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WINE ECONOMICS: EMERGENCE, DEVELOPMENTS, TOPICS

K. Storchmann*

ABSTRACT

Fine wine has a few characteristics that differentiate it from other agricultural commodities and beverages rendering it an interesting topic for economists. Fine wine can regularly fetch bottle prices that exceed several thousand dollars. It can be stored a long time and may increase in value with age. Fine wine quality and prices are extraordinarily sensitive to fluctuations in the weather of the year in which the grapes were grown. Wine is an experience good: that is, consumers often rely on “expert opinion” regarding quality and maturation prospects. This article describes the emergence and the unparalleled rise of wine economics since the 1980s to the present time and sheds light on its three main topics: finance, climate change and the role of expert opinion.

Keywords: wine economics, finance, climate change, expert opinion

1 INTRODUCTION

Adam Smith, David Ricardo, John Stuart Mill, Karl Marx and Leon Walras all wrote, to some extent, about wine (see Chaikind, 2010). However, most of these early writings touch on wine only in passing or refer to it as an example and are too scattered to constitute “wine economics” as an independent economic discipline. Wine economics as a discipline that analyses wine-related issues as its main focus entered the scene much later.

Over the last two decades, wine economics has emerged as a growing field, not only within agricultural economics, but in adjacent fields such as finance, trade, growth and environmental economics as well. There are several academic associations that are devoted to furthering the economics of wine. At the annual conferences of the largest one, namely the American Association of Wine Economics (AAWE), more than 200 wine economists from all over the world convene and present 130+ papers. Since 2006, and in addition to the agricultural economics journals, there has been an academic journal entirely devoted to wine and economics, called the *Journal of Wine Economics*.¹ Furthermore, wine

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economics research has been increasingly recognised by general economics journals as well.

This article aims to sketch the emergence of wine economics and recent developments in the literature. Furthermore, I want to shed some light on the three main research issues of wine economics, namely wine as an investment, environmental issues and the role of experts. The remainder of the article is organised as follows: section 2 provides some data on the development of wine in the scholarly literature over the last decades; section 3 describes the emergence of wine economics; the central topics of wine economics are introduced in sections 4, 5 and 6; and section 7 concludes and provides an outlook

2 DEVELOPMENTS

Although wine is not the most talked-about subject in the world, it may still be an important one compared to other beverages. In order to get an idea of the general relevance of the topic I conducted a simple Google search for words such as “wine” or “beer”. Certainly, counting Google hits as a measure of general relevance is not without problems. First, some topics may be discussed on the internet a lot while others are rather offline topics, that is online publications and bloggers may focus their “internet chatter” on some topics more than on others. Second, counting Google hits of single words may result in an exaggerated count when unrelated terms contain this word. For instance, all searches for “tea” will also contain references to “tea party”, which has little relation to the beverage. Third, the search is confined to the English language, which may disadvantage certain topics. For instance, “wine” may have resulted in relatively more results if the French word (i.e., *vin*) had been included. Notwithstanding these issues, a Google search may still lead to insightful results.

Figure 1 reports the results of this Google search, done on 5 September 2010, for beverage words, such as “coffee”, “milk”, “tea”, “water” and “wine”. With 343 million results, the word “wine” yields more hits than any other beverage, except for water. However, compared to words such as “bread” (450 million), “sport” (548 million), “sex” (586 million), “apple” (705), “money” (4 700 million) or “car” (5 570 million), the number of Google results for “wine” appears to be rather small.

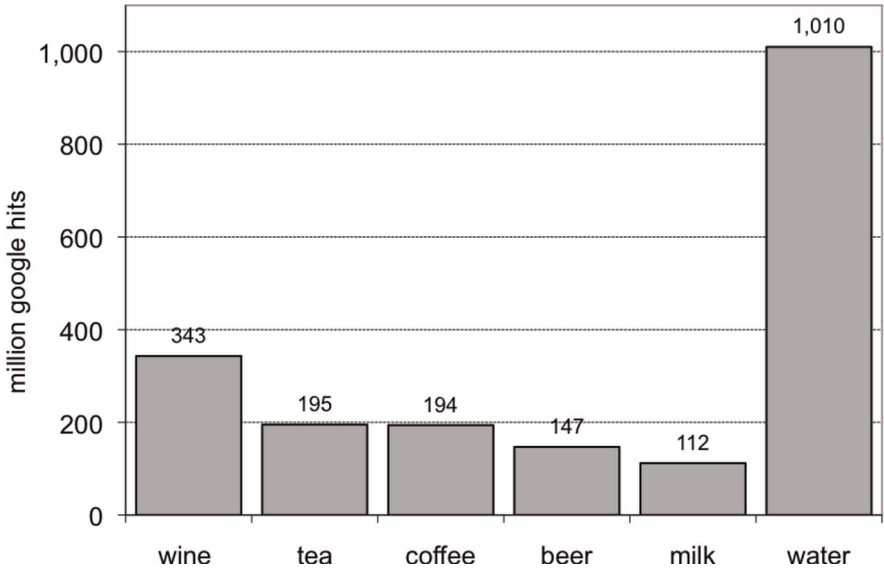


Figure 1: Google hits for selected beverages in million, September 2010

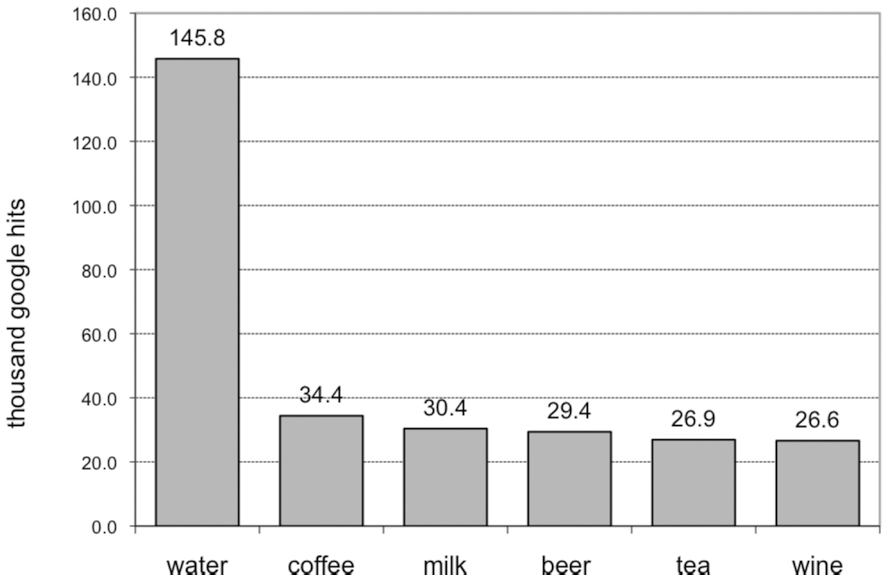


Figure 2: Google Scholar hits for selected beverages in *Business, Administration Finance and Economics*, 1940–2010 at 5 September 2010

Figure 2 provides the number of Google Scholar hits, that is hits in scholarly publications, from 1940 to 2010, for the same subjects. Since Google Scholar allows users to search by discipline, I confined the search to “business, administration, finance and economics”. Surprisingly, the general “internet chatter” by online publications, bloggers, and so on, is inadequately reflected in scholarly relevance. First, of the considered beverages, “wine” with 26 600 hits has the least scholarly coverage while – apart from “water” – “coffee” exhibits the highest coverage (34 000 hits). Second, and unsurprisingly, scholarly hits amount to only a very small fraction of all general hits. However, the range of the ratio “all Google hits to Google Scholar hits” is astoundingly high. While “milk” generates less than 3 700 general Google hits per Google Scholar hit this is almost 13 000 for wine (table 1). In fact, of all beverages wine has by far the most un-scholarly hits per scholarly hit. Clearly, more people have opinions about wine and write about them than they do about milk.

Table 1: Scholarly ratio of selected beverages

Beverage	All Google hits (in million)	Google Scholar hits	All Google hits per Google Scholar hit
Wine	343	26 600	12 895
Tea	195	26 900	7 249
Water	1 010	145 800	6 927
Coffee	194	34 000	5 706
Beer	147	29 400	5 000
Milk	112	30 400	3 684

Note: Google hits and Google Scholar hits from 1940–2010 as of 5 September 2010

These results are apparently not in line with the emergence of a new academic field called *wine economics*. However, there are two facts that again change the picture: the scholarly growth rate and the quality of the publications.

Compared to the other beverages, “wine” has consistently exhibited the largest scholarly growth rates since the 1980s. In contrast, “milk”, the beverage with the highest scholarly ratio (see table 1), experienced its largest growth rates in the 1960s and has lagged behind ever since.

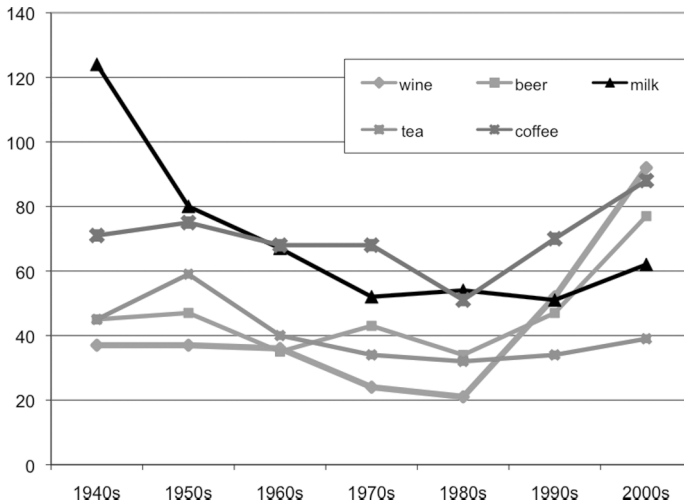


Figure 3: Google Scholar hits in top general Economics journals* from the 1940s to the 2000s

* *American Economic Review, Journal of Political Economy, Quarterly Journal of Economics, Review of Economics and Statistics, The Economic Journal*

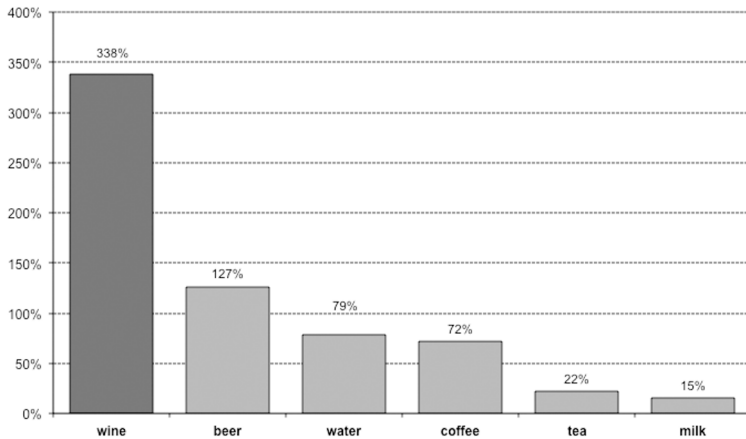


Figure 4: Growth rates of Google Scholar hits in top general Economics journals* from the 1980s to the 2000s

* *American Economic Review, Journal of Political Economy, Quarterly Journal of Economics, Review of Economics and Statistics, The Economic Journal*

In addition, when considering the scholarly hits in the top (applied) economics journals only,² “wine” exhibits the fewest hits for the 1980s but is first in the 2000s (figure 3).³ Figure 4 shows the corresponding growth rate from the 1980s to the present day. Among the six beverages, the growth rate of “wine” citations in top general economic journals is second to none. In fact, the growth rate of “wine” is higher than the one for the other five beverages combined.

The findings of the Google analysis can be summarised as follows: (i) compared to other beverages, “wine” exhibits a lively online presence suggesting, that wine is a topic people want to talk about; (ii) however, not all of this “internet chatter” is scholarly (of all beverages, “wine” has the highest “un-scholarly rate” – general Google hits per Google Scholar hit); (iii) although (or because) “wine” is prone to attract unscholarly internet hits, “wine” has experienced an extraordinary growth in the scholarly literature over the past two decades; (iv) when considering the journal quality of scholarly hits, “wine” has risen from the bottom in the 1980s to the top in the 2000s (its citation growth rate over this period is higher than for all the other beverages combined).

What has caused this enormous interest in wine over the last two decades, especially in the high-end general economic literature?

3 THE EMERGENCE

Fine wine has a few characteristics that differentiate it from other agricultural commodities and beverages, rendering it an interesting topic for economists. First, fine wine can regularly fetch bottle prices that exceed several thousand dollars. Second, fine wine can be stored a long time and may increase in value with age. Third, fine wine quality and prices are extraordinarily sensitive to fluctuations in the weather of the year in which the grapes were grown. Fourth, wine is an experience good: that is, a good whose quality is difficult to ascertain before consumption. As a result, consumers often rely heavily on “expert opinion” regarding quality and maturation prospects.

In 1986, Princeton Economics Professor Orley Ashenfelter launched a newsletter called *Liquid Assets – the International Guide to Fine Wines*. As the first publication of its kind and in stark contrast to the prevailing glossy literature on wine, *Liquid Assets* was devoted to the quantitative analysis of the fine wine market. Ashenfelter published auction prices and provided numerous economic analyses, such as an updated “new objective ranking of the chateaux of Bordeaux”. Like the original classification of 1855, Ashenfelter’s ranking was completely empirical and based on wine auction prices and not – as might be thought – on “expert opinion” (1988, 1997).⁴ Other articles have tackled issues such as the impact of wine critics on wine prices (Ashenfelter, 1992). *Liquid Assets* ran a successful campaign to allow wine drinkers to bring their own wine to New York

City restaurants (e.g., Ashenfelter, 1991). Another campaign focused on fine wine auctions and their legality in some states (Ashenfelter, 1987b).

However, the central theme of Ashenfelter's research published in *Liquid Assets* has always been the assessment of vintage quality for wines from various regions (e.g., Ashenfelter, 1986, 1987c, 1987d). Essentially, Ashenfelter devised an econometric model that explains auction prices of mature wines by referring to the wine's age and the weather of the year during which the grapes were grown. This model has proven very effective for the assessment of the quality of Bordeaux vintages and prediction of prices of matured wines.

Given that Ashenfelter was the editor of the prestigious *American Economic Review*,⁵ his wine-related works received considerable attention from economists and the general public alike. The *New York Times* has published numerous articles on Ashenfelter's wine economics research in its Wine and Food Section, in the Business Section as well as on the front page (e.g., Goldberg, 1987; Passell, 1990a, 1990b; Prial, 1990). TV channels, such as ABC, CNN, CNBC and Bloomberg, have aired special reports. The wine trade and wine critics, however, have been less intrigued. The New York wine merchant William Sokolin calls Ashenfelter's equation "somewhere between violent and hysterical" (Ayres, 2007). Robert Parker, the world's most influential wine critic, deems Ashenfelter's empirical approach "really a Neanderthal way of looking at wine. It is so absurd as to be laughable", in short "an absolute total sham" (Ayres, 2007).

Why is the wine world up in arms against an empirical approach to wine? Frank Prial of the *New York Times* writes:s:

[Ashenfelter] is accused of relegating the whole wine- tasting mystique to a minor role. Supposedly, the sipping, spitting, sniffing and note-taking so dear to wine romantics have all been rendered obsolete by mathematics (1990)

Ashenfelter published an updated version of his "Bordeaux equation" in 1995 (Ashenfelter, Ashmore and Lalonde, 1995) and later, in 2008 (Ashenfelter, 2008). The Bordeaux model is a cross-sectional model with the (natural logarithm of the) price index of a Bordeaux wine portfolio as dependent variable and the wine's age and various weather data as independent variables. Table 2 shows the results of three different variants. Column (1) reports the results when only age is used as explanatory variable; columns (2) and (3) also include weather variables. The equation given in column (2) is most commonly referred to as the "Bordeaux equation". It contains the main seeds of wine economics and its major research topics: (1) the value of wine as an alternative financial asset, (2) wine and climate change and (3) wine and expert opinion.

First, the Bordeaux equation laid the foundation for a large body of research in wine's role as an alternative financial asset. The age coefficient of 0.0238 (table

2, column (2)) represents the real rate of return to holding Bordeaux wine.⁶ One more year of age adds 2.38 per cent to the wine portfolio's value. Does that justify holding wine as an alternative asset in lieu of stock?

Table 2: Bordeaux wine prices and the weather

Independent variable	Dependent variable logarithm of London auction prices for mature red Bordeaux wines		
	(1)	(2)	(3)
Age of vintage	0.0354 (0.0137)	0.0238 (0.00717)	0.240 (0.00747)
Average temperature over growing season (April–September)		0.616 (0.0952)	0.608 (0.116)
Rain in August		−0.00386 (0.00081)	−0.00380 (0.000950)
Rain in the months preceding the vintage (October–March)		0.001173 (0.000482)	0.00115 (0.000505)
Average temperature in September			0.00765 (0.0565)
R-squared	0.212	0.828	0.828
Root mean squared error	0.575	0.287	0.293

Note: All regressions are of the (logarithm of) the price of different vintages of a portfolio of Bordeaux chateau wines on climate variables, using as data the vintages of 1952–80, excluding the 1954 and 1956 vintages, which are now rarely sold; all regressions contain an intercept, which is not reported. Standard errors are in parentheses.

Source: Ashenfelter (2008)

In addition to storing wine, consumers may also invest in Bordeaux wine futures one year after the harvest. The future prices are set by the producers and may not reflect the true market value of the wine which is not known before the wine is finally released and traded, that is three years after the harvest. Young Bordeaux *grands crus* are typically very tannic and need a maturation period of eight to ten years to be drinkable. Ashenfelter shows that, as the wines approach their drinkable age, the auction prices slowly converge toward their predicted price. Therefore, consumers may arbitrage if the initial future price is sufficiently lower than the expected market price from the Bordeaux equation (However, this is almost never the case). In this way, the Ashenfelter equation has paved the way for a new strain of research in wine and finance.

Second, Ashenfelter finds that a warm growing season, a dry harvest and plenty of rainfall in the preceding winter create ideal conditions for high-quality wine in the Bordeaux region. The Ashenfelter equation not only repeats facts already

known for 2 000 years, but also exactly quantifies the relationship between wine prices and weather. In addition, and this has become increasingly important, it can assess the effect of global warming on wine prices and thus on land values. The equations provided in table 2 show the positive effect of warming on Bordeaux wine prices, a result that has been confirmed for several northern European winegrowing regions. The opposite may be true for wine regions that are already at their growing season temperature optimum. The Bordeaux equation, therefore, also contains the seeds for many future articles on wine and climate change.

Third, the Bordeaux equation shows that the methods of wine experts are less reliable than quantitative methods of predicting a wine's quality. Since Bordeaux wines are not ready to be consumed before an age of about eight to ten years, vintage assessments need to forecast a vintage's quality. While the Bordeaux equation's predictions with an R^2 of 0.828 are fairly accurate, experts steadily adjust their ratings as more information about a wine's drinkability becomes available. Particularly mediocre vintages are oftentimes rated too high. For instance, in 1983, Parker deemed the 1975 vintage in Pomerol and St Emilion (sub-appellations within the Bordeaux winegrowing region) outstanding and awarded it 95 out of 100 points. He also added that the wines were too tannic to be drunk and should be stored a long time (a sign of a great vintage). However, as these wines matured, Parker dramatically adjusted his rating. In 1989, he awarded this very vintage only 88 points and recommended that the wines should be drunk immediately rather than stored. So within six years Parker's 1975 vintage rating dropped from outstanding to below average. In contrast, the Bordeaux equation predicted the mediocre quality of this vintage already in 1975, immediately after the harvest. In addition, expert opinion is not free. In order to obtain vintage ratings, consumers need to subscribe to Parker's newsletter or buy similar wine magazines. Weather data, on the other hand, are freely available online.⁷

4 WINE AND FINANCE

Only a very small minority of wines will gain in quality and price when properly stored. The overwhelming majority of wines produced will not benefit from being stored for more than two or three years. Wine investors mainly concentrate on the finest growths from Bordeaux and Burgundy and selected wines from California and Australia. Over the last 25 years, these wines have become the focus of an increasing number of investors and a large "wine investing industry" has evolved around this phenomenon. Similar to stock market indices, such as the Dow Jones Industrial Average, the London International Vintners Exchange (Liv-ex), a marketplace for wine merchants established in 1999, tracks wine prices and reports the development of several wine price indices.⁸

Not unexpectedly, the wine trade declares wine the ultimate asset. Wine generates above-average returns, helps to diversify an investor's portfolio and thus lowers the risk and – if all fails – one can still drink it. Zachy's, a major New York wine retailer and wine auction house, states that "top Bordeaux prices have increased in the auction market 25 to 50 per cent per year for the last several years" (Burton and Jacobsen, 2001, p.338). In 1998, Peter Meltzer, the auction correspondent of the *Wine Spectator*, the world's largest wine magazine, wrote that "throughout the 1990s, the wine market has outpaced the Dow Jones" (Burton and Jacobsen, 2001, p.338). More spectacular profit margins for selected wines were reported by Sokolin (1998).

The rapid increase in public attention has been accompanied by a growing body of economic literature that assesses the return to as well as the risk of investing in wine.

The studies by Ashenfelter (Ashenfelter *et al.*, 1995; Ashenfelter, 2008) mentioned in section 3 are based on prior work published in *Liquid Assets* (e.g., Ashenfelter, 1987a) and are cross-section analyses. Therefore, the coefficient of the age variable of the Bordeaux equation in table 2 reflects the effect of age at one point in time and reports the real rather than the nominal rate of return. Given that the Dow Jones index grew by 30.2 per cent (nominal) in 1991, a 2.4 per cent real wine return is fairly low. It should be noted that equities would also have yielded dividends while the only financial returns to wine are due to capital gains and investors also incur storage cost.

In a similar fashion, Jones and Storchmann (2001) and Haeger and Storchmann (2006) report cross-sectional real rate of returns for selected chateaux of Bordeaux wines and Californian Pinot Noirs, respectively, significantly below those for common stock.

In a pooled SUR model for Australian *Grange*, one of Australia's icon wines, traded in 1991–1993 auctions, Byron and Ashenfelter (1995) find nominal annual returns of between 12 and 18 per cent. They find market inefficiencies with many young wines being significantly underpriced.

Wood and Anderson analysed three Australian icon wines, Grange, St Henri and Hill of Grace. They also employed a SUR approach but modelled age as a cubic function; prices rise "when the wine is young, plateauing out around optimal drinking time, before increasing again in value as the wine becomes an 'antique' wine" (Wood and Anderson, 2006, p.146). Due to this specification, the real rate of return is dependent on the wine's age. For instance, Hill of Grace yielded a real return of 14.8 per cent in its second year, 0 per cent in year 20 and 10.4 per cent in year 30. Over the first 20 years of the wine's age, the average annual return equalled 4.3 per cent, which was significantly below the annualised 14.4 per cent growth rate of the Dow Jones.

Krasker (1979) conducted the first economic time series analyses of the rate of return to storing wine. Drawing on 137 observations of red Bordeaux and California Cabernet Sauvignon for the time period from 1973 to 1977 he found that the rate of return to holding wine was not significantly different from the one for risk-free US Treasury bills. In contrast Jaeger (1981) found, for a wine portfolio similar to Krasker's, that wine outperformed Treasury bills by 16.6 per cent. While Krasker's storage cost was endogenous and estimated at \$16.60 per case and year, Jaeger assumed a substantially lower exogenous annual storage cost of \$0.45. In addition, she used a longer time period from 1969–1977 – potentially lowering the dampening effect of the 1973–1975 recession. As Jaeger has shown in several variants of her model (Jaeger, 1981, p.589), the higher returns compared to Krasker's (1979) result were equally due to the different time period (+8.5 per cent) and the lower storage cost (+8.1 per cent).

Weil (1993) analysed the actual portfolio of a specific wine investor and tracked each of his purchases and sales from 1976 to 1992. The portfolio consisted of various Bordeaux, Burgundy and Northern Rhone wines. Overall, Weil (1993) analysed 68 transactions and accounts for actual storage costs, clearing fees and sales commissions. For each transaction, he compared the rate of return with a hypothetical return if the investor had invested in the Dow Jones during the same time period. As a result, while an investment in stock would have yielded an annualised rate of return of 19.3 per cent, the actual wine transactions only resulted in 6.5 per cent (all nominal and before income tax).

Burton and Jacobsen (2001) analysed the returns from storing Bordeaux wines for the time period from 1986 to 1996 using repeat-sales regressions. They compared the semi-annual returns of various wine portfolios against those of financial assets. As reported in table 3, Burton and Jacobsen found that a portfolio of first growths (6.7 per cent p.a.) barely outperformed risk-free Treasury bills (5.8 per cent), let alone the Dow Jones index (13.2 per cent). Even a portfolio of Sokolin's first investment grade wines did not yield more than 7.7 per cent.⁹ In fact, only top Parker rated wines of the 1982 vintage outperformed the Dow Jones during the observed time frame. When sales commission, insurance and storage were subtracted, however, the returns to 1982 wines were not different from equities (which, in addition, provided dividends).

Table 3: Annualised nominal rates of return for various wine portfolios, 1986–96

Aggregate	7.9%
First growth	6.7%
1961 vintage	
All	8.3%
First growths	9.6%
1982 vintage	13.9%
Parker's top 15	
All vintages	7.8%
1961 vintage	9.9%
1982 vintage	16.2%
Average prices	9.4%
Maximum prices	11.8%
Dow Jones	13.5%
T-Bills (1 year)	5.8%

Source: Burton and Jacobson (2001)

Table 4: Nominal annual rates of return for wine and other assets, 1986–1996

	All	First growths	1961	1982	Dow Jones	T-Bills
Annual return	7.9%	6.7%	8.3%	13.9%	13.5%	5.8%
Standard deviation	0.133	0.261	0.290	0.134	0.079	0.008

Source: Burton and Jacobson (2001)

As Burton and Jacobsen (2001) reported in table 4, not only does wine generally yield lower returns than stock, but wine investment is also riskier. The standard deviation of a portfolio consisting of all *grands crus* is more than twice as high as the one of the Dow Jones. Portfolios that focus on First Growths or the 1961 vintage only exhibit an even larger price variation.

More recently, Sanning, Shaffer and Sharratt, (2008) analysed Bordeaux auction prices from 1996–2003 using the Fama-French-Three-Factor Model and the Capital Asset Pricing Model (CAPM). They found a wide range of annualised risk adjusted returns averaging at approximately 8.5 per cent; the standard

deviations were similar to those found by Burton and Jacobsen (2001). However, Sanning *et al.* (2008) also found that the covariance between wine and equity market returns was close to zero, rendering wine a potential hedging asset that might offset or protect against stock market risks. Similarly, in a recent analysis of Australian wines, Fogarty found “that despite the return to Australian wine being lower than the return to standard financial assets, wine does provide a modest diversification benefit” (2010, p.119).

These findings found additional support by Masset and Henderson (2010), who analysed a 1996–2007 sample of Bordeaux wine prices. They found that wine can provide diversification risk-reduction benefits and calculate optimal portfolio shares for equity, wine and art for investors with different preferences with respect to expected returns, variance, skewness and kurtosis. Although it may be advisable for investors to hold a fraction of their portfolio in wine, Masset and Henderson also call for caution. First, wine is less liquid than stock. Second, diversification advantages may change over time. They computed a moving 24-month window correlation between the S&P 500 and two wine indices and showed that the correlation between equities and wine varies. While there was no correlation from 2000 until the financial crisis in October 2008, that changed significantly thereafter. The authors suspected the flight to more liquid assets to be the likely cause. Positive correlations between equities and wine will, however, potentially thwart any diversification strategy.

Masset and Weisskopf (2010) studied the profitability of wine investments during the financial crisis of 2008. Analysing different portfolios for five investor types (from conservative to aggressive) and taking risk aversion, different financial assets and various wine indices into consideration they showed that the addition of wine to a portfolio improves returns as well as skewness and kurtosis. Employing a conditional CAPM, they found that both alphas and betas vary with time.¹⁰ Wine returns appear to be unrelated to market risk but behave cyclically with the economy and the \$/EUR exchange rate. Di Vittorio and Ginsburgh (1996) reported similar findings for Medoc wine auctions at Christie’s.

Figure 5 shows the developments of the Liv-ex 50 and the Dow Jones Industrial Average index from December 1999 to April 2011. First, figure 5 depicts the covariance between wine market and stock market since 2008 (betas). The wine market follows the stock market. Second, figure 5 also displays the extraordinary growth in wine prices since about 2005 (alphas). This trend was only temporarily interrupted by the financial crisis.

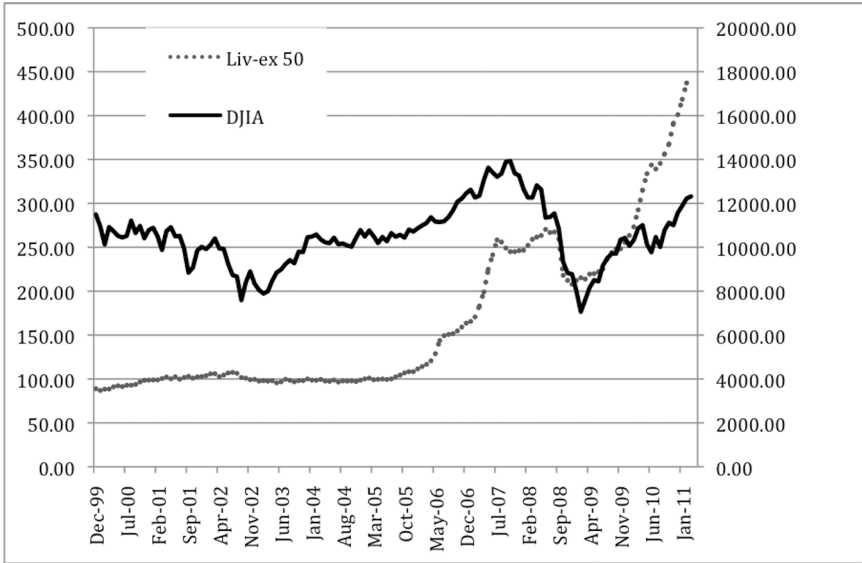


Figure 5: Liv-ex 50 and Dow Jones Industrial Index, December 1999 to April 2011

Jovanovic (2008) studied the prices of selected older Bordeaux wines (e.g. Lafite 1865, 1875, 1900; Margaux 1900; Yquem 1900) at auctions, on restaurant wine lists and at retail outlets over the past 100 years. Based on the works of Hotelling (1931), Jovanovic shows theoretically how bubble equilibria can form for exhaustible resources, such as wine. In most equilibria the price of a resource rises at the rate of interest. “In a bubble equilibrium, however, the consumption of the resource peters out, and a positive fraction of the original stock continues to be traded forever. And that may well be happening in the market for high-end Bordeaux wines” (Jovanovic, 2008, p.1).

5 WINE AND CLIMATE CHANGE

The first econometric evaluations of the effect of weather on wine prices were carried out by Ashenfelter and were published in *Liquid Asset* in the late 1980s (e.g., Ashenfelter, 1986, 1987c, 1987d, 1990). The Bordeaux equation in column 2 of table 2 reports a growing season temperature coefficient of 0.616: that is, an increase of 1 °C results in a 61.6 per cent price increase. Given that, since 1945, average Bordeaux growing season temperatures have ranged between 14.98 °C (1972) and 19.83 °C (2003) large price variations are hardly surprising. Predicted temperature increases for the European winegrowing regions for this century are between 1.5 °C and 5 °C (e.g., European Commission, 2009), an extent of

variation that is within the already experienced range of regular annual weather fluctuations. Predictions for precipitation are less reliable and generally conclude that precipitation will increase in Scandinavia and decrease in southern Europe. Assuming rising temperatures and no changes in precipitation, Ashenfelter's Bordeaux equation, therefore, predicts substantial price increases for Bordeaux *grands crus*.

Jones and Storchmann (2001) confirmed the positive effect of global warming on the Bordeaux wine region. They modelled the effect of weather by estimating cross-sectional equations for each of 21 selected *premiers crus* chateaux. Given that each chateau's wine is a unique blend that is either dominated by Cabernet Sauvignon or Merlot,¹¹ Jones and Storchmann first computed the weather's impact on the sugar and acid levels of each of these grape varieties. Taking into account the respective blend proportions they then proceeded with a price equation. They found that Merlot is more weather-responsive than Cabernet Sauvignon. That is, in a scenario of global warming, Merlot dominated wines, such as *Chateau Petrus*, would benefit above proportionally.

Ashenfelter and Storchmann (2010b) employed three different models to evaluate the effect of warming on Mosel vineyards in Germany. In a first model, they explained the Prussian vineyard classification from 1868. This vineyard classification was not carried out as an orientation guide for wine aficionados, but rather as a basis for fair and just taxes. The ranks were based on the land's profit and the tax rates were set accordingly. Using an ordered probit model, Ashenfelter and Storchmann (2010b) showed that the Prussia ranking (and thus the willingness to pay for wine) could be explained by referring to the main vineyard characteristics, namely soil type and the land's potential capability to capture income solar radiation, that is energy. In particular, the higher the potential solar energy of a vineyard, the better is its rank. The amount of solar radiation a plot of land can capture can be calculated similarly to a solar panel and depends on its latitude, slope and orientation. For the German Mosel, which is located at the northern frontier of professional viticulture, energy is a scarce resource and the best vineyards are south-facing and exhibit a 45-degree slope. In the next step, Ashenfelter and Storchmann (2010b) employed the Boltzmann equation to link solar radiation to temperature. Higher temperatures require more solar radiation. Higher solar radiation, in turn, will increase the likelihood of a certain vineyard being in a high-quality rank. As a result, further warming will shift the rank distribution of all Mosel vineyards from low to high quality and will thus increase land prices. Under a warming scenario of 3°C, the value of vineyards in the Mosel may double.

Ashenfelter and Storchmann (2010b) compared these results with two different time series models drawing on revenue data for Mosel wineries and accountancy

data of wineries from various West German winegrowing regions. These models suggest that a warming of 3°C may raise revenue by 150–180 per cent. Given the entirely different nature of all employed models, the results are remarkably consistent.

In a different article, Ashenfelter and Storchmann (2010a) showed that, depending on the wine sample considered, regressing price on temperature might result in biased results. Comparing auction, retail and wholesale prices yielded the strongest positive temperature effects for wines sold at auction and much smaller effects for the wholesale sample. Given that only a tiny fraction of the wines produced are sold at auction (e.g., only the highest-qualities) referring to auction prices may overstate the effect of warming.

In a long-run time series analysis covering the time period from 1800–2009, Chevet, Lecocq and Visser (2011) studied prices and yields of a *premier cru* chateau in the Bordeaux region. They found a positive impact of temperature on both yields and prices. However, while the temperature responsiveness of crop yields has fallen dramatically over time, prices have become substantially more sensitive to growing season temperature changes.¹² Apparently, technological improvements have helped winegrowers to lower the weather's impact on crop levels. However, the findings also suggest that prices are not driven by quantity produced alone. Quality effects and growing market demand must more than offset the price-declining effect of yield increases due to warmer growing seasons.

All the articles mentioned above employ linear temperature specifications: that is, the marginal effect of temperature on wine prices is implicitly assumed to be constant. This may be justified for regions in cooler climates, such as Bordeaux and Germany, or when drawing on data from colder time periods such as the “Little Ice Age” of the early and mid-19th century. For warmer regions, especially in the New World, non-linear specifications may be more appropriate. Byron and Ashenfelter (1995), in their analysis of Australian Grange (see section 4), regressed a squared function where wine prices grow with increasing temperatures but at a decreasing rate. Wood and Anderson (2006) also employed a squared temperature specification for Australian icon wine prices. Similarly, Haeger and Storchmann (2006) estimated a squared function for US Pinot Noirs that have their price-maximising peak at a growing season temperature of 22.2 °C (from April to September). Many US growing regions are already beyond the optimal temperature, while Burgundy as well as German wine regions are still benefiting from further warming.

Some studies focused on wine quality rather than on wine prices or winery profits. Jones *et al.* (2005) analysed the effect of temperature on Sotheby's vintage ratings from 1950 to 1999 for all major wine regions worldwide. They employed non-linear squared time series models for each region and show that there are

winners and losers of global warming. In general, while winegrowing regions in northern France and Germany will produce better wine quality with increasing temperatures, winegrowing regions in Spain, California and south Australia might suffer from any further warming.

Storchmann (2005) examined the weather determinants of the quality of Schloss Johannisberg wine in the German Rheingau region from 1700 to 2003 employing an ordered probit model. He drew on documented vintage classifications (such as “top wine”, “sour”, “lesser vintage”) in historical harvest books, grouped them into five quality ranks, and regressed these ranks on various weather data. The results showed that (1) English weather data are a good proxy variable for the actual weather conditions in the Johannisberg vineyards¹³ and (2) that moderate warming will improve the quality of Rheingau wines.

It is clear from these analyses that, in the wine industry as in many other industries, there are winners and losers from global warming. Changing climate requires many technological adjustments and varietal substitutions. In addition, in order to mitigate the deteriorating effects of temperature increases, viticultural regions tend to move toward the poles, to higher elevations or, for example in California, closer to the coast.

6 WINE AND EXPERT OPINION

6.1 Expert ratings and price impact

Since wine is an experience good, and its characteristics are not known to most wine drinkers before consumption, experts and their critical reviews may help to fill an information void. Accordingly, the market for expert opinion on wine is large. The seven major US wine magazines have a combined subscribership of more than 500 000 (table 5), with 350 000 alone for the *Wine Spectator*; wine magazine sales amount to well above \$25 million. In addition, there are a few foreign magazines (e.g. *Decanter*) and numerous smaller publications, online services (e.g. *JancisRobinson.com*) and wine blog websites.

Table 5: Subscriptions to selected US wine magazines in 2010

Magazine title	Founded	Subscriptions	Single copies sold	Subscription price ^a (\$)	Single copy price (\$)	Annual revenue from sales (\$)
<i>California Grapevine</i>	1973	3 000 ^b	n.a.	32.00		96 000
<i>Connoisseurs' Guide to California Wine</i>	1974	7 000 ^b	n.a.	90.00		630 000

<i>Wine Spectator</i>	1976	368 522	32 030	49.95	4.95	18 886 955
<i>Wine Advocate</i>	1978	50 000	0	75.00		3 750 000
<i>Wine Enthusiast</i>	1979	108 000	4 653	29.95	4.95	3 257 600
<i>Wine & Spirits</i>	1981	23 000	48 000	29.95	5.99	976 370
<i>The Wine News^d</i>	1985	30 250 ^b	24 750	25.00	5.00	880 000

Notes: ^a for 2010; ^b as of 1999; ^c online only, a hardcopy subscription costs \$120/year; ^d discontinued in 2010.

Sources: Pitcher (2003), The Association of Magazine Media (2011) and the websites of the respective magazines

Another remarkable fact shown in table 5 is the sudden and rapidly growing interest in expert opinion. The first US wine magazines all started out of California in the mid-1970s. Even *Wine Spectator* was originally launched in San Diego and was only moved to New York when Marvin Shanken bought the publication from founder Bob Morrissey in 1981. Given that there was no national wine magazine before the mid-1970s, this sudden and rapidly growing demand for expert opinion is fairly amazing.

Wine consumers and investors rely on experts in many ways. Experts predict the quality of particular (especially Bordeaux) vintages that have not been traded yet in order to help wine investors and connoisseurs to decide whether to buy futures. They describe a wine's taste and smell and rate wines or award gold medals to facilitate the consumer's choice.

Ashenfelter (e.g., 1987d, 1990, 1992, 2008; Ashenfelter *et al.*, 1995) has shown that expert opinion regarding Bordeaux vintage qualities can be seriously flawed. Relying on publicly available information, such as weather data, yields more reliable results. Furthermore, weather data about a certain vintage are available directly after the harvest, that is about half a year before the first experts have tasted and rated the vintage. In addition, weather information is available at no cost.

Ashenfelter (2008) has also shown that the Bordeaux wine market exhibits considerable inefficiencies. Directly after their release, the prices of many young wines deviate substantially from the predicted price based on weather. In fact, most vintages are overpriced. However, after about 10 years, when entering the drinkable stage, wine prices converge toward the predicted price based on the weather. According to Ashenfelter (2008), the over-pricing during the wines' early life is especially pronounced for vintages that are predicted to be the poorest. For instance, prices for the 1969 vintage decreased by 76 per cent within the first 15

years after its release: “This suggests that, in large measure, the ability of the weather to predict the quality of the wines is either unknown or ignored by the early purchasers and sellers of the wines” (Ashenfelter, 2008:F183).

A reverse anomaly is the 1982 Bordeaux vintage whose prices have soared significantly above the weather-predicted price and even 30 years after its release have not converged to the expected price (Ashenfelter, 2008). The main reason for this phenomenon may be the high praise for this vintage by wine critics, in particular by Parker, who is widely considered the most influential wine critic. For the 1982 vintage, Parker awarded a perfect score of 100 points to seven Bordeaux *grands crus*, more than for any vintage before.¹⁴

This raises the question whether and to what extent wine critics influence wine prices. Based on prior analyses by Ashenfelter (1990), Ashenfelter and Jones (2011) examined the efficiency and the price influence of expert ratings for Bordeaux wines. They contrasted the explanatory value of ordered vintage quality indicators by well-known experts with publicly available weather data to examine whether the experts’ opinion contains any private information beyond what is already publicly known. In two models they regressed wine prices first on expert ratings only, then on weather data only, and found that both kinds of variables are good price predictors. In the following step, they added the experts’ ratings to the weather data equation. As a result, expert ratings become inconsistent and insignificant suggesting that they do not contain any private information. This result finds further support from the fact that weather data are excellent predictors of the experts’ ratings. Haeger and Storchmann (2006) pursued a similar sequential approach and found that *Wine Spectator* points only marginally improve weather-based models of US Pinot Noir wine prices. Jones and Storchmann (2001) differentiated this approach by chateau and reported that prices of smaller chateaux, those that make Cabernet Sauvignon-dominated wines and those that have been rated highly in the past, are more sensitive to Parker points than others.

Hadj Ali and Nauges (2007) examined Bordeaux *en primeur* prices: that is, wine future prices that are set by the chateaux in the spring after the harvest. Using a hedonic approach, they found a statistically significant but small effect of critical points by *Wine Spectator* as well as by Parker in addition to fundamentals. Hadj Ali and Nauges (2007) found that Parker’s impact on future prices is fairly small: one additional Parker point results in an average price increase of 1.01 per cent.

Hadj Ali, Lecocq and Visser, (2008) referred to a natural experiment in order to disentangle the public and the private information content of expert ratings. Normally, the Bordeaux chateaux set their *en primeur* prices in the spring following the harvest – after Parker has tasted and rated the wines. The chateaux, therefore, have the opportunity to incorporate any possible private information contained in

Parker's rating into the price. However, in the spring of 2003, Parker did not visit the region and did not publish his assessment of the 2002 vintage before the fall of 2003. Thus, the chateaux set their 2002 *en primeur* prices without Parker's rating. The authors confirmed the small price relevance of critical points already found by Hadj Ali and Nauges (2007). The fact that Parker visits the Bordeaux region, tastes and rates *en primeur* wines has an average value of approximately €2.80 per bottle, less than 2 per cent of the average *en primeur* price for *premier cru*.

6.2 Experts and wine words

Wine critics and experts not only convey private information about a wine's quality by assigning grades or points but also provide verbal descriptions of the smell and taste. Parker alone has evaluated and described the appearance, smell and taste of more than 180 000 wines in his newsletter *The Wine Advocate*; *Wine Spectator* lists over 240 000 wine reviews on its website. Over the past 40 years, a rich wine vocabulary has evolved. According to Parker's *A glossary of wine terms*, wine descriptors include terms such as "angular", "backward", "decadent", and "dumb" (2011). For instance, Parker describes a Rhône wine as follows: "Deep ruby color includes purpose nuances. Closed aromatically, hints of crème de cassis and black cherries. Cuts broad swath across the palate with considerable depth and concentration. Tannic as well as broodingly backward" (Weil, 2007, p.140).

What is the informational value of wine words? In one of the first studies, the linguist Adrienne Lehrer (1975) examined the function and value of the wine language. She ran several experiments to assess the degree of useful communication about wine flavours. In one experiment she let people first describe three distinctly different wines. In subsequent blind tastings, she then asked the subjects to match the description with the wine. Surprisingly, the subjects were unable to produce a better than chance match, thus casting doubts on the informational value of wine words.

Lawless (1984) compared the matching ability of wine experts and non-experts when drawing on descriptions by either group. In his experiments, only expert tasters using expert descriptions performed slightly better than random. All other combinations, such as *expert descriptions and amateur tasters* or *amateur descriptions and amateur tasters*, resulted in outcomes that were not better than chance.

More recently, Weil (2007) analysed the value of wine words. He drew on published wine descriptions in *Wine Spectator* and Parker's *Wine Advocate* and asked subjects to match three wines with the corresponding description. The overall matching performance was random.

Why do wine consumers rely on expert opinion if they do not provide any practical use? Quandt (2007) analysed the wine market by referring to a book by Princeton University philosophy professor Harry G. Frankfurt entitled *On bullshit* (2005). He concluded: “I think the wine trade is intrinsically bullshit-prone and therefore attracts bullshit artists” (Quandt, 2007, p.135). This seems to be confirmed by the relatively high un-scholarly Google hit ratio reported in table 1.

However, according to Ramirez (2010), wine descriptions appear to influence not only wine critics but also producers. Analysing 2 700 *Wine Spectator* reviews of Napa Cabernet Sauvignon and employing a dynamic price model he found that the length of the review (measured by the number of characters) has a significant positive price effect – even after controlling for quality. In addition, he found that the price effect does not result from “purely analytical” words, but rather from metaphorical language. This suggests that consumers find prose more persuasive than neutral descriptions; so wine descriptions may meet other needs besides the mere transmission of information.

6.3 Expert failure

Not only can expert opinion be of little informational value, but it can also be significantly flawed. Hodgson (2008) analysed the performance of wine judges at a major US wine competition from 2005 to 2008, where panels of four wine judges assess samples of 30 wines and award medals (Gold, Silver, Bronze) to excellent wines. Unknown to the judges, Hodgson inserted triplet pourings of one bottle into the sample: that is, three of the 30 wines within one flight were identical. Only 10 per cent of the judges were able to rank these wines within the same medal rank; another 10 per cent assessed the triplet wines within a two-medal range: that is, 80 per cent of the examined judges ranked identical wine more than two medal ranks apart. In addition, even the 10 per cent of judges who assigned the same quality rank to identical wines were unable to repeat this performance in the following year. These results suggest that experts award medals at random.

This conclusion finds further support in a second study by Hodgson (2009). Hodgson, a wine maker himself, observed that wines entered into several competitions rarely received identical evaluations in each of them. A wine might obtain a gold medal in one competition and nothing in another. If a gold medal were a good predictor for quality, then the probability of receiving a gold medal at competition B should *not* be independent of whether this wine already obtained a Gold at competition A. In fact, a wine that receives a Gold at A should have a higher than random chance of obtaining a Gold at B.

However, Hodgson (2009) found that this is not the case. The probability of obtaining a Gold medal at B is stochastically independent and follows the binomial probability distribution. For instance, if the chance of receiving a Gold at any

competition were 10 per cent and if the distribution of Gold medals were random (i.e., independent) the chance of receiving two Gold medals would equal $0.1 \times 0.1 = 0.01$ Hodgson found that this is the case for wine competitions and states “that chance alone may account for the number of Gold medals that a wine receives” (2009, p.8).

Expert opinion does not only suffer from a lack of expertise, however: sometimes conflicts of interest may result in biased outcomes. Reuter (2009) examined whether wineries that advertise in *Wine Spectator* receive better critical evaluations of their wines. He exploited the fact that the other large wine magazine, *Wine Advocate*, does not accept winery advertising. Although advertisers and non-advertisers obtain similar ratings, when he controlled for quality by referring to *Wine Advocate* ratings, Reuter (2009) found that advertisers receive almost one more critical point than do non-advertisers.

But even worse, Robin Goldstein (2008) reported that, in addition to being flawed or biased, expert opinion can be entirely made up. Goldstein applied for the *Wine Spectator Award of Excellence* that is regularly given to restaurants with an outstanding wine list. However, Goldstein has never either owned or managed a restaurant. Instead, he launched a website of a fictitious restaurant in Milan, Italy, and obtained an Italian phone and fax number. He submitted his application, a letter and a \$250 fee – and after an evaluation phase of a few weeks, he indeed received the *Wine Spectator Award of Excellence*.

This means that *Wine Spectator* granted an award of distinction to a nonexistent restaurant. The expert’s service: so conveying information about an experience good has become an experience good (or even a credence good) itself. Ashenfelter, Goldstein and Riddell (2011) showed in a theoretical and empirical model that earning a *Wine Spectator Award of Excellence* is meaningless for the quality of the wine list. Only restaurants that can charge their customers for the cost incurred will apply for the award. Thus, after controlling for the quality of food, service and décor, Ashenfelter *et al.* (2011) found that applying for (and receiving) a *Wine Spectator Award of Excellence* only results in higher prices.

However, the issue of flawed or even fraudulent expert opinion is not unique to the wine industry. A recent ABC News report on the Better Business Bureau (BBB), an institution that evaluates and rates businesses in the US, showed that numerous nonexistent businesses, such as a fictitious firm named Hamas, received impeccable ratings as long as they paid the evaluation fee. Others that declined to pay, such as Disneyland or some of Wolfgang Puck’s restaurants, received an F (Rhee and Ross, 2010). Clearly, there are inherent issues when the evaluatee pays the expert who evaluates him or her. There has long been a suspicion that the evaluations of business rating companies such as Moody’s, Fitch or Standard & Poor’s may be equally flawed.

7 SUMMARY

Compared to other beverages, wine enjoys a lively internet presence; wine writers, critics, bloggers, consumers, winegrowers and merchants all write about wine. In contrast, there has been significantly less scholarly work conducted on wine than on any other beverage. As a result, a Google search shows that the general internet chatter on wine per Google Scholar hit is second to none among all beverages. While milk generates less than 4 000 general Google hits per scholarly citation, it is almost 13 000 for wine. Clearly, more people have opinions about wine and write about them than they do about milk.

However, the scholarly economics work on wine has grown substantially since the mid-1980s. Meanwhile, wine has become the leading beverage cited particularly in high-end general economics journals. In 2006, the AAWE was founded and the association's publication, the *Journal of Wine Economics*, is entirely devoted to economic issues related to wine.

The origins of wine economics can be found in the newsletter *Liquid Assets*, which was launched by Orley Ashenfelter in 1986. *Liquid Assets* has been devoted to a quantitative way of looking at the wine market. Ashenfelter's most influential wine paper was arguably his analysis of Bordeaux wine prices and the weather, for it contains the seeds of the three major research topics in wine economics: finance, climate and experts.

More than 25 years after the launch of *Liquid Assets*, we can look back to a substantial and increasing body of high-end economic literature in all of these three fields. It appears to be typical for wine economics that the findings of many analyses have implications that reach beyond the wine market. Financial wine studies not only analyse the effects of portfolio diversification and risk control, but also contribute to general research on the development of asset bubbles. Analyses of wine and weather sketch a complex picture of winners and losers of climate change. Wine-related research on the role and value of expert opinion can be applied to seemingly wine-distant issues such as business rating agencies like Standard & Poor's or Moody's.

Over the past decade, the research into wine economics has diversified. There has been a particularly growing research interest in issues related to market regulation, quality signalling and consumer search.

The repeal of Prohibition in the US in 1933 granted states the authority to regulate the production, distribution and consumption of alcohol, resulting in a wide range of rules and standards across the country; for instance, many states prohibited direct interstate wine shipping. Riekhof and Sykuta (2005) analysed the political economy of interstate shipment regulations and showed that wine distributors are the driving force behind shipping restrictions. Wiseman and Ellig (2004) investigated wine prices in Virginia and concluded that the prohibition of

out-of-state online sales has resulted in a 10 per cent increase in prices. Sharma (2010) analysed whether direct shipping restrictions impair smaller firms more than larger ones. Jaeger and Storchmann (2011) examined the impact of various wine market regulations in the US on consumer search and retail price variations.

Various articles have analysed the effect of reputation on wine prices and decomposed the effect into the components of product, firm, regional reputation (e.g. Landon and Smith, 1998; Schamel, 2009; Costanigro, McCluskey and Goemans 2010; Frick, Eggert and Högrevé 2011). Cross, Planting and Stavins (2011) analysed the impact of regional reputation on Oregon vineyard prices. Schnabel and Storchmann (2010) assessed the role of prices as quality signals in the German wine market. Roberts, Khaire and Rider (2011) examined whether a winery can signal quality and command higher prices by hiring a well-known winemaker from a prominent competitor.

Certainly, wine economics research will not stop here. One apparent new impulse may come from the rise of Asian wine markets and the resulting dramatic increase in fine wine prices. Wine may provide valuable insights in the forming of bubbles and the soaring number of counterfeits.

NOTES

- 1 Apart from the *Journal of Wine Economics* of the AAWWE, there are several journals that, although not purely economics oriented, also publish economic wine-related analyses; these journals are the *International Journal of Wine Business Research* of the Academy of Wine Business Research, the *Journal of Wine Research* of the Institute of the Masters of Wine and the *International Journal of Wine Research*.
- 2 These figures refer to *American Economic Review*, *Journal of Political Economy*, *Quarterly Journal of Economics*, *Review of Economics and Statistics* and *The Economic Journal*.
- 3 The word “wine” must be mentioned in either the title or the abstract of the article.
- 4 Historically, all vineyard classifications were based on wine prices, land prices or land profits. The existence of professional “wine critics” is a fairly recent phenomenon from no earlier than the 1970s.
- 5 In fact, he edited the AER from 1985 to 2001 having had the longest tenure, second only to the founding editor, Davis Dewey (1911–1940).
- 6 Note that “real” does not refer to the CPI basket of consumer goods but rather to wine only.
- 7 The Royal Netherlands Meteorological Institute provides numerous long time series data from weather stations all over the world at no charge (Koninkrijk Nederlands Meteorologisch Instituut, 2011).
- 8 The Liv-ex indices are Liv-ex Fine Wine 50, Liv-ex Fine Wine 100, Liv-ex Fine Claret Chip, Liv-ex Wine Investible Index, and Liv-ex Fine Wine 500 (Liv-ex, 2011).
- 9 When considering sales commission, insurance and storage these return rates fall to 5.7 per cent for average prices and 8.4 per cent for maximum prices, respectively (Burton and Jacobsen, 2001).

- 10 Alpha is a risk-adjusted measure of the so-called active return on an investment. Beta describes the relation of an asset's return compared to the whole market.
- 11 Many chateaux add smaller quantities of Cabernet Franc, Petit Verdot, Malbec and/or Carménère. For Chateau Cheval Blanc, however, Cabernet Franc is the dominant variety.
- 12 While the yield coefficient has fallen from 0.31 (1847–1900) to 0.08 (1961–2009) the price coefficient has increased from 0.004 (1839–1900) to 0.45 (1961–2009) (Chevet *et al.*, 2011).
- 13 This squares with the results of an analysis by Lecocq and Visser (2006) who analysed Bordeaux wine prices. They compared the results when drawing on data from only one weather station to those from numerous local stations. They conclude that using localised data does not improve the models' explanatory power.
- 14 Other outstanding Parker-rated Bordeaux vintages are (number of 100-point wines in parenthesis): 2000 (7), 1961 (4), 1945 (3), 1989 (3) and 1990 (3).

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