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Model selection and Akaike Information Criteria: An example from wine ratings and prices

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Abstract

The effect of wine ratings on pricing has been a question for wine consumers for some time. Ultimately, wine preference, and thus how one judges a wine, is a subjective endeavor. Wine professionals have long rated wines and those published ratings have some effect on consumer sales. Previously, wine studies have found that there is a connection between rating and price. This study looks to try to verify that connection through insuring that best fit model development is used. For the first time in wine research, the authors have utilized Akaike Information Criteria (*AIC*) to compare different models and more dynamic hypothesis testing to explore the relationship between ratings and prices of wines. In the end, it was confirmed that there is a link, and the use of *AIC* also helped to not only confirm previous findings, but also to identify a new concern in wine ratings.

Keywords: Wine; Wine rating; Model testing; Akaike Information Criteria

1. Introduction

Doubtlessly, wines have been assessed since we first started to consume them. Whether it be the 1855 Bordeaux classification or the multitude of informal wine ratings performed by internet bloggers, cooking magazines, mail-order retailers, and other sources, these evaluations have impacted how wines have been priced and how consumers have accepted these wines. None, however, have been as dominant or divisive as the ratings of Robert Parker and the Wine Spectator.

In the field of economics, an "experience good" is something that is difficult to detect before the actual consumption of that product (Nelson, 1970). For wine, being and experience good, consumers must rely on quality evaluations by product experts. This is not dissimilar to other products for which Consumer Reports provides quality evaluations, only consumers have to look for ratings by Wine Spectator, the WineAdvocate, the Wine Enthusiast, phone apps, blogs and a multitude of other ways for quality ratings of wine. As found in research by Roberts and Reagans (2007) on critical exposure and price–quality relationships, consumers are concerned about quality and rely on "expert opinion."

There have been many that have worked to assess wine quality and to tie that with a pricing model. The literature explores all manner of methods including wine's quality, status, and so forth. Landon and Smith (1998) suggested that a wine's reputation showed to have a greater influence on price, even more so than its actual quality. The study by Roberts and Reagans (2007) found that ratings do have an actual effect on pricing strategies of producers and that prior ratings influence the pricing decisions of a current release. That said, another study Lockshin (1993) found when a new vintage is released, the wholesale price is determined by the taste and negotiations between the maker and the wholesaler. This was confirmed through discussions with distribution companies, as expert

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tasting and evaluations are part of the negotiation and pricing decisions. And lastly, Roberts and Reagans (2007) also found that practiced wine analysts reach comparable conclusions about quality most of the time.

Other research shows to have used hedonic price modeling to help us to better understand how wine pricing and quality relate. Combris et al. (1997) and Landon and Smith (1998), used sensory methods to try and determine the quality of wines from Bordeaux. This concluded in the development of a pricing system based on these influences. However, they failed to address the simpler problem of whether ratings correlate with price. Researchers have looked at hedonic prices for wine attributes and found that ratings do have an effect on what consumers are willing to pay for a wine (Schamel and Anderson, 2003). For this study, the authors did not want to look at consumer's willingness to pay, as price can vary greatly in the United States by retail or restaurant venue. Also, while acknowledging the importance of hedonic pricing models, the authors felt that previous research has already done a good job of addressing wine as a product category.

In a study on the price/quality connection in Bordeaux wines, Landon and Smith (1998) found a positive association between the ratings of Wine Spectator and the wines' reported price. Similarly, others have found the same connection with one using the Connoisseur's Guide (Benjamin and Podolny, 1999) in a study of wines from California and another the study of wines from Australia and New Zealand using quality ratings from James Halliday and Winestate (Schamel and Anderson, 2003). Another study looked at wide variances in listed prices of the Wine Spectator's ratings of 2001 vintage of California Cabernet Sauvignon but not wholesale pricing. Ultimately, it was found that only a handful of articles address wine in relation to price and ranking by wine critics, and only one has looked at it from the wholesale standpoint. We chose to look at wholesale pricing and a more accurate descriptor of price because restaurants and other hospitality providers typically purchase wines from a wholesale distributor that tends to have exclusive distribution of a wine within a region or state. This is a more accurate and stable price for a wine, as retailer and restaurant mark-up is not stable nor standard.

To sum it up, wine reviewers, such as those from the Wine Spectator magazine, impact choices of consumers and thus wine sales. A previous study by Taylor and Baber (2009) found the wholesale price and vintage of a wine were significant in the predictors of a wine's rating. However, it is not clear that the researchers in that study chose the correct model to arrive at that conclusion. For the current study, the use of Akaike Information Criteria (*AIC*) will help to reinforce or debunk the previous findings.

Null hypothesis testing, in the sense that some value is calculated and then compared against some critical value in a given distribution, is a firmly established statistical practice. In regression analysis, a *t*-value is often the value of interest, and this *t*-value is in turn at least somewhat dependent upon the model or equation estimated. However, quite often, the model itself receives only a cursory thought. Many times, researchers are interested only in the relationship between two variables, while the regression equation or model estimated is merely a means to an end. This can have certain drawbacks. An under-fitted model may not adequately capture the true nature of what determines the variable of interest; an over-fitted model may increase variability in the estimated equation or lead to information loss in increased degrees of freedom. Ideally, a model would be able to capture the true relationship between the variables of interest while not losing generality from over-fitting the data, or what Burnham and Anderson (2002) call a "parsimonious model". Multimodal inference, in the form of Akaike Information Criteria (*AIC*), is a powerful method that can be used in order to determine which model best fits this description. This paper uses *AIC*, along with traditional null-hypothesis testing, in order to determine the model that best describes the factors that influence the rating for a wine. Specifically, once the best model is determined, the relationship between a wine's price and its rating is explored.

2. Research background

2.1. A brief background on AIC

AIC was first developed by Akaike (1973) as a way to compare different models on a given outcome. For example, if researchers are interested, as in this paper, in what variables influence the rating of a wine and how these variables influence the rating of a wine, one may estimate several different regression models. For example, the price of the wine, the type of grape used, or the region the wine was produced in may all play a role in determining the rating of a wine. Regression equations may be run that include just price, or price and region information, or any other combination of variables. Often, though, the model itself receives little thought and is treated as only a tool to reveal the relationship between the outcome and a specific variable. As discussed above, the selection of the model is important, as under-fitting a model may not capture the true nature of the variability in the outcome variable, while an over-fitted model loses generality. *AIC* is then a way to select the model that best balances these drawbacks. Once a best model is selected, traditional null-hypothesis testing can then be used on the best model to determine the relationship between specific variables and the outcome of interest.

Akaike (1973) showed that this selection of the "best" model is determined by an *AIC* score:

$$AIC = 2K - 2\log(\mathscr{L}(\hat{\theta}|y)),$$

where K is the number of estimable parameters (degrees of freedom) and $\log \mathscr{L}(\hat{\theta}|y)$ is the log-likelihood at its maximum point of the model estimated. The constant "2" remains "for historical reasons" (Burnham and Anderson, 2002). Hurvich and Tsai (1989) further refined this estimate to correct for small data samples:

$$AICc = AIC + \frac{2K(K+1)}{n-K-1},$$