus Frequency

```
The regression equation is
Decibel = - 6.99 - 0.00929 Frequency


Predictor        Coef    SE Coef       T      P
Constant       -6.986      1.961   -3.56  0.007
Frequency  -0.0092906  0.0006843  -13.58  0.000


S = 2.87488   R-Sq = 95.8%   R-Sq(adj) = 95.3%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  1523.6  1523.6  184.35  0.000
Residual Error   8    66.1     8.3
Total            9  1589.8


Unusual Observations

Obs  Frequency  Decibel      Fit  SE Fit  Residual  St Resid
  1        463  -16.200  -11.287   1.687    -4.913     -2.11R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_1 versus Frequency_1

```
The regression equation is
Decibel_1 = - 9.08 - 0.0165 Frequency_1


9 cases used, 1 cases contain missing values


Predictor         Coef   SE Coef       T      P
Constant        -9.078     2.522   -3.60  0.009
Frequency_1  -0.016452  0.001204  -13.67  0.000


S = 3.46771   R-Sq = 96.4%   R-Sq(adj) = 95.9%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  2245.9  2245.9  186.77  0.000
Residual Error   7    84.2    12.0
Total            8  2330.1


Unusual Observations

Obs  Frequency_1  Decibel_1     Fit  SE Fit  Residual  St Resid
  9         3347     -58.40  -64.14    2.13      5.74      2.10R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_2 versus Frequency_2

```
The regression equation is
Decibel_2 = - 4.23 - 0.00472 Frequency_2


Predictor         Coef   SE Coef      T      P
Constant        -4.235     4.935  -0.86  0.416
Frequency_2  -0.004716  0.001357  -3.48  0.008


S = 7.21999   R-Sq = 60.2%   R-Sq(adj) = 55.2%


Analysis of Variance

Source          DF       SS      MS      F      P
Regression       1   629.70  629.70  12.08  0.008
Residual Error   8   417.03   52.13
Total            9  1046.72


Unusual Observations

Obs  Frequency_2  Decibel_2    Fit  SE Fit  Residual  St Resid
  1          584     -19.80  -6.99    4.25    -12.81     -2.19R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_3 versus Frequency_3

```
The regression equation is
Decibel_3 = - 17.7 - 0.00506 Frequency_3


Predictor          Coef    SE Coef      T      P
Constant        -17.743      2.794  -6.35  0.000
Frequency_3  -0.0050568  0.0006831  -7.40  0.000


S = 4.00406   R-Sq = 87.3%   R-Sq(adj) = 85.7%


Analysis of Variance

Source          DF       SS      MS      F      P
Regression       1   878.68  878.68  54.81  0.000
Residual Error   8   128.26   16.03
Total            9  1006.94


Unusual Observations

Obs  Frequency_3  Decibel_3     Fit  SE Fit  Residual  St Resid
  2         1406     -17.00  -24.85    1.99      7.85      2.26R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_4 versus Frequency_4

```
The regression equation is
Decibel_4 = - 11.0 - 0.00602 Frequency_4


Predictor          Coef    SE Coef       T      P
Constant        -11.043      1.865   -5.92  0.000
Frequency_4  -0.0060200  0.0005737  -10.49  0.000


S = 2.61601   R-Sq = 93.2%   R-Sq(adj) = 92.4%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  753.45  753.45  110.10  0.000
Residual Error   8   54.75    6.84
Total            9  808.20
```

Regression Analysis: Decibel_5 versus Frequency_5

```
The regression equation is
Decibel_5 = - 11.6 - 0.00565 Frequency_5


7 cases used, 3 cases contain missing values


Predictor          Coef    SE Coef       T      P
Constant        -11.637      2.630   -4.42  0.007
Frequency_5  -0.0056491  0.0005248  -10.76  0.000


S = 3.12168   R-Sq = 95.9%   R-Sq(adj) = 95.0%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  1129.1  1129.1  115.86  0.000
Residual Error   5    48.7     9.7
Total            6  1177.8
```

Regression Analysis: Decibel_6 versus Frequency_6

```
The regression equation is
Decibel_6 = - 20.3 - 0.0108 Frequency_6


9 cases used, 1 cases contain missing values


Predictor          Coef    SE Coef       T      P
Constant        -20.294      3.549   -5.72  0.001
Frequency_6  -0.0107854  0.0009428  -11.44  0.000


S = 4.89214   R-Sq = 94.9%   R-Sq(adj) = 94.2%
```

```
Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  3131.9  3131.9  130.86  0.000
Residual Error   7   167.5    23.9
Total            8  3299.4


Unusual Observations

Obs  Frequency_6  Decibel_6     Fit  SE Fit  Residual  St Resid
  1          663     -36.00  -27.44    3.01     -8.56     -2.22R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_7 versus Frequency_7

```
The regression equation is
Decibel_7 = - 9.71 - 0.00447 Frequency_7


7 cases used, 3 cases contain missing values


Predictor         Coef   SE Coef      T      P
Constant        -9.712     2.481  -3.92  0.011
Frequency_7  -0.004467  0.001274  -3.51  0.017


S = 2.88326   R-Sq = 71.1%   R-Sq(adj) = 65.3%


Analysis of Variance

Source          DF      SS      MS      F      P
Regression       1  102.27  102.27  12.30  0.017
Residual Error   5   41.57    8.31
Total            6  143.83


Unusual Observations

Obs  Frequency_7  Decibel_7     Fit  SE Fit  Residual  St Resid
  4         1637     -22.60  -17.03    1.10     -5.57     -2.09R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_8 versus Frequency_8

```
The regression equation is
Decibel_8 = - 15.7 - 0.0122 Frequency_8


Predictor         Coef   SE Coef       T      P
Constant       -15.702     3.756   -4.18  0.003
Frequency_8  -0.012155  0.001165  -10.44  0.000
```

```
S = 5.47161   R-Sq = 93.2%   R-Sq(adj) = 92.3%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  3260.4  3260.4  108.90  0.000
Residual Error   8   239.5    29.9
Total            9  3499.9


Unusual Observations

Obs  Frequency_8  Decibel_8     Fit  SE Fit  Residual  St Resid
  1          531     -33.00  -22.16    3.22    -10.84     -2.45R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_9 versus Frequency_9

```
The regression equation is
Decibel_9 = - 16.6 - 0.00972 Frequency_9


8 cases used, 2 cases contain missing values


Predictor         Coef   SE Coef      T      P
Constant       -16.572     3.521  -4.71  0.003
Frequency_9  -0.009718  0.001878  -5.17  0.002


S = 5.14145   R-Sq = 81.7%   R-Sq(adj) = 78.6%


Analysis of Variance

Source          DF      SS      MS      F      P
Regression       1  707.69  707.69  26.77  0.002
Residual Error   6  158.61   26.43
Total            7  866.30


Unusual Observations

Obs  Frequency_9  Decibel_9     Fit  SE Fit  Residual  St Resid
  1          330     -11.40  -19.78    3.01      8.38      2.01R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_10 versus Frequency_10

```
The regression equation is
Decibel_10 = - 21.7 - 0.00689 Frequency_10


Predictor           Coef    SE Coef      T      P
Constant         -21.708      2.909  -7.46  0.000
Frequency_10  -0.0068940  0.0009991  -6.90  0.000
```

```
S = 4.26110   R-Sq = 85.6%   R-Sq(adj) = 83.8%


Analysis of Variance

Source          DF       SS      MS      F      P
Regression       1   864.50  864.50  47.61  0.000
Residual Error   8   145.26   18.16
Total            9  1009.76
```

Regression Analysis: Decibel_11 versus Frequency_11

```
The regression equation is
Decibel_11 = - 21.3 - 0.0231 Frequency_11


7 cases used, 3 cases contain missing values


Predictor          Coef   SE Coef       T      P
Constant        -21.326     2.953   -7.22  0.001
Frequency_11  -0.023145  0.001750  -13.23  0.000


S = 3.48446   R-Sq = 97.2%   R-Sq(adj) = 96.7%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  2124.7  2124.7  174.99  0.000
Residual Error   5    60.7    12.1
Total            6  2185.4
```

Regression Analysis: Decibel_12 versus Frequency_12

```
The regression equation is
Decibel_12 = - 11.1 - 0.0125 Frequency_12


9 cases used, 1 cases contain missing values


Predictor           Coef    SE Coef       T      P
Constant         -11.063      2.411   -4.59  0.003
Frequency_12  -0.0124977  0.0009898  -12.63  0.000


S = 3.11428   R-Sq = 95.8%   R-Sq(adj) = 95.2%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  1546.1  1546.1  159.42  0.000
Residual Error   7    67.9     9.7
Total            8  1614.0
```

Regression Analysis: Decibel_13 versus Frequency_13

```
The regression equation is
Decibel_13 = - 9.34 - 0.0124 Frequency_13


Predictor          Coef   SE Coef      T      P
Constant         -9.338     3.216  -2.90  0.020
Frequency_13  -0.012357  0.001780  -6.94  0.000


S = 4.70981   R-Sq = 85.8%   R-Sq(adj) = 84.0%


Analysis of Variance

Source          DF      SS      MS      F      P
Regression       1  1068.5  1068.5  48.17  0.000
Residual Error   8   177.5    22.2
Total            9  1246.0
```

Regression Analysis: Decibel_14 versus Frequency_14

```
The regression equation is
Decibel_14 = - 18.9 - 0.0181 Frequency_14


9 cases used, 1 cases contain missing values


Predictor          Coef   SE Coef       T      P
Constant         -18.897     2.430   -7.78  0.000
Frequency_14  -0.018076  0.001406  -12.85  0.000


S = 3.32128   R-Sq = 95.9%   R-Sq(adj) = 95.4%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  1822.3  1822.3  165.20  0.000
Residual Error   7    77.2    11.0
Total            8  1899.5


Unusual Observations

Obs  Frequency_14  Decibel_14     Fit  SE Fit  Residual  St Resid
  7          2121      -63.50  -57.24    1.38     -6.26     -2.07R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Decibel_15 versus Frequency_15

```
The regression equation is
Decibel_15 = - 25.7 - 0.0121 Frequency_15


8 cases used, 2 cases contain missing values
```

```
Predictor          Coef   SE Coef       T      P
Constant         -25.706     2.728   -9.42  0.000
Frequency_15  -0.012095  0.001153  -10.49  0.000


S = 3.36103   R-Sq = 94.8%   R-Sq(adj) = 94.0%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  1243.4  1243.4  110.07  0.000
Residual Error   6    67.8    11.3
Total            7  1311.2
```

Regression Analysis: Decibel_16 versus Frequency_16

```
The regression equation is
Decibel_16 = - 17.0 - 0.0132 Frequency_16


9 cases used, 1 cases contain missing values


Predictor           Coef    SE Coef       T      P
Constant         -16.960      1.815   -9.34  0.000
Frequency_16  -0.0131887  0.0007779  -16.95  0.000


S = 2.51897   R-Sq = 97.6%   R-Sq(adj) = 97.3%


Analysis of Variance

Source          DF      SS      MS       F      P
Regression       1  1823.7  1823.7  287.42  0.000
Residual Error   7    44.4     6.3
Total            8  1868.2
```

Regression Analysis: Decibel_17 versus Frequency_17

```
The regression equation is
Decibel_17 = - 10.1 - 0.0147 Frequency_17


8 cases used, 2 cases contain missing values


Predictor           Coef    SE Coef       T      P
Constant         -10.1415     0.9399  -10.79  0.000
Frequency_17  -0.0146631  0.0004753  -30.85  0.000


S = 1.21377   R-Sq = 99.4%   R-Sq(adj) = 99.3%


Analysis of Variance
```

```
Source          DF      SS      MS       F      P
Regression       1  1402.0  1402.0  951.66  0.000
Residual Error   6     8.8     1.5
Total            7  1410.9
```

Regression Analysis: Del. Db versus Frequency

```
The regression equation is
Del. Db = - 0.11 - 0.00136 Frequency


Predictor        Coef    SE Coef      T      P
Constant       -0.105      1.306  -0.08  0.938
Frequency  -0.0013603  0.0004556  -2.99  0.017


S = 1.91438   R-Sq = 52.7%   R-Sq(adj) = 46.8%


Analysis of Variance

Source          DF      SS      MS     F      P
Regression       1  32.665  32.665  8.91  0.017
Residual Error   8  29.319   3.665
Total            9  61.984
```

Regression Analysis: Del. Db_1 versus Frequency_1

```
The regression equation is
Del. Db_1 = - 7.24 + 0.00104 Frequency_1


9 cases used, 1 cases contain missing values


Predictor        Coef   SE Coef      T      P
Constant       -7.239     3.085  -2.35  0.051
Frequency_1  0.001035  0.001472   0.70  0.505


S = 4.24158   R-Sq = 6.6%   R-Sq(adj) = 0.0%


Analysis of Variance

Source          DF      SS     MS     F      P
Regression       1    8.89   8.89  0.49  0.505
Residual Error   7  125.94  17.99
Total            8  134.83


Unusual Observations

                 Del.
Obs  Frequency_1  Db_1    Fit  SE Fit  Residual  St Resid
  1          374  0.00  -6.85    2.61      6.85      2.05R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Del. Db_2 versus Frequency_2

```
The regression equation is
Del. Db_2 = 6.17 - 0.00260 Frequency_2


Predictor          Coef    SE Coef      T      P
Constant          6.165      2.265   2.72  0.026
Frequency_2  -0.0026009  0.0006229  -4.18  0.003


S = 3.31431   R-Sq = 68.5%   R-Sq(adj) = 64.6%


Analysis of Variance

Source          DF      SS      MS      F      P
Regression       1  191.50  191.50  17.43  0.003
Residual Error   8   87.88   10.98
Total            9  279.38


Unusual Observations

                 Del.
Obs  Frequency_2  Db_2   Fit  SE Fit  Residual  St Resid
  2         1170  9.10  3.12    1.65      5.98      2.08R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Del. Db_3 versus Frequency_3

```
The regression equation is
Del. Db_3 = 0.08 - 0.000677 Frequency_3


Predictor          Coef    SE Coef      T      P
Constant          0.078      3.671   0.02  0.984
Frequency_3  -0.0006770  0.0008975  -0.75  0.472


S = 5.26095   R-Sq = 6.6%   R-Sq(adj) = 0.0%


Analysis of Variance

Source          DF      SS     MS     F      P
Regression       1   15.75  15.75  0.57  0.472
Residual Error   8  221.42  27.68
Total            9  237.17


Unusual Observations

Obs  Frequency_3  Del. Db_3    Fit  SE Fit  Residual  St Resid
  2         1406       9.00  -0.87    2.61      9.87      2.16R
  3         2105     -11.10  -1.35    2.16     -9.75     -2.03R

R denotes an observation with a large standardized residual.
```

Regression Analysis: Del. Db_4 versus Frequency_4

```
The regression equation is
Del. Db_4 = - 0.96 - 0.000394 Frequency_4


Predictor          Coef    SE Coef      T      P
Constant         -0.963      2.019  -0.48  0.646
Frequency_4  -0.0003939  0.0006212  -0.63  0.544


S = 2.83249   R-Sq = 4.8%   R-Sq(adj) = 0.0%


Analysis of Variance

Source          DF      SS     MS     F      P
Regression       1   3.225  3.225  0.40  0.544
Residual Error   8  64.184  8.023
Total            9  67.409
```

Regression Analysis: Del. Db_5 versus Frequency_5

```
The regression equation is
Del. Db_5 = - 4.69 - 0.00026 Frequency_5


7 cases used, 3 cases contain missing values


Predictor         Coef   SE Coef      T      P
Constant        -4.689     5.243  -0.89  0.412
Frequency_5  -0.000258  0.001046  -0.25  0.815


S = 6.22171   R-Sq = 1.2%   R-Sq(adj) = 0.0%


Analysis of Variance

Source          DF      SS     MS     F      P
Regression       1    2.35   2.35  0.06  0.815
Residual Error   5  193.55  38.71
Total            6  195.90
```

Regression Analysis: Del. Db_6 versus Frequency_6

```
The regression equation is
Del. Db_6 = 0.24 - 0.00176 Frequency_6


9 cases used, 1 cases contain missing values


Predictor          Coef    SE Coef      T      P
Constant          0.240      3.506   0.07  0.947
Frequency_6  -0.0017601  0.0009315  -1.89  0.101


S = 4.83316   R-Sq = 33.8%   R-Sq(adj) = 24.3%
```

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	83.41	83.41	3.57	0.101
Residual Error	7	163.52	23.36		
Total	8	246.92			

Regression Analysis: Del. Db_7 versus Frequency_7

The regression equation is
Del. Db_7 = - 1.43 - 0.00005 Frequency_7

7 cases used, 3 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-1.434	3.338	-0.43	0.685
Frequency_7	-0.000054	0.001714	-0.03	0.976

S = 3.88019 R-Sq = 0.0% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.01	0.01	0.00	0.976
Residual Error	5	75.28	15.06		
Total	6	75.29			

Regression Analysis: Del. Db_8 versus Frequency_8

The regression equation is
Del. Db_8 = 1.29 - 0.00214 Frequency_8

Predictor	Coef	SE Coef	T	P
Constant	1.286	4.078	0.32	0.761
Frequency_8	-0.002140	0.001265	-1.69	0.129

S = 5.94144 R-Sq = 26.4% R-Sq(adj) = 17.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	101.10	101.10	2.86	0.129
Residual Error	8	282.41	35.30		
Total	9	383.50			

Regression Analysis: Del. Db_9 versus Frequency_9

The regression equation is
Del. Db_9 = - 5.05 + 0.00036 Frequency_9

8 cases used, 2 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-5.051	3.555	-1.42	0.205
Frequency_9	0.000359	0.001896	0.19	0.856

S = 5.19151 R-Sq = 0.6% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.96	0.96	0.04	0.856
Residual Error	6	161.71	26.95		
Total	7	162.68			

Regression Analysis: Del. Db_10 versus Frequency_10

The regression equation is
Del. Db_10 = 1.24 - 0.00144 Frequency_10

Predictor	Coef	SE Coef	T	P
Constant	1.240	3.397	0.37	0.725
Frequency_10	-0.001438	0.001167	-1.23	0.253

S = 4.97602 R-Sq = 16.0% R-Sq(adj) = 5.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	37.59	37.59	1.52	0.253
Residual Error	8	198.09	24.76		
Total	9	235.68			

Unusual Observations

Obs	Frequency_10	Del. Db_10	Fit	SE Fit	Residual	St Resid
4	1879	-11.00	-1.46	1.77	-9.54	-2.05R

R denotes an observation with a large standardized residual.

Regression Analysis: Del. Db_11 versus Frequency_11

The regression equation is
Del. Db_11 = - 5.58 - 0.00082 Frequency_11

7 cases used, 3 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-5.583	5.252	-1.06	0.336
Frequency_11	-0.000825	0.003112	-0.27	0.802

S = 6.19766   R-Sq = 1.4%   R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	2.70	2.70	0.07	0.802
Residual Error	5	192.06	38.41		
Total	6	194.75			

Regression Analysis: Del. Db_12 versus Frequency_12

The regression equation is
Del. Db_12 = - 3.36 - 0.00027 Frequency_12

9 cases used, 1 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-3.359	3.494	-0.96	0.368
Frequency_12	-0.000266	0.001435	-0.19	0.858

S = 4.51379   R-Sq = 0.5%   R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	0.70	0.70	0.03	0.858
Residual Error	7	142.62	20.37		
Total	8	143.32			

Unusual Observations

Obs	Frequency_12	Del. Db_12	Fit	SE Fit	Residual	St Resid
4	1856	-13.20	-3.85	1.58	-9.35	-2.21R

R denotes an observation with a large standardized residual.

Regression Analysis: Del. Db_13 versus Frequency_13

The regression equation is
Del. Db_13 = - 0.42 - 0.00134 Frequency_13

Predictor	Coef	SE Coef	T	P
Constant	-0.423	4.005	-0.11	0.918
Frequency_13	-0.001341	0.002217	-0.60	0.562

S = 5.86490   R-Sq = 4.4%   R-Sq(adj) = 0.0%

Analysis of Variance

```
Source          DF      SS     MS     F      P
Regression       1   12.58  12.58  0.37  0.562
Residual Error   8  275.18  34.40
Total            9  287.76
```

Regression Analysis: Del. Db_14 versus Frequency_14

```
The regression equation is
Del. Db_14 = - 4.45 - 0.00006 Frequency_14


9 cases used, 1 cases contain missing values


Predictor          Coef   SE Coef      T      P
Constant         -4.449     3.147  -1.41  0.200
Frequency_14  -0.000062  0.001822  -0.03  0.974


S = 4.30184   R-Sq = 0.0%   R-Sq(adj) = 0.0%


Analysis of Variance

Source          DF      SS     MS     F      P
Regression       1    0.02   0.02  0.00  0.974
Residual Error   7  129.54  18.51
Total            8  129.56
```

Regression Analysis: Del. Db_15 versus Frequency_15

```
The regression equation is
Del. Db_15 = - 0.87 - 0.00154 Frequency_15


8 cases used, 2 cases contain missing values


Predictor          Coef   SE Coef      T      P
Constant         -0.874     4.156  -0.21  0.840
Frequency_15  -0.001538  0.001757  -0.88  0.415


S = 5.12097   R-Sq = 11.3%   R-Sq(adj) = 0.0%


Analysis of Variance

Source          DF      SS     MS     F      P
Regression       1   20.11  20.11  0.77  0.415
Residual Error   6  157.35  26.22
Total            7  177.46
```

Regression Analysis: Del. Db_16 versus Frequency_16

```
The regression equation is
Del. Db_16 = - 3.26 - 0.00062 Frequency_16
```

9 cases used, 1 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-3.255	3.041	-1.07	0.320
Frequency_16	-0.000618	0.001303	-0.47	0.650

S = 4.22033 R-Sq = 3.1% R-Sq(adj) = 0.0%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	4.00	4.00	0.22	0.650
Residual Error	7	124.68	17.81		
Total	8	128.68			

Regression Analysis: Del. Db_17 versus Frequency_17

The regression equation is
Del. Db_17 = - 1.60 - 0.00194 Frequency_17

8 cases used, 2 cases contain missing values

Predictor	Coef	SE Coef	T	P
Constant	-1.603	1.326	-1.21	0.272
Frequency_17	-0.0019378	0.0006703	-2.89	0.028

S = 1.71179 R-Sq = 58.2% R-Sq(adj) = 51.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	24.487	24.487	8.36	0.028
Residual Error	6	17.581	2.930		
Total	7	42.069			

Descriptive Statistics: Decible Slope, Del. Db Slope

Variable	N	N*	Mean	SE Mean	StDev	Variance	CoefVar
Decible Slope	18	0	-0.01098	0.00120	0.00510	0.0000260	-46.43
Del. Db Slope	18	0	-0.000997	0.000193	0.000820	0.000000672	-82.18

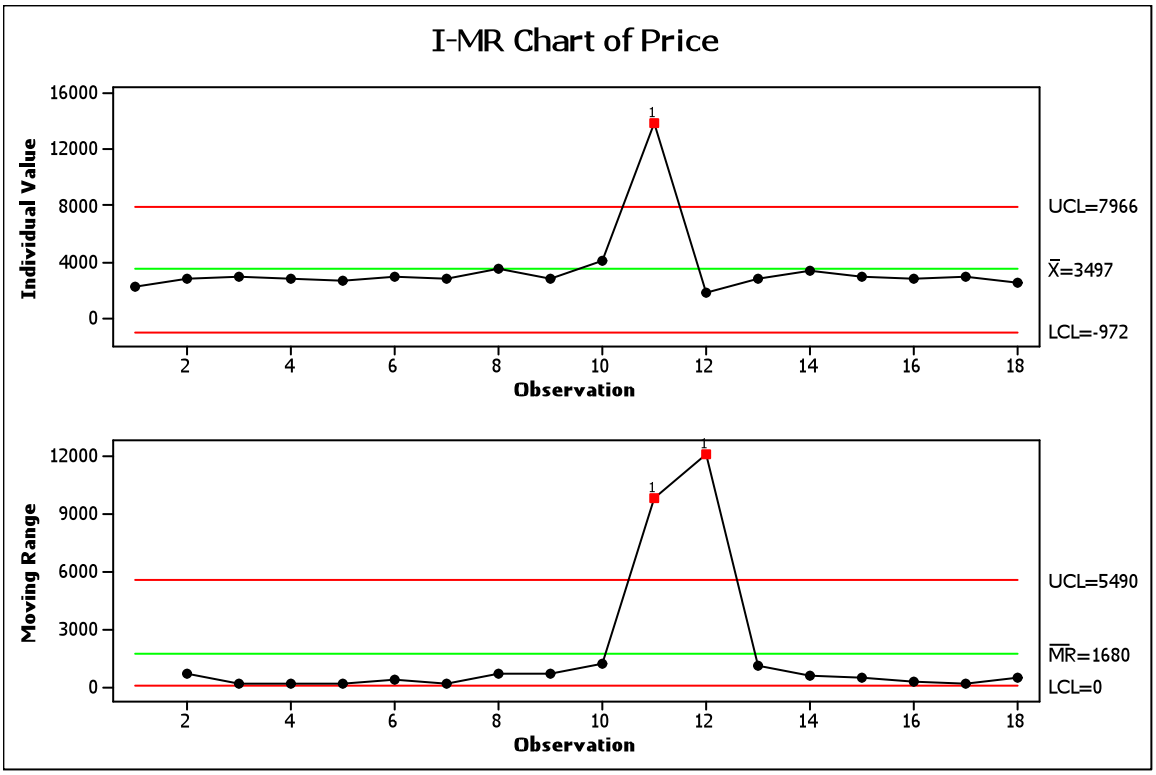
Variable	Sum of Squares	Minimum	Q1	Median	Q3	Maximum
Decible Slope	0.00261	-0.02310	-0.01358	-0.01145	-0.00593	-0.00470
Del. Db Slope	0.0000293	-0.002600	-0.001595	-0.000930	-0.000268	0.000360

Variable	Range
Decible Slope	0.01840
Del. Db Slope	0.002960

Two-Sample T-Test and CI: Del. Db Slope, Del. Db Slope_1

```
Two-sample T for Del. Db Slope vs Del. Db Slope_1

                   N       Mean     StDev  SE Mean
Del. Db Slope     11  -0.001032  0.000808  0.00024
Del. Db Slope_1    7  -0.000943  0.000899  0.00034


Difference = mu (Del. Db Slope) - mu (Del. Db Slope_1)
Estimate for difference:  -0.000089
95% CI for difference:  (-0.001009, 0.000831)
T-Test of difference = 0 (vs not =): T-Value = -0.21  P-Value = 0.835  DF = 11
```

I-MR Chart of Price



Test Results for I Chart of Price

```
TEST 1. One point more than 3.00 standard deviations from center line.
Test Failed at points:  11
```

Test Results for MR Chart of Price

```
TEST 1. One point more than 3.00 standard deviations from center line.
Test Failed at points:  11, 12

* WARNING * If graph is updated with new data, the results above may no
          * longer be correct.
```

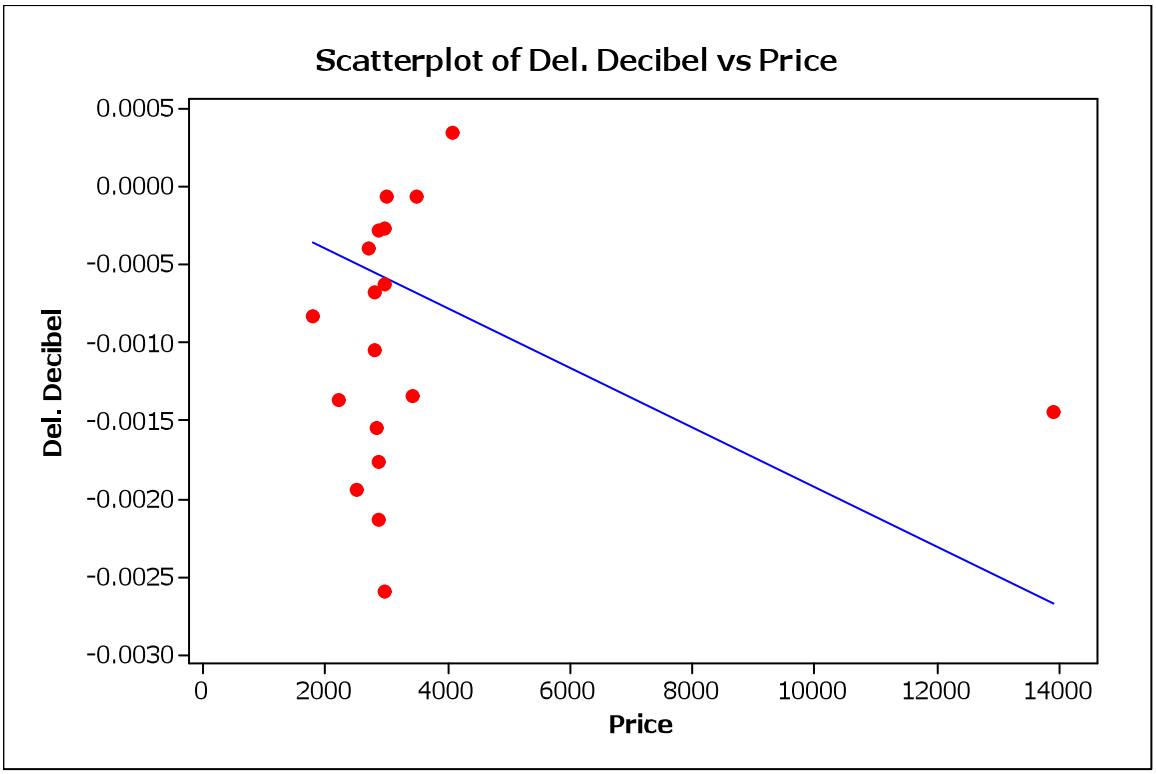
Regression Analysis: Decibel_1 versus Adjusted Price_1

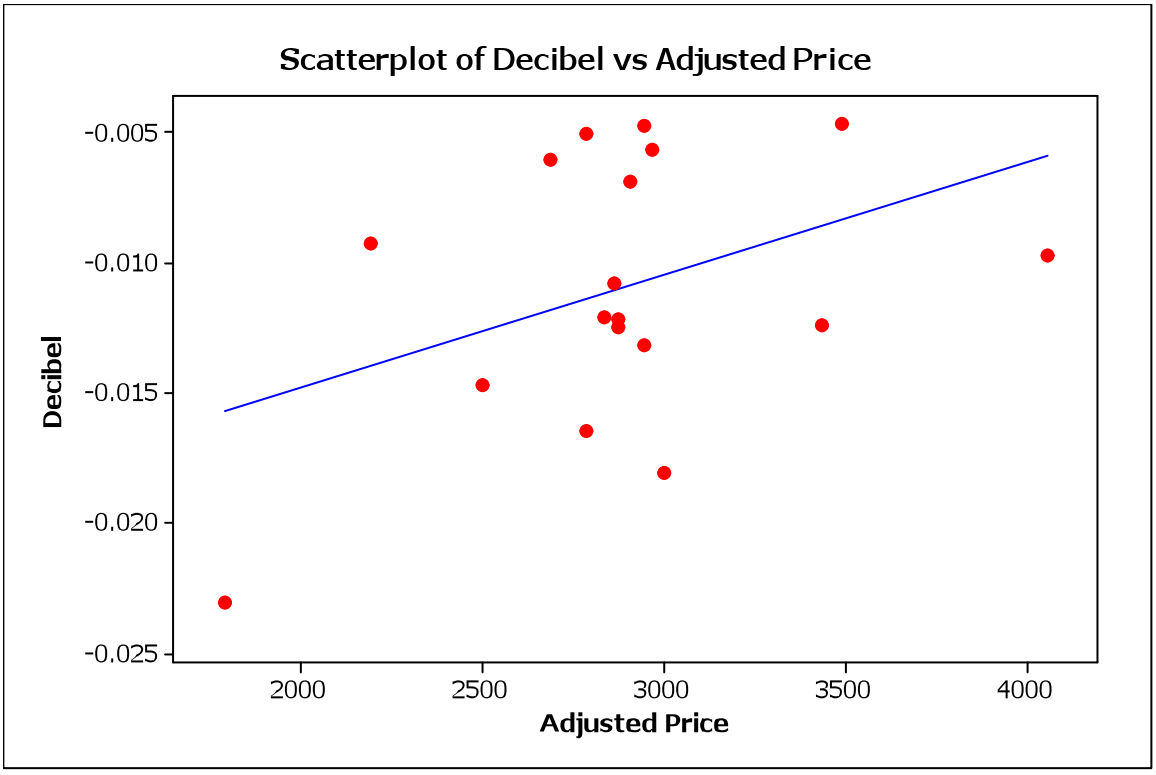
```
The regression equation is
Decibel_1 = - 0.0362 + 0.000010 Adjusted Price_1


Predictor               Coef     SE Coef      T      P
Constant           -0.036158    0.007690  -4.70  0.001
Adjusted Price_1  0.00000977  0.00000279   3.51  0.007


S = 0.00391998   R-Sq = 57.7%   R-Sq(adj) = 53.0%


Analysis of Variance

Source          DF          SS          MS      F      P
Regression       1  0.00018885  0.00018885  12.29  0.007
Residual Error   9  0.00013830  0.00001537
Total           10  0.00032715
```

Residual Histogram for Decibel_1

Regression Analysis: Decibel_1_1 versus Adjusted Price_1_1

```
The regression equation is
Decibel_1_1 = - 0.0241 + 0.000003 Adjusted Price_1_1


Predictor                 Coef     SE Coef      T      P
Constant             -0.024146    0.007916  -3.05  0.028
Adjusted Price_1_1  0.00000346  0.00000250   1.39  0.224


S = 0.00280295   R-Sq = 27.8%   R-Sq(adj) = 13.3%


Analysis of Variance

Source          DF           SS           MS     F      P
Regression       1  0.000015089  0.000015089  1.92  0.224
Residual Error   5  0.000039283  0.000007857
Total            6  0.000054372
```


Scatterplot of Del. Decibel vs Price
0.0005
0.0000
-0.0005
-0.0010
-0.0015
-0.0020
-0.0025
-0.0030
Del. Decibel
0
2000
4000
6000
8000
10000
12000
14000
Price


Scatterplot of Decibel vs Adjusted Price
-0.005
-0.010
-0.015
-0.020
-0.025
Decibel
2000
2500
3000
3500
4000
Adjusted Price