

## Vinum Verum Viribus? Systematic Errors in Wine Alcohol Labels

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### Vinum Verum Viribus: Wine True Strength

Using international data for 18 vintages, we find systematic differences between the actual and stated alcohol content of wine. Our results suggest that rising alcohol content of wine may be a nuisance by-product of producer responses to evolving market and production environments.

Our recent (December 2015) article in the *Journal of Wine Economics*, “Splendide Mendax: False Label Claims about High and Rising Alcohol Content of Wine,” sparked a flurry of media attention around the world. (For example, see articles by Sarah Kapton in the *Daily Telegraph* and Tom Withdraw in the *Daily Mail* in December 2015, and by Roberto Ferdman in the *Washington Post* in January 2016.) In that article, we analyzed data from the Liquor Control Board of Ontario (LCBO), Canada, which tests every wine imported into that province and records several characteristics, including the actual and stated alcohol content.

Drawing on our analysis of 91,432 observations of individual wines tested by the LCBO, we reported two main findings, the second of which attracted the most attention. First, over the years 1992–2009, the alcohol content of the wines trended up, with an overall average increase of about 0.5 percentage points on a base of 12–13% by volume. Second, we found systematic patterns of differences between the actual alcohol content of wines and the alcohol content reported on the label, with labels tending to understate the alcohol content for higher alcohol wines. For instance, of the total of 14,218 California wines in our sample, 8,880 (62.5%) understated the alcohol content.

These labeling errors may be economically significant, even if they do not exceed legal tolerances. Wineries

may have incentives to understate or overstate the alcohol content if they perceive a market preference for a particular range of alcohol content for a given style of wine. Other reasons may include tax avoidance; for instance, the U.S. tax rate is \$1.07 per gallon for wine with 14% alcohol or less, and \$1.57 per gallon for wine above 14% but less than 21% alcohol.

While every bottle of wine reports alcohol content on the label, the tolerances are wide. United States law allows a range of plus or minus 1.5 percentage points for wine with 14% alcohol by volume or less, and plus or minus 1.0 percentage points for wine with more than 14% alcohol by volume, and other countries have similarly large tolerances. These are wide bands compared with the relevant range of variation in the marketplace—the vast majority of wine consumed as table wine has between 12% and 15% alcohol.

Significantly, however, the tolerance for labeling errors does not permit misclassifying wine between tax categories in the United States. It is not legal to label wine as having more than 14% alcohol if it has 14% or less, and it is not legal to label wine as having 14% or less if it has more than 14% alcohol. In our sample of U.S. wines, 1,412 (9%) are labeled as having 14% alcohol or less, when it is actually over 14%, and 299 (2%) are labeled as having more than 14% alcohol when it is actually 14% or less. It would be illegal to sell these wines with those labels in the United States.

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**Table 1. Average Alcohol Content by Country of Origin of Wine**

Year	Number of Observations	Alcohol % by Volume		
		Actual	Reported	Difference
<b>Old World</b>				
France	25,404	13.0	12.9	-0.10
Italy	19,806	13.0	12.9	-0.09
Spain	2,993	13.4	13.2	-0.21
Portugal	2,321	13.0	12.9	-0.05
<b>Total</b>	<b>50,524</b>	<b>13.0</b>	<b>12.9</b>	<b>-0.10</b>
<b>New World</b>				
Argentina	1,778	13.8	13.6	-0.24
Australia	9,617	13.7	13.7	-0.09
Canada	4,113	12.8	12.6	-0.13
Chile	3,744	13.7	13.4	-0.27
New Zealand	2,125	13.2	13.2	-0.06
South Africa	3,347	13.5	13.4	-0.09
United States	16,184	13.9	13.7	-0.23
<b>Total</b>	<b>40,908</b>	<b>13.7</b>	<b>13.5</b>	<b>-0.17</b>
<b>World</b>	<b>91,432</b>	<b>13.3</b>	<b>13.2</b>	<b>-0.13</b>
Under-reported alcohol	52,178	13.6	13.2	-0.42
Over-reported alcohol	29,461	12.9	13.2	0.32
Correct alcohol %	9,793	13.1	13.1	0.00

### Rising Alcohol Content and the Role of Climate

Wines from cooler places tend to have less alcohol than wines from hotter places, and in general “Old World” wines, predominantly from Europe, tend to have less alcohol than “New World” wines, mainly from the Americas, Australia, and South Africa. On average, in our sample, Old World wines have about 0.63 percentage points less alcohol than comparable New World wines, and white wines typically have about 0.50 percentage points less alcohol than red wines.

In our sample, between 1992 and 2007 the average alcohol content of wine trended up for both red and white wine, regardless of its country of origin. Among countries and between colors of wines, the size of the average increase ranges from about 0.2 to 2.0 percentage points, with an overall average increase of about 0.50 percentage points.

What does climate change have to

do with any of this? Not much, as far as we can tell. We acquired region-specific climate data for 1992–2008 from several sources, mainly the NOAA National Climatic Data Center, and created an index of heat during the growing season for each wine-producing country or region.

We estimated a variety of models in which we regressed alcohol content against trend variables, and country- and region-specific factors as well as this heat index. We found that holding other factors constant, a one-degree Fahrenheit increase in the average growing season temperature everywhere in the world would cause the average alcohol content of wine to increase by only 0.05 percentage points.

The main lesson from these results is that increases in growing season temperature do not account for much of the growth in the average alcohol content of wine, for two reasons. First, temperature did not increase by very much in most places over the time period of

our data. Second, our estimates suggest that a relatively large change in the heat index, outside the range observed in this paper, would be required to bring about an appreciable increase in the alcohol content of wine. These findings parallel those from our earlier work, in which a similar heat index for California contributed very little to explaining increases in either the sugar content of California winegrapes or the alcohol content of California wine.

### Actual versus Reported Alcohol

Table 1 shows the average values for reported and actual alcohol content and the discrepancies between them, country by country and for the entire, pooled sample. The average difference—the reported minus actual alcohol content—was -0.13% alcohol by volume, over all samples. Wine from every country on average had higher actual content than was declared on the label, and the average understatement was relatively large for wines from the countries with higher average alcohol content (i.e., the United States, Australia, Spain, Chile, and Argentina).

Of course, these average values mask a lot of variation within countries and between red and white wines, and some of these details were the subject of further analysis in our longer paper (Alston et al. 2015). Importantly, the average figures conceal the fact that in many instances, the labels overstate the alcohol content of wine, even though it is understated on average, as displayed in the lower part of Table 1.

In over half of the observations (52,178, or 57.1% of the total), alcohol content was understated by 0.01 percentage points or more. For this group, on average, the actual alcohol content was 13.6% and the reported alcohol content was 13.2%, with a discrepancy of 0.42 percentage points.

A discrepancy of 0.4 percentage points might not seem large relative to an actual value of 13.6% alcohol by

volume, but is much more significant compared with the typical range for wines in a particular category. For instance, Napa Valley Cabernet Sauvignon might be expected to have alcohol content within the range of 13.5–14.5% alcohol by volume, and an average error of 0.4 percentage points is high in the context of this range.

The size of the understatement was similar between red and white wines. The patterns are somewhat different if we further split the data in this group between the New and Old World sources; Old World wine labels understated the alcohol content to a smaller extent than New World wine labels.

Labels for a significant, albeit smaller, number of wines (29,461, or 32.2% of the sample) erred in the opposite direction, overstating the true alcohol content by 0.01 percentage points or more. On average, the actual alcohol content for this group was 12.9% by volume, and the reported alcohol percentage was 13.2%, with a discrepancy of 0.32 percentage points. Within this group, the size of the overstatement was similar between red and white wines, and similar between the New World and Old World sources.

A little over one-tenth of the useful sample—9,793 observations—were wines with reported alcohol within 0.01 percentage points of the actual alcohol. In this category, Old World red wine had an average alcohol content of 13.0% by volume; Old World white, 12.5%; New World red, 13.6%; and New World white, 13.1%.

### Demand for Labeling Errors?

It is relatively inexpensive to measure the alcohol content of wine reasonably precisely, although some of the devices used may entail larger measurement errors. To comply with tax regulations, at least in the United States, it is necessary to provide information on alcohol content. More important, alcohol content is also an element of

quality control in winemaking. Consequently, we expect that commercial wineries, for the most part, have relatively precise knowledge of the alcohol content of the wines they produce.

Some tolerance for error in wine alcohol labels is appropriate for several reasons. One reason is to allow for measurement error, since the instruments (and perhaps their users) are not always perfectly precise. Probably the most common method for wineries is the ebulliometer, which compares the boiling temperature of water and the boiling point of wine, to determine the alcohol concentration (which lowers the boiling point). Amerine and Joslyn (1951) claim  $\pm 0.2\%$  accuracy for the method. Random measurement error at this rate cannot account for systematic bias to the extent we observe in our data.

In addition, commercial reality dictates some tolerance to allow for the fact that wine labels may have to be printed months in advance of the final determination of the content of the particular wine, and therefore must be based on predictions made at the time of ordering the labels. Also, a particular label may have to apply to multiple lots of the “same” wine that vary in their alcohol content. Even so, a tolerance of  $\pm 1.5$  percentage points seems generous.

Winemakers can manage the alcohol content and other characteristics of the wine, at a cost, but cannot cheaply vary the quantity of alcohol independently from other characteristics. For instance, to achieve riper, more intense, fruit flavors may require longer “hang times” for grapes that also imply more concentrated sugar and higher alcohol wine.

Consumers may happily pay a premium for the resulting flavors yet prefer not to have (or, at least, know about) the concomitant increase in alcohol content. In such a setting, it may be profitable for the winery to give the consumer both the desired



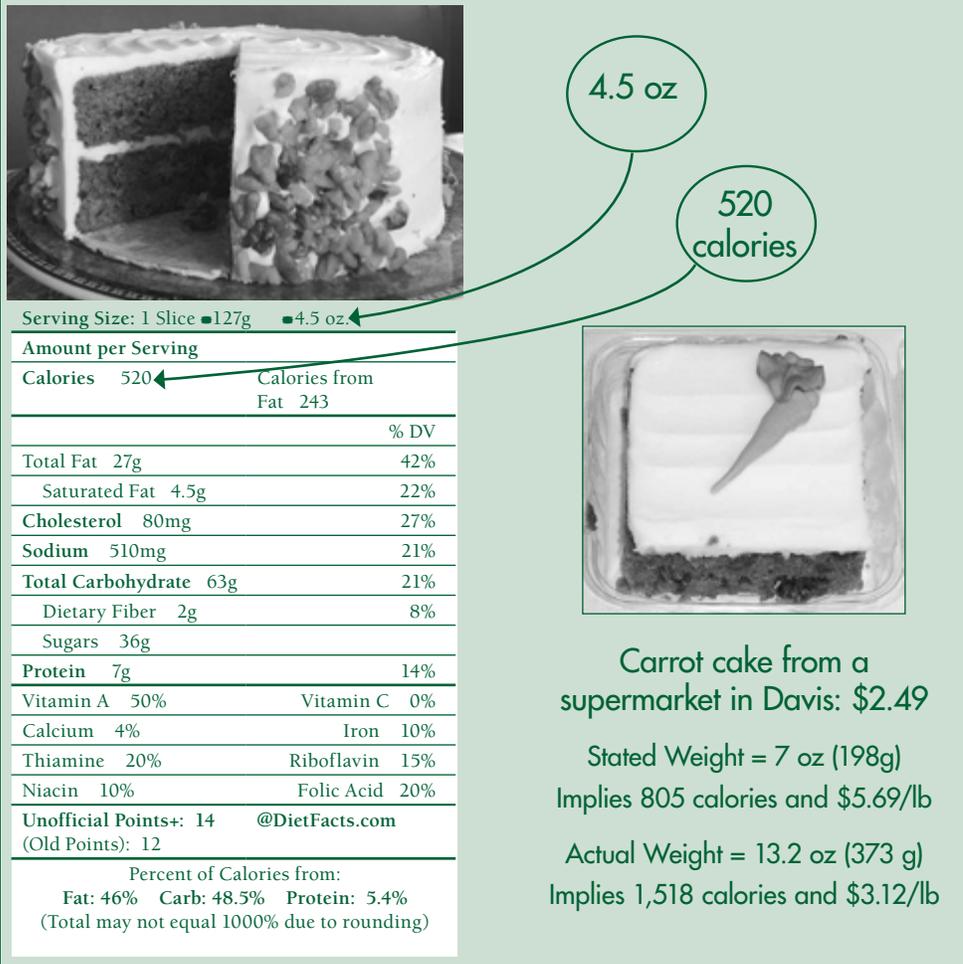
*Wineries may have incentives to understate or overstate the alcohol content if they perceive a market preference for a particular range of alcohol content for a given style of wine.*

wine characteristics and the preferred label information, by understating the true alcohol content.

We base this speculation in part on discussions with several winemakers who have told us informally that they chose to understate the alcohol content on a particular wine label, within the range of error permitted by the law. They made this choice because they believed it would be advantageous for marketing the wine to have a stated alcohol content closer to what consumers would expect to find in a high-quality wine of the type in question.

Similar phenomena can be observed in other settings. In some of our own as-yet unpublished work, we have observed that when supermarkets offer pre-cut pieces of cake in standardized package sizes (e.g., 12 oz), typically the actual size of the piece is much larger than the stated size—well more than could be rationalized by a desire to avoid offering an undersized piece (Figure 1 on page 4). This phenomenon is consistent with a theory that the buyer would rather have a large piece of cake but imagine it is smaller and less caloric, and the seller (generously) provides what they buyer wants.

Figure 1. Which Price Matters: Dollars or Calories?



### The Role of Prices

The propensity for mislabeling wine may vary with the price of wine. One reason is that the tax rates might vary with alcohol content. For instance, as noted, in the United States the Federal excise tax rate increases by \$0.50 per gallon for wine having more than 14% alcohol. For the lowest-priced wines, which may sell at wholesale for only a few dollars per gallon, an additional \$0.50 per gallon is a significant disincentive for producing wines having more than 14% alcohol, whereas for premium wines, this tax difference is negligible. Also, characteristics such as intense ripe flavors of wine that are associated with high ratings by some experts and tend to be correlated with higher alcohol content may be less demanded in entry-level wines than in premium wines.

To examine this possibility, we estimated our model using the 17,862 observations for the years 1992–2007 for which we have prices. Our results indicate that the reporting error increases with increases in the price of wine. The predicted reporting error for a wine selling for \$40 per bottle or more is 0.26 percentage points higher than that for a wine selling for less than \$10.

### Conclusion

Our findings support the idea that winemakers may be tweaking alcohol content on the label to reflect their perceptions of market norms and expectations for the alcohol percentage for a given type of wine (defined by variety, place of origin, and so on). Given the rise in wine alcohol over our study period and the negative press and reviews for high-alcohol wines, it is not

too surprising to see winemakers tending to err in the direction of understating the alcohol content of some types of wines, in ways that the law allows. The wide error tolerances provided by the current U.S. law took effect in 1949. Perhaps it is time to review that policy.

Alston, J.M., K.B. Fuller, J.T. Lapsley, G. Soleas, and K.P. Tumber. "Vinum Verum Viribus? Systematic Errors in Wine Alcohol Labels." *ARE Update* 19(4) (2016): 1-4. University of California Giannini Foundation of Agricultural Economics.

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### For additional information, the authors recommend:

Alston, J.M., K.B. Fuller, J.T. Lapsley, and G. Soleas. "Too Much of a Good Thing? Causes and Consequences of Increases in Sugar Content of California Wine Grapes." *Journal of Wine Economics* 6(2) (2011): 135–159. <https://ideas.repec.org/p/ags/mondwp/162514.html>.

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