Golden Oldies: An Empirical Analysis of Vintage Guitar Sales on Ebay

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I. Introduction

Buying vintage instruments and gear is a viable investment strategy – a 1959 Les Paul

can go for $100,000 today, and most vintage dealers are predicting the value of most products

will steadily increase over time. According to David Gruhn, a leading expert in the field of

vintage guitars, in the last twenty-five years, top-of-the-line vintage guitars have outperformed

the stock market, precious metals and other collectibles. The market for buying and selling

vintage instruments and gear is massive in America. Dealers from across the country handle a

substantial stock of secondary market products, popular publications such as Gruhn's Guide to

Guitars and Vintage Guitar Price Guide track value and appraisal minutiae for hundreds of

models from as many different manufacturers, and there is a considerable market for vintage

guitars, basses, and gear on internet auction sites such as mygear.com and ebay.com.

A search for "guitar" on ebay.com returns over 4,000 results classified as "Vintage (pre-

1980)." As of this writing, in the last ninety days, there have been over 6,000 completed auction

or sale listings for the same search. Ebay is an important medium for the trade, buying, and

selling of vintage guitars. As vintage instruments are a proven investment product, this study

intends to determine the feasible liquidity of vintage instruments, specifically products

manufactured by Fender, on Ebay. Some vintage Stratocasters are being listed at prices well over

$10,000, while a substantial portion of guitars and basses listed on Ebay did not sell at all – of

the recorded sample of 225 observations, about a third of these products had actually been

recorded as sold products. Furthermore, according to the Vintage Guitar Price Guide, the 42-

Index[1] has shown a recent 10% decline in Fender values, making a study of this particular

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1   An appraisal value index maintained by Vintage Guitar Price Guide that tracks a total of 42 different models of
    guitars and basses made by Gibson, Fender, and Martin. All included models were manufactured between the
    years 1930-1965.

manufacturer apropos.

While guitar store deals and transactions between private individuals still comprise much of the market for vintage guitars, Ebay has become a popular medium of sale. The low transaction costs of posting a listing, ease of advertising, and quick dissemination of information are appealing for sellers, while the powerful search engine, breadth of products, and possibility of winning an auction at a low price entice buyers. Bajari and Hortaçsu, in their paper, "Economic Insights from Internet Auctions," point out that internet auctions create liquid markets for specialized product categories. However, it is unclear as to whether or not this holds true for vintage guitars. Kazumori and McMillan posited that asymmetric information is the most serious limitation facing the growth of internet auctions as a legitimately accepted market. The implications of asymmetric information, as they relate to the market for vintage guitars, are somewhat more serious. There are several factors that determine the value of a vintage instrument, and as most vintage guitars are purchased with the intent of eventual resale, variables such as the condition of the instrument, whether or not the instrument still bears its factory-original electronics and hardware, and the age of the instrument are all of tantamount importance to buyers. Furthermore, as Eaton pointed out, many of the other informative signals necessary to appraise the instrument in the first place are highly subjective. There is no standard as to what differentiates a guitar from being in "mint" condition as opposed to merely "excellent" condition, and two different guitars that have the same conditional descriptors from two different sellers may be in highly disparate conditions.

A wealth of research has been done on the behavior of auction mechanisms, the secondary market, and Ebay in particular. However, most of the available literature on internet

auctions only examines auctions as a mechanism, rather than how a specific product operates within that mechanism. The paper most closely related to the spirit of this particular study, Eaton's "Valuing Information: Evidence from Guitar Auctions on E-bay," discussed the value of informative signals in the market for used Paul Reed Smith guitars. However, Eaton's model is more concerned with the details of the auction rather than the product being sold. This study is differentiated from Eaton's not only in the choice of product to be examined (used vintage guitars rather than used Paul Reed Smith guitars), but also in the empirical analysis of the market. The model to be developed here will attempt to capture the value of the actual product in question – exactly what types of features will influence the price of a guitar auction on Ebay, and whether or not the product will sell at all.

II. Full Literature Review

A large literature exists on internet auctions. Many studies have been performed on the impact of feedback and reputation on internet auction prices. Lucking-Reiley, Melnik and Alm, Houser and Wooders, Livingston, and Yin have all found that feedback and reputation are statistically significant, but do not have a very large effect on price. Feedback and reputation most matter in the early stages of a user's transaction history, but after this initial period of "establishing" oneself, the marginal effect of feedback and reputation is very small.

Akerlof examined information asymmetry and how it affected market outcomes. The conclusion of his work was that when the quality of a good cannot be observed with certainty, adverse selection will occur – lower prices will crowd out quality goods in the market, since buyers will not offer prices high enough to induce the sale of quality goods. Akerlof called this "the lemon problem." Genesove provided four criteria that a market must meet to exhibit

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Akerlof's lemon problem.

At the point of sale, there must be asymmetric information regarding the quality of the good.

The buyer and seller must both value the quality of the good.

Between the buyer and the seller, the party less informed as to the quality of the good determines the price.

Extra-trading institutions will not fully eliminate the uncertainty regarding the quality of the good.

Ebay auctions for vintage guitars and basses would seem to fulfill these criteria. First, as the seller is the only member of the transaction in a position to physically inspect the good, clearly, the seller knows more about the good than the buyer. Second, an individual desiring to sell a vintage guitar clearly values the quality of the good enough to know that it is salable, while the quality of a vintage guitar is of utmost quality to a collector (which presumably the buyer is). Third, in auction listings, the buyer determines the price of the good by bidding up the price, with the price at point of sale determined by the final bid submitted[2]. Fourth, escrow services and return offers provide useful information signals, but will not fully eliminate uncertainty. As Genesove's criteria for the lemon problem were met in the auction market for used guitars, Eaton adapted the Akerlof model of the market for used cars to the market for used guitars, which is relevant to this study and will be discussed in greater detail.

The focus of Eaton's paper was the value of information signals in Ebay auctions. His

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2   This is subject to the highest submitted bid meeting or exceeding the seller's hidden "reserve price," which is the minimum acceptable price for the good. Also, "Buy It Now" or "Best Offer" product listings do not operate under auction mechanisms, and instead offer fixed prices or allow the seller to accept or reject individual offers made by interested buyers. In this type of sale, the price would not be determined by the less informed party (the buyer), leading to the conclusion that adverse selection would not manifest, and the market would not exhibit the lemon problem.

work estimated the value of signals that are intended to reduce uncertainty on the part of the buyer – for example, whether or not pictures were included, an escrow service was available, or the seller accepted credit cards. Eaton concluded that these information signals did hold economic value, as they were statistically significant in a model developed to forecast whether or not Paul Reed Smith guitars would actually sell on Ebay. However, as far as the actual product in question was concerned, the only variable Eaton tracked was the type of model being sold. For vintage dealers, there is much more data to be collected to properly appraise the instrument. As this paper intends to analyze what variables best capture the value of a vintage guitar, using Ebay's market as a framework, the lack of several important qualitative variables in Eaton's study makes it ineffective to this end.

III. Theory

Eaton adapted Akerlof's model to the market for used guitars. A review of his methodology will establish that the better a buyer can gauge the quality of a used guitar on an Ebay auction, the higher the price that guitar will command.

As a vintage guitar is a good that is typically purchased with the intent of eventual resale, the quality of the instrument is of the utmost importance to buyers. A consumer in the market for a used guitar can purchase the item in person or over the internet. If buying in person, the consumer will be able to inspect the instrument to his or her satisfaction, and the quality of the instrument will be known (no asymmetry of information). If buying over the internet, the quality of the instrument will not be known with certainty.

Let D_g be the value of a guitar that a consumer purchases in person. The quality of this guitar is examinable and therefore known to the buyer. I_g is the value of a high-quality guitar

purchased over the internet, while I_b is the value of a low-quality guitar purchased over the internet. Suppose that a high-quality guitar is purchased with probability B, and a low-quality guitar is purchased with probability 1-B. As a guitar purchased in person is examinable, its quality is known. Therefore, the consumer's expected value of this guitar will equal its true value: $E_D = D_g$. A guitar purchased over the internet is not personally examinable, so its expected value will be $E_I = B(I_g) + (1-B)(I_b)$.

Since this study treats vintage guitars as investment products, assume that a low-quality guitar is not salable, so $U_b = 0$. p_D and p_I will represent the prices of guitars purchased in person and guitars purchased over the internet, respectively. For a consumer to be indifferent between purchasing a guitar in person and purchasing a guitar over the internet, the equality $E_D - p_D = E_I - p_I$ must hold. Rearranging the equation yields:

$$p_I = E_I - (E_I - p_D)$$

$$p_I = B(I_g) - (D_g - p_D)$$

In this model, the probability of purchasing a high-quality guitar, B, is positively correlated with the price. This implies that the more accurately a consumer can judge the quality of an instrument, the higher the price that that instrument will be able to command[3]. In Ebay auctions, it is expected that B < 1. Uncertainty over the quality of the good will reduce B, and by extension, the final auction price. Sellers, then, desire to take steps to reduce uncertainty regarding the quality of the instrument for sale, as they will be able to command higher prices for the goods they are selling.

When attempting to capture the price of a vintage guitar listing on Ebay, there are three

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3   This is assuming that the instrument in question actually is of high quality. If the instrument is of low quality, a more accurate appraisal, will of course, lower the price. Theoretically speaking, since U_b has been set equal to zero, a low quality instrument would not sell at all.

categories of details to consider. The first is the structure of the auction. This includes what methods of payment the seller is willing to accept, where the seller is willing to ship, and whether or not pictures were included. The structure of the auction is instrumental to reducing uncertainty regarding the seller as an individual – establishing a feeling of trustworthiness between the seller and the buyer, and creating an inviting mood to entice prospective buyers to bid. This will have some bearing on the price of the auction, as this category is perhaps most important as to whether or not consumers will bid on the auction at all.

The second category is concerned with details of the seller. It includes details such as how many guitars the seller has sold previously, whether or not the seller seems knowledgeable about guitars, and the seller's feedback rating. Much like the structure of the auction, these variables have more to do with reducing uncertainty regarding the seller rather than establishing the quality of the actual product. However, these information signals are still prospectively relevant to determination of the final auction price.

The third category considered is the details of the actual product being sold. This includes the year the guitar was manufactured, whether or not its finish and hardware are factory-original, and whether or not a case is included. These are the descriptors that would reduce uncertainty regarding whether or not the guitar itself will be high-quality or low-quality, as opposed to information signals that reduce uncertainty regarding the seller.

There are several variables of interest that determine the quality of a vintage guitar. Each variable that might determine the price of a guitar listing on Ebay has been considered for the model by a specific rationale.

III.a. Descriptors

Auction Details

Price

The dependent variable for the price-predictive model. The price the item had at the termination of its auction, whether or not it was actually sold. For the probabilistic model, this would likely decrease the chance of an instrument selling, as fewer consumers would be able to afford it.

Init Price

The initial price of the product. For a Buy It Now/Best Offer sale, there is no "initial price," so this value defaults to the price at point of sale (if the product sold) or price at point of offer (if the product did not sell). For the likelihood of a sale, a very high initial price may push away more prospective customers than it invites.

Buy It Now/Best Offer?

If the product is operating under a Buy It Now/Best Offer mechanism, data for bids, price, initial price, auction length, unique bidders, change, both quantitatively and behaviorally. For both the price-predictive and probabilistic models, this descriptor will capture some of those effects.

Pictures

Whether or not pictures were included with the auction, and if so, how many. Sellers are more inclined to trust an auction that has documented its product well.

WasSold

If the product was not sold, the instrument may have been pitched at too high a price.

Shipping

A higher shipping cost is likely to mean that the seller will insure the item when shipping it. A lower cost is likely to mean insurance is not being offered.[4]

Returns

A premium may exist for sellers willing to handle returns.

Credit Cards

A premium may exist for sellers willing to accept credit cards in addition to standard PayPal services.

ShipsWorldwide

A premium may exist for sellers willing to ship anywhere in the world, and may attract bidders from a wider customer base.

NumBids

A greater number of bids on a product, by necessity, drives the price up higher. For a Buy It Now/Best Offer sale, this tracks the number of prospective offers listed in the product's history.

UniqueBids

The number of unique Ebay users who placed bids on the item. This variable is of interest since it is representative of how many "serious" customers were interested in the item. For a Buy It Now/Best Offer sale, this tracks the number of prospective offers from unique Ebay users listed in the product's history.

AuctionLength

The longer an auction runs, the more time Ebay users will have to place bids on it. This gives the item a longer window to have its price driven up. This will be measured in days. For a Buy It Now/Best Offer sale, the length of an auction is impossible to track, so this value defaults

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4   This would correlate strongly with whether or not a case is included with the guitar.

to zero. However, this is likely just as well, since a greater span of time for Buy It Now/Best Offer sales will not necessarily generate increasingly higher offers, whereas for auctions, multiple bids will necessarily become higher and higher.

Counters

Some Ebay auction pages list counters that reveal the number of page views an auction. A higher counter number means that more people viewed the auction page, and gives a representation of how popular the auction was. This is functionally similar to tracking the number of unique bids, although it tracks the number of prospective customers rather than the number of "serious" ones.

Seller Details

Feedback

The seller's feedback score. This is an easy way for prospective buyers to determine the trustworthiness of a seller, as judged by consumers who have bought from the seller before. It also will reveal whether or not the seller has "established" his or herself as an experienced Ebay user. Despite the conclusions of other papers that this variable does not have a very large impact on auction prices, it was found to be statistically significant nonetheless, and will be examined in the model.

Dealer

Ebay users will either be private citizens, or actual companies operating in the secondary market. If the user is clearly not a private citizen, the user will be marked as a dealer. A prospective buyer would likely feel more comfortable buying from a dealer rather than private citizen.

NumGuitarsSold

Ebay users can view other completed listings for items the seller has sold previously, and can narrow this by product type. When selling an expensive item such as a vintage guitar, experience selling items such as this may influence prospective buyers' bids, as well as whether or not they bid at all.

Knowledgeable

This holistic variable represents whether the seller appears to have in-depth knowledge of the product he is selling. This is determined by judging whether or not the seller extensively details the product and its minutiae on the auction page, such as instrument history, modifications made (if applicable), how many times it has changed hands, et cetera. This may serve as an information signal regarding the seller's pedigree as a guitar salesman.

SellerViews

Ebay users can track how many times other users have viewed a seller's page. This can help gauge the popularity of a seller, which may be an important sign of seller experience to a prospective buyer.

Product Details

Year

The year the guitar in question was manufactured. Generally speaking, a guitar's value is positively correlated with age.

Model

The model of the guitar. Guitar models are valued differently, making this an important dummy variable to include. The models included in the study were Fender Stratocasters,

Mustangs, Jaguars, Jazzmasters, and Jazz Basses.

Finish

The color or pattern of the guitar's finish. Some finishes are more popular than others and this would likely impact the dependent variable. To constrict the number of regressors that would be caused by a large number of different finishes, a handful of finishes were included as dummies, with finishes that saw very few observations (and were therefore comparatively rare) simply labeled "Custom."

FinishOriginal

Whether the guitar was refinished (i.e. repainted) or not. Original finishes are more highly valued than refinished products.

Condition

A holistic rating to objectively categorize the guitar's condition at point of auction. Making the assumption that used guitars are only liquid if they in are at least salable condition, this trinary value denotes if the guitar is in acceptable (0), good (1), or excellent (2) condition.

Case

Whether or not the instrument includes a hardcover case. A case serves to protect the guitar as an investment product, and at higher price ranges, a hardcover case is expected.

Case Condition

The condition of the case, if one is included. Determined similarly to the instrument's condition, or 0 if the case is not original to the instrument.

Modified

Any modifications or repairs made to the product hitherto the point of auction are

believed to cause a significant decline in value; however, almost every guitar sold on Ebay was refretted or otherwise repaired in some way, so to make this an effective variable, it only tracks whether or not the pickups, tuners, or potentiometers have been replaced.

While each of these variables have been considered for the model, the actual empirical analysis will determine which of them are statistically significant and capture the price of a vintage guitar on Ebay. To do this, these variables will be used in a regression and tested for significance. The model will be run iteratively with insignificant variables excluded, until only significant variables remain. The final model will provide the best explanation for what determines the price of a vintage guitar auction on Ebay.

To work with so many unsold goods, a second regression will be run with "WasSold" as the dependent variable. This second model will estimate the likelihood of an item selling using a logistic binary choice model. This analysis will use a similar approach to the first model, in that all variables will be tested to begin with, and the model will be refined iteratively.

It is important to note that, despite the breadth of variables considered for this model, there are still more variables that might have been considered before data collection began. First, while a seller's feedback score has been included in the data set, the percentages of negative and positive feedback the seller received have not. Houser and Wooders, as well as Lucking-Reiley et al., all found that increases in negative feedback led to very small, albeit statistically significant, decreases in final bid prices. Including this data in the model would have captured additional information about the auction.

Furthermore, some additional descriptors of the instrument itself might have been included. The type of wood used to construct the neck may have had an impact on the value of

the instrument to sellers. Similarly, whether or not the guitar's finish included binding may have increased the value of the instrument.

IV. Empirical Analysis

To build the data set for this study, 225 unique observations of guitar auctions and sale listings on Ebay were collected. For each observation, each of the variables considered for the model was recorded by hand. As previously mentioned, of the 225 observations, about one-third of the products examined actually sold on Ebay.

The purpose of this study is to examine two variables of interest: the price of a vintage guitar auction on Ebay, and the likelihood of such an instrument selling. It is hypothesized that the variables of interest detailed in the previous section will serve as good predictors for these two response variables.

IV.a. Price-Predictive Model of the Guitar Market

The first dependent variable to be examined will be price. To begin the empirical analysis, we perform a regression that includes all possible regressors in the model. The base case will be a listing for a Sunburst-finish Stratocaster that ended on a Sunday, with dummy variables to indicate otherwise[5].

Iterative t-tests will break down the model and reveal which variables are statistically significant.

For each regressor i,

Ho: $\beta_i = 0$

Ha: $\beta_i \neq 0$

For all variables except Init Price in the price-predictive all-inclusive model, do not reject

5   This is the "Price-predictive all-inclusive model," and can be found on Page 32.

Ho. Conclude that, for the purposes of determining price, the initial price of the auction is the only statistically significant variable. With every possible regressor included, the model breaks down almost entirely for the purposes of determining price. However, there are some important considerations regarding the data set that will merit a restructuring of the model.

Recall that only approximately one-third of the products examined (82 of 225) actually sold. Of these, slightly over one-half (53 of 82) were auction-only listings, as opposed to Buy It Now/Best Offer listings. Since so many observations were unsold goods with zero bids, the initial price was the same as the price at the point of the listing's termination. This makes the high t-statistic of Init Price highly suspect. To solve this problem, the sample will be restricted to goods that have differing initial and final prices.

Restricting the sample in this manner is easily performed by only using data listed as both sold and as having a nonzero number of bids. Auctions that include a Buy It Now/Best Offer option are still used in the model, as this does not necessarily preclude the listing being an auction (it may simply be an auction with the Buy It Now option offered). Sorting the data in this way gives a sample of 68 observations. The variable WasSold, now a constant, has been removed from the model[6].

With the sample fixed to accommodate Init Price, a higher portion of variability is explained; however, now, not a single variable is statistically significant. The number of regressors is reduced to make the model more specific. The presence of counters in an auction page may serve as an indicator of the listing's popularity, but does not necessarily increase the desirability of the instrument. Similarly, the number of views on a seller's page is a good indicator of how many users were interested in the seller's history, but has no intrinsic bearing on

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6   This is the "Price-predictive sold goods model," and can be found on Page 33.

the value of the instrument itself. Since we are strictly examining auction listings in this smaller sample, Buy it Now/Best Offer? is no longer necessary to include. Reserve Met? is likewise ineffectual, as we are only examining sold products in this model; if a product was sold, its reserve price must have been met. Buy it now/Best Offer Price may complicate the model in the same way Init Price did with many 0-bid listings, so it will be removed. The possible accelerative effect that weekend-closing auctions would have had on bidding will already be captured in the number of bids that a product received, and by the same token, so too would the effects of a longer-running auction. As a result, both AuctionLength and the dummy set of Day Auction Ended variables will both be stricken. The informative signals given by whether or not the seller is a dealer are more or less contained by the number of guitars a seller has sold; as it seems redundant to include both of these variables in the same model, we will only use NumGuitarsSold[7].

In the resultant model, the t-statistic for Init Price is now much higher than before, though no other variable still approaches statistical significance. Nevertheless, this model is an even better fit for explaining price than the previous one, as its R-Sq is only slightly less, and its adjusted R-Sq is significantly higher. Restricting the regressors to include only descriptors of the instrument itself is the most specific model that will be developed. For simplicity's sake, the only descriptor to be included, as far as the instrument's finish goes, is whether or not the finish is original.

In the instrument-specific model[8], again, none of the variables are concluded to be statistically significant, and the portion of variability explained by the model has decreased

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7   This is the "Price-predictive refined sold goods model," and can be found on Page 34.
8   This model can be found on Page 35.

considerably when compared to the previous best-fit model, suggesting important information regarding value descriptors is being omitted in this instrument-specific model. By extension, we can conclude that the sale price of an instrument on Ebay is determined by more than the instrument itself.

The refined sold goods model was the best fit for the purposes of explaining price. While none of the variables can be interpreted as statistically significant, the values of the coefficients in this model might corroborate some claims regarding the descriptors.

IV.b. Price-Predictive Model: Conclusions

The negative coefficient of year indicates that the value of the guitar does increase with age (i.e., the smaller the value for year, the older the guitar is, and the less the forecast price will decrease). An original finish is indeed purported to have a positive effect on the guitar's forecast price. A modified guitar will be forecast with a lower price than one that has not been modified. A rare, custom finish is valued much higher than any other finish, which makes intuitive sense and is reported by the model. A vintage Stratocaster (the base guitar dummy variable in the model) is valued higher than any other guitar model in the statistical model, which makes sense as the Mustang and Jaguar were intended to be student-grade or middle-grade guitars and as such were offered at lower price points. There is a far smaller comparative discrepancy between Stratocasters and Jazz Basses and Stratocasters and Telecasters, which is also a reasonable conclusion as Telecasters were near the same price grade as Stratocasters, and Jazz Basses were also professional-grade instruments. The knowledgeability of the seller is reported to have value as an informational signal, as well as the number of guitars sold. A greater number of bids would drive up the price by necessity, so the coefficient of NumBids is neither surprising nor

enlightening.

Some of the regression results ended up being counterintuitive. While the convenience of credit card auctions was expected to be offered at a premium, a premium in excess of $1000 is somewhat absurd. For auctions that accepted returns, the forecast price of the instrument was actually lower than an auction that did not accept returns. The regression predicted a similar result for auctions that offered to ship worldwide. The condition of the instrument was predicted to have almost no bearing at all on price, whereas an instrument sold with a pristine case had a much higher forecast price than one with a poor-condition case. The model expects unique bids to exert a downward force on price. As expected, Feedback was predicted to have a very small impact on price, but the regression predicted that higher feedback scores would lead to lower prices. Most surprising of all was perhaps the negative coefficient of ln(Pictures). This regressor was expected to have a positive, nonzero coefficient, but instead was predicted to push price down by almost $100 for an auction having as few as three photographs (most auctions had at least 6).

The refined sold goods model has some serious problems in terms of statistical significance, for which a model with a smaller amounts of regressors (the instrument-specific model) was developed in an attempt to correct. However, pulling regressors out of the model actually made the model *worse*, as t-statistics for variables were almost uniformly lower and the R-Sq was significantly lower than the refined sold goods model. With so many unsold goods, there simply was not enough data to test for all the regressors that were likely to impact price. Restricting the data set to only include goods that had sold under an auction mechanism left us with insufficient data to study price. Almost all of the unsold goods had zero bids or offers, and

the addition of many listings operating under Buy It Now/Best Offer excluded these goods from the study, as their prices could not be bid up in the same way auction listings were. Essentially, results are inconclusive since a large enough data set to work with the many regressors necessary to capture the price of a vintage guitar is not available. More sold-goods auction listings would have yielded a more conclusive study, although due to the nature of the products being investigated in this study, the source of data was somewhat limited (only so many completed listings for these specific products could be found).

Furthermore, instruments seemed to sell at random. An otherwise unremarkable guitar with a rare off-black finish sold for more than $14000, while a pristine Stratocaster with a good-condition case and a verifiable seller pedigree fetched very few bids at all and sold for less than $5000. There seemed to be little of anything correlated between listings that had actually sold. In an attempt to understand this, the next model we will develop will be a probabilistic model that is intended to determine what influences the likelihood of an instrument selling.

IV.c. Probabilistic Model of the Guitar Market

A binary-choice model will allow the model to work with so many unsold goods in the data set, which is a major advantage over attempting to estimate price.

Similar to how the price model was developed, the probabilistic model will first include all descriptors, and the model will be iteratively broken down. Again, for the dummy variables used, the base case will be a listing for a Sunburst-finish Stratocaster that closed on a Sunday.

To test for significance, conduct a Wald test on each regressor. The Wald test uses the square of the z-statistic, which gives a Wald statistic with a chi-squared distribution and one degree of freedom.

For each regressor i,

Ho: $\beta_i = 0$

Ha: $\beta_i \neq 0$

Under these testing parameters, a regressor bearing a z-statistic with absolute value less than 0.1265 will be concluded to be not statistically significant, as its Wald statistic (square of the z-statistic) will not fall within the specified rejection region. From looking at the z-statistics, the all-inclusive probabilistic model[9] merits some restructuring. Whether or not the instrument was modified does not seem to be statistically significant for determining whether or not the instrument is likely to sell. This is a reasonable variable to drop from a predictive model, as it seems a more important determinant of value than the likelihood of the instrument selling. The amount of views a seller has on his or her page was expected to have some bearing on the likelihood of the good being sold, but for the Wald test, we do not reject the null hypothesis of this regressor being zero; it should be ejected from the model. Furthermore, as meeting an auction's reserve is a known necessary condition for the product to be sold, it seems redundant to include it in the probabilistic model. The lot of variables for finish should be left in the model.

In the refined probabilistic model[10], shipping cost, the price of a Buy It Now/Best Offer listing, and whether or not the instrument's finish is original are all concluded to be not statistically significant (dummies are left alone).

With these variables removed, all regressors included in the final probabilistic model[11] are now concluded to be statistically significant, with the exception of the dummy variable denoting an auction ending on a Saturday. Other indicator variables in this category are concluded to be

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9 This model can be found on Page 36.
10 This model can be found on Page 37.
11 This model can be found on Page 38.

statistically significant. What conclusions can be drawn from the final probabilistic model?

IV.d. Probabilistic Model: Conclusions

For a logistic binary-choice statistical model, let L be the numerical evaluation of the regression equation. The probability of a guitar selling equals $1/(1+\exp(-L))$. It follows, then, that for any regression coefficient B, as B increases, L also increases, and therefore, the predicted probability that a guitar will sell also increases. This simplifies our results considerably.

While the negative coefficient for year might not seem surprising – older guitars are typically higher valued, after all – it is important to consider that far more 1970's models sold than any other vintage of guitar sampled in the study[12], and furthermore, newer models had lower prices[13], which, according to the model, should also have increased the likelihood of a sale. The negative coefficient of price is not surprising, as a higher-priced model would fall above more consumers' buyer values, decreasing the customer base and therefore the likelihood of a sale. The convenience of returns was apparently a big draw for customers, though the suggested repulsive effect of sellers that accepted credit cards is a rather counterintuitive conclusion. Worldwide shipping and the instrument's condition both exerting positive impacts on the instrument's likelihood-of-sale were fairly logical conclusions, whereas feedback again was shown to have a curiously downward force on the probability of a sale (even if it was an extremely small amount). A Buy It Now/Best Offer type listing actually decreased the chance of a sale, which makes intuitive sense – buyers were not able to bid up to their buyer value, and instead had to either take or leave a pre-named price (or let the seller accept or decline their offer). This pre-

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12 Recall that the guitars studied in this paper included only 50's, 60's, and 70's models.
13 Fender was purchased by CBS in 1965, who enacted cost-cutting design decisions that ultimately led to a large influx of cheaper Fender instruments during the late 60's and the 1970's. The combination of lower-priced instruments and increased output from Fender can hardly be ignored as an effect on the greater availability and propensity to sell of the 1970's models.

named price typically ended up being more than any Ebay user's buyer value for such a product, as the data set corroborates – of the 82 sold products, 30 offered Buy It Now/Best Offer mechanisms, and only 10 were actually bought via Buy It Now/Best Offer as opposed to the auction mechanism.

As expected, a good-condition instrument is forecast to have a better chance of selling than a poor-condition one, as is an instrument that is sold with a case. Curiously, the predicted probability of the instrument selling actually fell as the condition of the case improved, while the diminuitive negative impact of the counters on a seller's page, while similarly counterintuitive, was about as small as expected. The negative coefficient of Knowledgeable might not be as strange as expected: a knowledgeable seller would know more information about the value of his or her own guitar, and be able to offer it at a price that more accurately values it. For high-value, high-quality instruments, buyers would want the seller to *not* recognize the value of his or her own product – they would hope that the seller would undervalue their own product and offer it at a price below the true value. A buyer that could recognize this would stand to come out significantly ahead.

The initial price of a listing is difficult to consider in the model, as it only really affects the small portion of listings that were both sold goods and auction listings. However, it does make sense that a higher initial price would serve to attract fewer potential bidders, so the negative coefficient for Init Price makes intuitive sense. Oddly enough, what was intuitively one of the best determinants of the likelihood of a product selling, the number of bids a product had, was estimated to decrease it rather than increase it. An auction with any bids at all was rare enough, and almost all those that had at least one bid sold, making this a highly suspect result.

The model's positive prediction of the amount of unique bids a listing received, however, is much more sensical. The length of an auction was expected to increase the chance that the listing would sell, as there would be a wider window of opportunity for prospective customers to find and bid on or purchase the item in question; however, the model does not corroborate this claim. Whether or not a seller was a dealer of guitars is estimated to increase the likelihood of the instrument selling, which makes sense as this was expected to have value as an informative signal regarding the trustworthiness of the seller. The number of guitars a seller had previously sold was similarly expected to increase the likelihood of a sale; however, the model predicts that it has a very small negative impact on this probability.

Regarding the many indicator variables used in the model, a blonde-finish guitar was the most likely finish of model to sell, whereas Candy Apple Red was the least likely finish to sell. However, this may be correlated with the fact that many Stratocasters were finished in Candy Apple Red, and a small amount of Stratocasters actually sold in relation to the rest of the instrument models included in the regression. A custom finish was expected to significantly increase the probability of a sale (as it would greatly increase the desirability of the instrument). However, such a finish was predicted to have a negative impact on the likelihood of a sale – this may be due to the fact that custom finishes were offered at high prices, and price negatively affected the probability of a good being sold.

For specific models of guitars, Mustangs were predicted to sell more often than any other instrument, and Telecasters are expected to sell particularly poorly. This is intuitively sound for Mustangs, as Fender Mustangs were introduced as a lower-price instrument to capture the middle market. Telecasters were of a professional grade similar to the Stratocaster, making the predicted

discrepancy between the two suspect.

The model predicts that weekend-closing auctions were actually the least likely days to sell a product on, as every weekday had a greater positive influence on the forecast probability than either of the two weekend days.

Finally, pictures were indeed predicted to increase the likelihood of a sale.

The logistic model is useful for answering the second question this study was investigating – what determines the likelihood of a guitar listing on Ebay selling – but while the final model did not bear the same problems of statistical significance that the price-predictive model did, many of its conclusions did not follow logically from what was expected. Again, the data set is suspected to be at the root of the problems plaguing attempts to model guitar auctions and sales on Ebay. Due to the high quantity of unsold goods, high quantity of auctions with zero bids at all, and differing mechanisms of sale (auctions versus Buy It Now/Best Offer), the observations in the data set are not as homogenous as modeling this market demands.

V. Summary of Results

In an attempt to model the massive market for vintage guitars, a study was performed that used the market for vintage guitars on Ebay as a data set. This study attempted to model the products in two ways: first, what are the determinants of price for a vintage guitar being sold on Ebay, and second, what factors determine whether or not the instrument will sell at all. There were significant problems with the models.

The results of the first portion of the study were inconclusive. The only way to model price was to use listings for instruments that had actually sold (modeling a price-predictive model on products that did not have a selling price would be nonsensical), which effectively

shrunk the data set from 225 observations to 68 observations. With a high number of regressors and a small sample size, every single variable included in the model was concluded to be not statistically significant. Decreasing the number of regressors in the model led to a significantly lower goodness-of-fit for the model, suggesting that the deleted regressors had contained important information. Ultimately, the results of the best-fit model were scattered: for as many hypothesized claims that the model corroborated (i.e. older guitars will have higher prices), it made as many, if not more, completely counterintuitive claims (i.e. a higher number of pictures will decrease the forecast price of an auction).

The results of the second portion of the study were similarly inconclusive. A probabilistic model allowed for the use of so many unsold goods in the data set, making sample size no longer a problem. However, the heterogeneity of the data ultimately made for inconclusive results. There was a disproportionately high amount of unsold goods in the data set, differing mechanisms of sale, and many of the auctions had zero bids at all, ruining the usefulness of the listing's initial price as a regressor (the initial price was equivalent to the final price in an inordinate number of observations). As with the first portion of the study, some of the model's predictions confirmed hypotheses, while other predictions seemed illogical.

Redoing this study would necessitate an entirely new data set, and likely a different source of data as well. As stated before, it is believed that the lack of a large quantity of homogenous data has caused the models developed to break down. It also limits the amount of specificity with which a model can be developed. For example, what specifically drives the price of a Stratocaster up, as opposed to a Telecaster, would have been of interest, or perhaps investigating different vintages of guitars independently of one another. However, in having to

constrict the data set to sold-good auction listings only, an additional restriction to one specific model or vintage would have not allowed for a very inclusive model, as the data set would have been extremely small (likely less than 20 observations). As far as vintage guitar deals are concerned, it is entirely likely that Ebay is simply not a good source for data of this type. It is the author's opinion that most transactions of vintage instruments happen personally, between private individuals, and that most people willing to pay a large amount of money for a vintage instrument would not do so unless they could physically inspect the instrument themselves. This would explain the reason that so many goods are unsold: the author believes that, more often than not, transactions of this nature simply do not happen over the internet. However, alternative data sources for this particular type of market would be difficult to find. Furthermore, as previously mentioned, some other important variables of interest (both product and auction details) that were not collected for this study would merit inclusion in a redone model.

Most of the instruments that do sell on Ebay are recently manufactured models that sell for fewer than $2000, which is simply considered by Vintage Guitar Price Guide to be in the middle-range of guitar values. While there is a large market for the sale of vintage instruments on Ebay, there is not a large market for their purchase. So few sold goods operating under differing sale mechanisms makes an appropriate sample difficult to build, which necessitates bringing in many new models to expand the sample, complicating the model even further. A study of the price and likelihood-of-sale for vintage guitars is feasible, but using a data set of Ebay auctions to do so may not be.

Appendix A: Data Set Outline

	Jaguar	Jazz Bass	Jazzmaster	Mustang	Stratocaster	Telecaster	Total (Sold)
# 1950's (Sold)	0 (0)	0 (0)	5 (1)	0 (0)	6 (0)	5 (2)	16 (3)
# 1960's (Sold)	17 (6)	13 (5)	9 (3)	22 (13)	27 (4)	16 (3)	104 (34)
# 1970's (Sold)	1 (0)	8 (4)	3 (1)	10 (6)	41 (18)	42 (15)	105 (44)
Total (Sold)	18 (6)	21 (9)	17 (5)	32 (19)	74 (22)	63 (20)	225 (81)

	Jaguar	Jazz Bass	Jazzmaster	Mustang	Stratocaster	Telecaster	Across All Models
Average Asking Price of Unsold Models	$8,684.72	$6,574.17	$5,020.16	$1,520.70	$10,158.21	$6,768.33	$7,516.55
Average Price of Sold Models	$2,965.27	$5,184.97	$3,331.60	$1,021.89	$3,270.88	$3,108.02	$2,896.91
Average Condition of Models	1.44	1.33	1.24	1.38	1.5	1.41	1.42
Percentage of Cases Included	0.94	1	0.82	0.84	0.78	0.95	0.88
Percentage of Original Finishes	0.83	0.95	0.82	0.75	0.8	0.75	0.8
Percentage of Instruments Modified	0.22	0.14	0.42	0.53	0.42	0.41	0.39
Number of Buy It Now/Best Offer Listings (Sold via this mechanism)	8 (0)	11 (3)	11 (3)	16 (6)	39 (10)	31 (7)	116 (29)
Number of Auction Listings (Sold via this mechanism)	10 (6)	10 (6)	6 (2)	16 (13)	35 (12)	32 (13)	109 (52)

Appendix B: Auction Theory

Ebay's auctions operate under a type of auction mechanism known as an English auction. This variety is an open ascending price auction (as opposed to closed, in which bids are secretly submitted and bidders cannot see what bids have been submitted). Auctions are used typically because the seller of a good is unsure about the maximum value that bidders attach to the product in question. In the market for vintage guitars, sellers know that the same resources for appraisal are available to both them and the buyers. The market value of the instrument, then, is already known. The sellers may not know individual buyer values, but they are aware of a price over which any rational consumer would not pay. As Ebay listings are not always auctions, buyers will know when sellers have priced Buy It Now/Best Offer listings at too high of a price.

However, bids may still have power as information signals, due to the fact that the type of product being sold – a vintage guitar – is not a common value good. Most, but not all consumers that desire to purchase a vintage instrument wish to do so for the purpose of eventual resale, and may base their buyer value on some postulated future value rather than the current market value. Other consumers may not wish to purchase the instrument for resale at all and would simply like it as an expensive status symbol or decoration. Still others may be most interested in simply owning the guitar to play and make use of it[14]. Each of these differing reasons for ownership will change the desirability of the instrument to the prospective buyer. A guitar player that fancies a Fender Telecaster over a Fender Stratocaster may be prepared to pay much more for the Telecaster, even if the Stratocaster is forecast to have a much higher resale value – the resale value is not of tantamount importance to the consumer, whereas the model itself is.

Vintage guitar auctions on Ebay, as private value open-ascending auctions, are at least

---

14 Vintage guitars are often prized as much for their sound and playability as their investment value.

weakly equivalent to second-price sealed bid auctions. In this type of auction, bids are submitted secretly by all bidders, and the winner with the highest bid pays the second-highest price that was submitted. Second-price sealed bid auctions have a weakly dominant strategy, which is for buyers to bid up to their value.

Proof: Consider Bidder 1, and suppose that p_1 is the highest competing bid. By bidding his buyer value, x_1, Bidder 1 will win if $x_1 > p_1$, and will not win if $x_1 < p_1$ (in the case of equality, Bidder 1 is indifferent between winning and losing). If Bidder 1 bids an amount $z_1 < x_1$, then if $x_1 > p_1 > z_1$, Bidder 1 loses, whereas if he had bid x_1 he would have made positive profit. If $x_1 > z_1 \geq p_1$, Bidder 1 would still have made $x_1 - p_1$ worth of profit. So, bidding less than x_1 can never increase profit, and in some circumstances might actually decrease it.

So, what might have been expected would be the following: due to the easy availability of appraisal materials and personnel for vintage guitars, the true value of the instrument is known to both the buyer and the seller. Of all parties interested in purchasing a vintage instrument, assume at least one of them will value the guitar at its appraisal price. As bidders seek to maximize their profits, we would assume that the bidder valuing the guitar at its appraisal price would play the weakly dominant strategy of bidding precisely his buyer value. So, for each instrument that sold, we would expect it to sell at least at its market value, and possibly more, if a consumer whose private value exceeds the market value of the instrument is also bidding.

However, for the few guitars that did sell, they were consistently sold at prices below the values suggested by appraisal sources such as Vintage Guitar Magazine Price Guide. For example, a low-quality condition 1965 Stratocaster, in a common color, is valued at $20,000 in the aforementioned price guide. A good-condition 1965 Stratocaster in an Olympic White finish

(a common finish for the instrument) sold for $11,950, almost half of the market valuation for the product. The initial bid for this product was $9.99, so the initial price was certainly inviting. The auction closed with 32 bids, 18 of them unique, which signifies a large spread of consumers in the sample of bidders. It seems reasonable to assume that at least one of those bidders, then, might have valued this product at its appraisal value. This particular listing was an English auction for a vintage guitar (not a common value product), so bidders were expected to follow the modeled strategy of bidding their buyer value. Why, then, did such an ideal auction close at a price so disparate from what the model predicted?

There are four likely reasons. The first would be the asymmetry of information involved in such a sale. The earlier section of this study, "Full Literature Review," discussed how the market for vintage guitars on Ebay might exhibit the lemon problem in greater detail. While the seller of the $11,950 guitar had posted 16 high-quality photographs of his instrument and offered complete contact information, no informational signal is as powerful as a personal inspection by a prospective buyer. This is especially true for a buyer that values the guitar as an instrument first, rather than an investment product. The second reason is simply because prospective bidders are not following the auction from start to close. Unlike an English auction in which the bidders are physically present, on an internet English auction, bidders may bid once on a product and never return to the listing again, even if their buyer value exceeds the current price of the listing. They may simply forget about the auction, find another product that they place a higher value on, or lose interest in the product. The third reason might be that the bidder's buyer value simply outpaced his or her budget constraint, leaving the bidder unable to bid up to his buyer value at all. Finally, it is again the author's opinion that most transactions involving vintage instruments

occur in-person, and that the values in Vintage Guitar Magazine Price reflect prices as would be accepted by vintage guitar dealers themselves. The populace at large may still value the instrument at a lower price than a professional dealer would, which would explain the large discrepancy in the sale price of the earlier observation.

In summary, Ebay cannot be expected to behave under the standard model of private value, open-ascending auctions, at least in the market for vintage guitars. The complicating effect of such heterogeneous data, as well as some possible issues with internet auctions fitting into the model of the private value English auction, make sales difficult to estimate under this model.

Price-predictive all-inclusive model

```
Predictor                         Coef  SE Coef      T      P
Constant                        182460   179312   1.02  0.310
Year                            -92.02    90.79  -1.01  0.312
Shipping                        -2.228    5.976  -0.37  0.710
Returns                         -420.2    845.4  -0.50  0.620
Credit Cards                      2072     1426   1.45  0.148
ShipsWorldwide                   241.4    450.5   0.54  0.593
Condition                       -61.80    98.10  -0.63  0.530
WasSold                             54     1046   0.05  0.959
Feedback                       -0.0389   0.1133  -0.34  0.732
Buy it Now/Best Offer?           -42.2    472.5  -0.09  0.929
Reserve met?                     -1103     1164  -0.95  0.345
Buy it now/Best Offer Price     0.1363   0.1141   1.19  0.234
FinishOriginal                   -2459     1106  -2.22  0.027
Case                              1063     1414   0.75  0.453
Case Condition                  -132.5    435.1  -0.30  0.761
Modified                         251.2    819.5   0.31  0.760
Counters                        0.2634   0.6690   0.39  0.694
Knowledgeable                    318.8    899.9   0.35  0.724
Init Price                      0.8192   0.1329   6.17  0.000
NumBids                          247.8    167.2   1.48  0.140
UniqueBids                      -310.1    302.9  -1.02  0.307
AuctionLength                   -23.67    19.85  -1.19  0.235
Dealer                          1399.1    930.4   1.50  0.134
NumGuitarsSold                  -0.431    4.600  -0.09  0.926
SellerViews                    -0.0616   0.1721  -0.36  0.721
Finish_Blonde                     -495     1533  -0.32  0.747
Finish_Nat                        1882     1434   1.31  0.191
Finish_Candy Apple Red            -159     1483  -0.11  0.915
Finish_Olympic White              2504     1534   1.63  0.105
Finish_Black                      -816     1621  -0.50  0.615
Finish_Blue                        859     2025   0.42  0.672
Finish_Custom                     -305     1393  -0.22  0.827
Model_Telecaster                  -169     1339  -0.13  0.900
Model_Mustang                    -1772     1526  -1.16  0.247
Model_Jaguar                      2831     1746   1.62  0.107
Model_Jazzmaster                  -945     1975  -0.48  0.633
Model_Jazz Bass                    496     1594   0.31  0.756
Day Auction Ended_Monday          -752     1326  -0.57  0.571
Day Auction Ended_Tuesday         2686     1498   1.79  0.075
Day Auction Ended_Wednesday       -522     1393  -0.37  0.708
Day Auction Ended_Thursday        -737     1367  -0.54  0.590
Day Auction Ended_Friday         -1106     1365  -0.81  0.419
Day Auction Ended_Saturday          56     1404   0.04  0.968
lnPictures                       559.8    517.7   1.08  0.281

S = 5037.32   R-Sq = 70.3%   R-Sq(adj) = 63.2%
```

Degrees of freedom for the all-inclusive model: 225 – 48 – 1 = 174
Level of significance: $\alpha = 10\%$
From the student's t-table, the rejection region is specified at t = 1.645

Price-predictive sold goods model

```
Predictor                      Coef  SE Coef       T       P
Constant                     527120   132648    3.97   0.001
Year                        -266.07    66.71   -3.99   0.001
Shipping                      1.559    9.295    0.17   0.868
Returns                      -567.2    750.5   -0.76   0.457
Credit Cards                    618     1201    0.51   0.612
ShipsWorldwide                 -4.9    170.7   -0.03   0.977
Condition                      8.10    38.19    0.21   0.834
Feedback                   -0.05799  0.09086   -0.64   0.529
Buy it Now/Best Offer?         -392     1284   -0.31   0.763
Reserve met?                   -285     2633   -0.11   0.915
Buy it now/Best Offer Price  0.3789   0.4012    0.94   0.354
FinishOriginal                462.1    807.6    0.57   0.573
Case                           -212     1021   -0.21   0.837
Case Condition                352.0    504.3    0.70   0.492
Modified                       -2.8    703.9   -0.00   0.997
Counters                      0.606    1.162    0.52   0.607
Knowledgeable                -391.2    767.8   -0.51   0.615
Init Price                   0.3513   0.4036    0.87   0.393
NumBids                       83.01    82.53    1.01   0.325
UniqueBids                    -76.7    137.5   -0.56   0.582
AuctionLength                   1.7    121.9    0.01   0.989
Dealer                        268.6    643.9    0.42   0.680
NumGuitarsSold                2.556    4.634    0.55   0.586
SellerViews                  0.0571   0.2119    0.27   0.790
Finish_Blonde                -701.2    948.5   -0.74   0.467
Finish_Nat                    -97.5    979.5   -0.10   0.922
Finish_Candy Apple Red        -29.5    932.2   -0.03   0.975
Finish_Olympic White          -1006     1238   -0.81   0.425
Finish_Black                    -16     1293   -0.01   0.990
Finish_Blue                   -20.2    923.7   -0.02   0.983
Finish_Custom                -407.4    931.2   -0.44   0.666
Model_Telecaster            -1617.8    950.6   -1.70   0.102
Model_Mustang                 -2908     1073   -2.71   0.012
Model_Jaguar                  -2779     1212   -2.29   0.031
Model_Jazzmaster              -3199     1560   -2.05   0.051
Model_Jazz Bass                -242     1157   -0.21   0.836
Day Auction Ended_Monday        475     1009    0.47   0.642
Day Auction Ended_Tuesday     886.6    896.7    0.99   0.333
Day Auction Ended_Wednesday    -665     1029   -0.65   0.524
Day Auction Ended_Thursday     -619     1112   -0.56   0.583
Day Auction Ended_Friday      136.3    848.6    0.16   0.874
Day Auction Ended_Saturday    382.3    965.2    0.40   0.696
lnPictures                    -13.0    405.4   -0.03   0.975


S = 1412.28   R-Sq = 91.0%   R-Sq(adj) = 75.2%
```

Degrees of freedom for the sold goods model: $68 - 48 - 1 = 19$
Level of significance: $\alpha = 10\%$
From the student's t-table, the rejection region is specified at $t = 1.729$

Price-predictive refined sold goods model

```
Predictor                 Coef   SE Coef       T      P
Constant                481222    102182    4.71  0.000
Year                    -243.12     51.64   -4.71  0.000
Shipping                  4.640     7.253    0.64  0.526
Returns                  -349.0     428.7   -0.81  0.421
Credit Cards             1071.8     869.7    1.23  0.226
ShipsWorldwide           -110.3     138.5   -0.80  0.431
Condition                  8.86     30.53    0.29  0.773
Feedback               -0.03232   0.05534   -0.58  0.563
FinishOriginal            331.2     555.7    0.60  0.555
Case                       20.6     785.4    0.03  0.979
Case Condition            359.2     375.1    0.96  0.345
Modified                 -100.1     472.9   -0.21  0.834
Knowledgeable             189.1     488.1    0.39  0.701
Init Price              0.70412   0.09316    7.56  0.000
NumBids                   74.73     54.97    1.36  0.182
UniqueBids               -24.3      104.8   -0.23  0.818
Dealer                    185.4     448.0    0.41  0.681
NumGuitarsSold            3.591     2.238    1.60  0.117
Finish_Blonde           -390.4      712.0   -0.55  0.587
Finish_Nat                60.4      723.3    0.08  0.934
Finish_Candy Apple Red     7.0      770.0    0.01  0.993
Finish_Olympic White    -820.0      965.9   -0.85  0.402
Finish_Black            -267.1      994.3   -0.27  0.790
Finish_Blue             -201.1      750.3   -0.27  0.790
Finish_Custom            237.5      633.5    0.37  0.710
Model_Telecaster       -1932.6      672.8   -2.87  0.007
Model_Mustang          -3228.9      714.2   -4.52  0.000
Model_Jaguar           -3216.0      836.2   -3.85  0.000
Model_Jazzmaster       -3106.8      994.0   -3.13  0.004
Model_Jazz Bass         -871.0      827.8   -1.05  0.300
lnPictures              -120.7      309.7   -0.39  0.699


S = 1272.49   R-Sq = 89.0%   R-Sq(adj) = 79.8%
```

Degrees of freedom for the refined sold goods model: $68 - 30 - 1 = 37$

Level of significance: $\alpha = 10\%$

From the student's t-table, the rejection region is specified at $t = 1.645$

Price-predictive instrument-specific model

```
Predictor            Coef   SE Coef      T      P
Constant           757679    125388   6.04  0.000
Year               -382.32     63.57  -6.01  0.000
Condition           -16.56     38.44  -0.43  0.668
FinishOriginal       559.0     732.4   0.76  0.449
Case                  -321      1055  -0.30  0.762
Case Condition       593.7     417.8   1.42  0.161
Modified            -489.0     622.5  -0.79  0.436
Model_Telecaster   -1539.3     818.3  -1.88  0.065
Model_Mustang      -4585.4     848.6  -5.40  0.000
Model_Jaguar         -4507      1161  -3.88  0.000
Model_Jazzmaster     -4126      1251  -3.30  0.002
Model_Jazz Bass       -180      1050  -0.17  0.865


S = 2005.19   R-Sq = 58.3%   R-Sq(adj) = 49.9%
```

Degrees of freedom for the instrument-specific model: 68 – 11 – 1 = 56
Level of significance: α = 10%
From the student's t-table, the rejection region is specified at t = 1.645

Probabilistic all-inclusive model

```
Predictor                          Coef     SE Coef      Z      P  Odds Ratio
Constant                        283.190     165.220   1.71  0.087
Year                          -0.151137   0.0841352  -1.80  0.072        0.86
Price                         0.0000302   0.0001375   0.22  0.826        1.00
Shipping                      0.0012982   0.0045683   0.28  0.776        1.00
Returns                         1.91977    0.770654   2.49  0.013        6.82
Credit Cards                   -1.64445     1.39066  -1.18  0.237        0.19
ShipsWorldwide                 0.566227    0.541007   1.05  0.295        1.76
Condition                       1.82931    0.731433   2.50  0.012        6.23
Feedback                     -0.0000563   0.0000817  -0.69  0.490        1.00
Buy it Now/Best Offer?         0.222704    0.882928   0.25  0.801        1.25
Reserve met?                    9.53064     2.00457   4.75  0.000    13775.38
Buy it now/Best Offer Price  -0.0001226   0.0001518  -0.81  0.419        1.00
FinishOriginal                 -1.66664    0.843378  -1.98  0.048        0.19
Case                           0.656848     1.06836   0.61  0.539        1.93
Case Condition                 0.142484    0.415727   0.34  0.732        1.15
Modified                     -0.0774069    0.635927  -0.12  0.903        0.93
Counters                     -0.0007324   0.0008131  -0.90  0.368        1.00
Knowledgeable                  0.828018    0.703158   1.18  0.239        2.29
Init Price                   -0.0003423   0.0002069  -1.65  0.098        1.00
NumBids                      -0.0346665    0.194373  -0.18  0.858        0.97
UniqueBids                     0.681995    0.391148   1.74  0.081        1.98
AuctionLength                 -0.223200   0.0961956  -2.32  0.020        0.80
Dealer                         0.671709    0.815219   0.82  0.410        1.96
NumGuitarsSold               -0.0059473   0.0090575  -0.66  0.511        0.99
SellerViews                   0.0000144   0.0001234   0.12  0.907        1.00
Finish_Blonde                   2.27889     1.31399   1.73  0.083        9.77
Finish_Nat                    -0.593892     1.03891  -0.57  0.568        0.55
Finish_Candy Apple Red         -2.27191     1.39817  -1.62  0.104        0.10
Finish_Olympic White          -0.923746     1.20140  -0.77  0.442        0.40
Finish_Black                   -2.33001     1.30908  -1.78  0.075        0.10
Finish_Blue                   -0.152008     1.63287  -0.09  0.926        0.86
Finish_Custom                 0.0941672     1.08973   0.09  0.931        1.10
Model_Telecaster               -1.67500     1.07469  -1.56  0.119        0.19
Model_Mustang                  0.949846     1.21015   0.78  0.433        2.59
Model_Jaguar                   -1.37100     1.75553  -0.78  0.435        0.25
Model_Jazzmaster                2.50798     1.76338   1.42  0.155       12.28
Model_Jazz Bass                0.693266     1.32259   0.52  0.600        2.00
Day Auction Ended_Monday        1.17950     1.01000   1.17  0.243        3.25
Day Auction Ended_Tuesday       1.34288     1.34143   1.00  0.317        3.83
Day Auction Ended_Wednesday    0.395528     1.04962   0.38  0.706        1.49
Day Auction Ended_Thursday     0.750331     1.10908   0.68  0.499        2.12
Day Auction Ended_Friday        2.12042     1.14684   1.85  0.064        8.33
Day Auction Ended_Saturday    -0.666214     1.14121  -0.58  0.559        0.51
lnPictures                      1.19633    0.444196   2.69  0.007        3.31
```

Degrees of freedom for the Wald test, all-inclusive model: 1
Level of significance: $\alpha = 10\%$
From the x^2 table, the rejection region is specified at $x^2 = 0.016$

Probabilistic model, refined

```
Predictor                        Coef      SE Coef       Z      P   Ratio
Constant                      128.718      107.992    1.19  0.233
Year                        -0.0659542   0.0547804   -1.20  0.229    0.94
Price                       -0.0000452   0.0001091   -0.41  0.679    1.00
Shipping                    -0.0001076   0.0031765   -0.03  0.973    1.00
Returns                      0.732369     0.446896    1.64  0.101    2.08
Credit Cards                -0.894698     0.940662   -0.95  0.342    0.41
ShipsWorldwide               0.346143     0.326912    1.06  0.290    1.41
Condition                    0.773605     0.350391    2.21  0.027    2.17
Feedback                    -0.0000246   0.0000356   -0.69  0.491    1.00
Buy it Now/Best Offer?      -0.587226     0.590218   -0.99  0.320    0.56
Buy it now/Best Offer Price -0.0000120   0.0001211   -0.10  0.921    1.00
FinishOriginal              -0.0069205    0.570207   -0.01  0.990    0.99
Case                         0.531601     0.703199    0.76  0.450    1.70
Case Condition              -0.0971324    0.215685   -0.45  0.652    0.91
Counters                    -0.0002297   0.0005288   -0.43  0.664    1.00
Knowledgeable               -0.176395     0.464170   -0.38  0.704    0.84
Init Price                  -0.0002027   0.0001636   -1.24  0.215    1.00
NumBids                     -0.0337796   0.0996911   -0.34  0.735    0.97
UniqueBids                   0.306308     0.181962    1.68  0.092    1.36
AuctionLength               -0.125463    0.0573801   -2.19  0.029    0.88
Dealer                       0.431641     0.501219    0.86  0.389    1.54
NumGuitarsSold              -0.0032668   0.0025003   -1.31  0.191    1.00
Finish_Blonde                1.19348      0.892005    1.34  0.181    3.30
Finish_Nat                  -0.792949     0.741429   -1.07  0.285    0.45
Finish_Candy Apple Red      -1.35385      0.843895   -1.60  0.109    0.26
Finish_Olympic White        -0.822285     0.822687   -1.00  0.318    0.44
Finish_Black                -1.06897      0.859243   -1.24  0.213    0.34
Finish_Blue                 -0.599038     1.03078    -0.58  0.561    0.55
Finish_Custom               -0.129234     0.741577   -0.17  0.862    0.88
Model_Telecaster            -1.99400      0.780550   -2.55  0.011    0.14
Model_Mustang                0.302514     0.790219    0.38  0.702    1.35
Model_Jaguar                -1.43390      1.07510    -1.33  0.182    0.24
Model_Jazzmaster            -1.53759      1.00551    -1.53  0.126    0.21
Model_Jazz Bass             -0.743165     0.789170   -0.94  0.346    0.48
Day Auction Ended_Monday     1.10317      0.743764    1.48  0.138    3.01
Day Auction Ended_Tuesday    1.18593      0.826018    1.44  0.151    3.27
Day Auction Ended_Wednesday  0.591307     0.759692    0.78  0.436    1.81
Day Auction Ended_Thursday   0.235993     0.710484    0.33  0.740    1.27
Day Auction Ended_Friday     1.30778      0.752967    1.74  0.082    3.70   1.07
Day Auction Ended_Saturday   0.0085385    0.738388    0.01  0.991    1.01   0.30
lnPictures                   0.195208     0.278094    0.70  0.483    1.22   0.77
```

Degrees of freedom for the Wald test, refined probabilistic model: 1
Level of significance: $\alpha = 10\%$
From the x^2 table, the rejection region is specified at $x^2 = 0.016$

Probabilistic model, final

```
Predictor                        Coef    SE Coef      Z      P    Ratio
Constant                      129.201    103.822    1.24   0.213
Year                        -0.0661960  0.0525980  -1.26   0.208   0.94
Price                       -0.0000461  0.0001105  -0.42   0.677   1.00
Returns                      0.731278   0.444303    1.65   0.100   2.08
Credit Cards                -0.878300   0.918910   -0.96   0.339   0.42
ShipsWorldwide               0.351118   0.327518    1.07   0.284   1.42
Condition                    0.776761   0.345372    2.25   0.025   2.17
Feedback                    -0.0000248  0.0000353  -0.70   0.483   1.00
Buy it Now/Best Offer?      -0.621157   0.485527   -1.28   0.201   0.54
Case                         0.532598   0.695792    0.77   0.444   1.70
Case Condition              -0.0969169  0.213183   -0.45   0.649   0.91
Counters                    -0.0002276  0.0005259  -0.43   0.665   1.00
Knowledgeable               -0.181775   0.445093   -0.41   0.683   0.83
Init Price                  -0.0002124  0.0001362  -1.56   0.119   1.00
NumBids                     -0.0337587  0.0951646  -0.35   0.723   0.97
UniqueBids                   0.303848   0.174590    1.74   0.082   1.36
AuctionLength               -0.125578   0.0566640  -2.22   0.027   0.88
Dealer                       0.433704   0.499945    0.87   0.386   1.54
NumGuitarsSold              -0.0032491  0.0024889  -1.31   0.192   1.00
Finish_Blonde                1.19499    0.889796    1.34   0.179   3.30
Finish_Nat                  -0.785037   0.728806   -1.08   0.281   0.46
Finish_Candy Apple Red      -1.35135    0.839167   -1.61   0.107   0.26
Finish_Olympic White        -0.810325   0.811428   -1.00   0.318   0.44
Finish_Black                -1.07422    0.836268   -1.28   0.199   0.34
Finish_Blue                 -0.589133   1.01580    -0.58   0.562   0.55
Finish_Custom               -0.131267   0.707857   -0.19   0.853   0.88
Model_Telecaster            -1.98993    0.776176   -2.56   0.010   0.14
Model_Mustang                0.302109   0.780924    0.39   0.699   1.35
Model_Jaguar                -1.42740    1.06402    -1.34   0.180   0.24
Model_Jazzmaster            -1.54029    0.992692   -1.55   0.121   0.21
Model_Jazz Bass             -0.746335   0.776055   -0.96   0.336   0.47
Day Auction Ended_Monday     1.10346    0.740960    1.49   0.136   3.01
Day Auction Ended_Tuesday    1.18844    0.821147    1.45   0.148   3.28
Day Auction Ended_Wednesday  0.589070   0.759352    0.78   0.438   1.80
Day Auction Ended_Thursday   0.233161   0.701133    0.33   0.739   1.26
Day Auction Ended_Friday     1.30884    0.743269    1.76   0.078   3.70
Day Auction Ended_Saturday   0.0134017  0.735955    0.02   0.985   1.01
lnPictures                   0.194579   0.275317    0.71   0.480   1.21
```

Degrees of freedom for the Wald test, final probabilistic model: 1

Level of significance: $\alpha = 10\%$

From the x^2 table, the rejection region is specified at $x^2 = 0.016$

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