May 1994

The price of grange: an oenometric investigation

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"The Price of Grange: an Oenometric Investigation"

by

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DISCUSSION PAPER NO 54

May 1994

University Drive, Gold Coast,QLD,4229
AUSTRALIA

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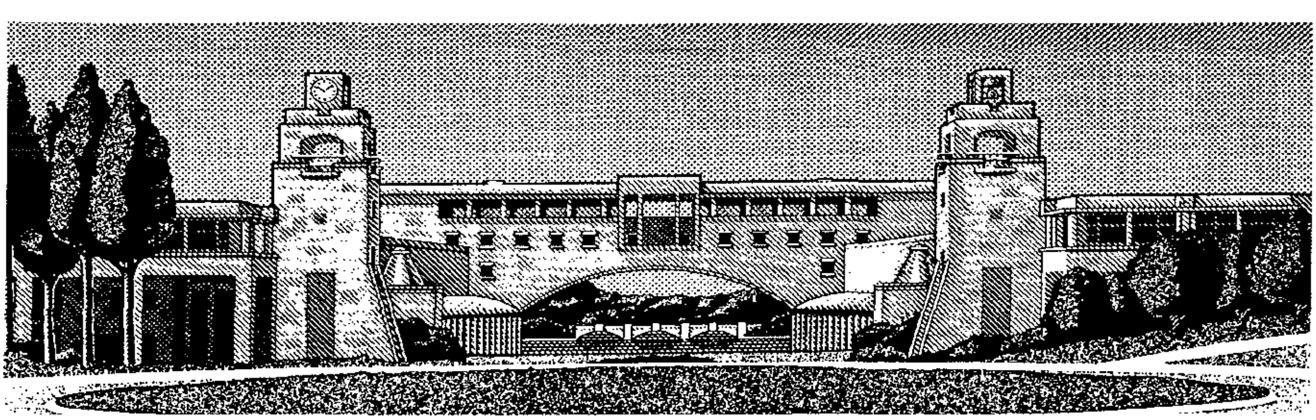

B O N D U N I V E R S I T Y

May 1994

The Price of Grange: an Oenometric Investigation

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Recently Ashenfelter, Ashmore and Lalonde found they could explain the price, and by implication, the quality, of Bordeaux vintages by a combination of age and weather variables. This paper applies the same ideas to Grange Hermitage, the only Australian wine with sufficient history to warrant a comparable study. Weather does not appear to play the same role as in Bordeaux, which may be due to the fact that Grange is a blended wine or that the market in Australia is too thin or that the climatic variation in Australia is unimportant in wine growing.

I. Introduction

In a recent, as yet unpublished paper, Ashenfelter, Ashmore and Lalonde [1993], demonstrate that the price of vintage Bordeaux wines is largely explained by the weather during the growing period. The authors form a price index for Bordeaux wines by averaging the prices of 13 chateaux. They then fit a regression line to this price index for the period 1952 to 1980 using age and three weather-during-vintage variables as predictors. Equating price at auction with the perceived quality of the wine, which is, in fact, the method used by the French authorities in ranking chateaux; if weather and age explain price, weather and age explain quality. This means that an investor has an objective guide to the quality of young wines when cellaring. Ashenfelter, Ashmore and Lalonde found that they could explain 83% of the variation in vintage wine prices with four variables; the age of the wine, the average temperature during the growing season, rain in August and September and the rain in the winter (October to March) preceding the vintage. Age, winter rain and temperature have positive effects on price, whereas rain in the harvest and pre-harvest period has a negative effect.

[1] I am grateful to Lynda Bourke for research assistance, to Stewart Langton of Langton's Fine Wine Auctions for his interest and for providing, collecting and processing the price data for me, to Mike Farmilo, the Winemaker (Red) at Penfolds for helpful comments and advice and to the Bureau of Meterology in Adelaide for their assistance and help. In fact, everyone I spoke to, whether it was librarians or marketing managers, was extremely helpful and interested in the project and the results. Such is the esteem in which Grange is held.

[2] It is a very sad coincidence that the first draft of this paper was written just before the death of Max Schubert, the father of Grange Hermitage. I hope that this paper will not be interpreted as a statistical trivialisation of his accomplishments. It is intented, in the spirit of scientific endeavour, to establish if the variation in Grange can be explained by climatic factors - which presumably are implicit in the winemaker's skill. This paper is an attempt to quantify the art and skill behind the legend.

The authors make the comment that "great vintages for Bordeaux wines to the years in which August and September are dry, the growing season is warm, and the previous winter has been wet". The regression evidence they offer in support of this is reproduced below.

$$\text{(1)}\quad \log(\text{price}) = \underset{(.0071)}{.0238}\,\text{Age} + \underset{(.0952)}{.616}\,\text{AvTempGrow} - \underset{(.00081)}{.00386}\,\text{Rain Aug-Sep} + \underset{(.00048)}{.00117}\,\text{Rain Oct-Mar}$$

No intercept was given for the equation, although one was fitted, standard errors are contained in parenthesis, so the t-statistics are all above 3 and, as mentioned the R^2 is 0.83. If age is the only explanator of the log of price, only 21% of that variation is explained. Thus the inescapable conclusion, price variation is attributable to weather variation and quality ten or twenty years hence is largely explained by the weather in the vintage year.

The interesting question, to an Australian, is whether the same phenomenon is observed here. The initial reaction is that one is unlikely to be successful in predicting wine vintages in Australia for at least two reasons: (i) because the climate is so good there is not sufficient weather variation to produce the quality variability observed in European vintages and (ii) the auction system is relatively undeveloped, trading is thin and prices are likely to be more volatile as a result.

Langton's [1991,1993] provide a record of maximum and minimum prices for wines they have auctioned in the eighteen month periods 1991-1992 and 1992-1993. Average prices are not reported in those publications; however, they kindly provided price, quantity and date records of each sale from January 1991 to May 1994. The average price for each vintage, by year was then calculated. The weather data in Australia are readily accessible and the Bureau of Meteorology in Adelaide provided monthly records for rainfall, minimum and maximum temperatures for the Barossa, Adelaide, Clare and Coonawarra. Penfold's Grange Hermitage is a blend of Shiraz grapes, drawn predominantly from the Barossa valley but with a contribution from the Clare valley. The legend is that it used to be grown at Magill near Adelaide and there are even rumours of some of Coonawarra in the mix. The blend is a well-kept company secret.[3]

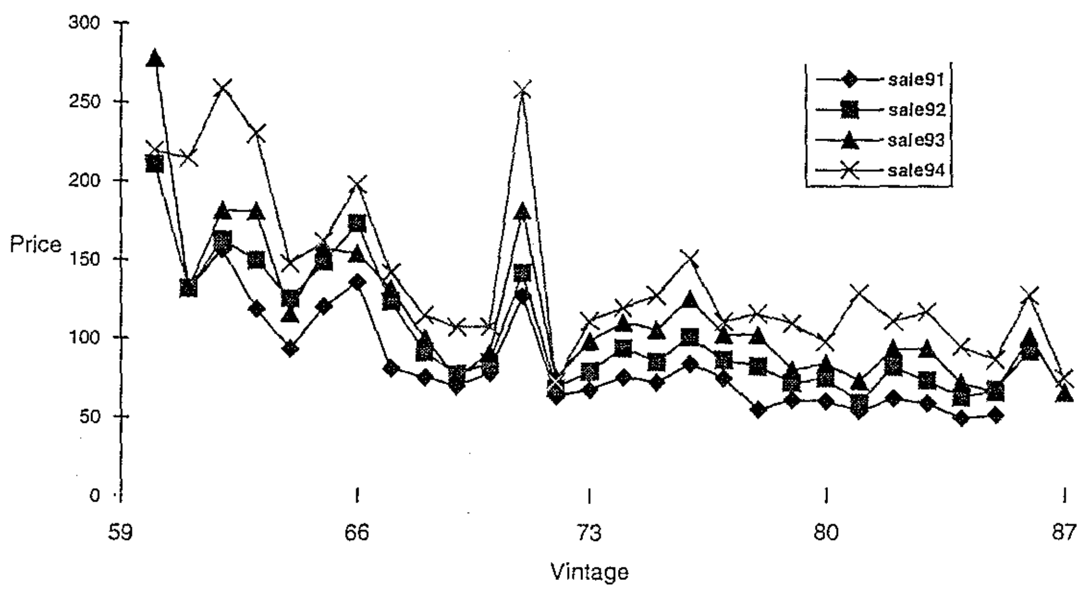
[3] Ideally, with access to the winemaker's notes over the last 30 years, a weather index might be created reflecting, the proportions from each area.

II. The Problem

Grange was traded continuously in the 1991-1994 auctions at Langton's back to the 1951 (first) vintage. A few of the early vintages were not traded in a particular year and represent missing observations. However, many of the early vintages are scarce and beyond their optimal life and their price reflects scarcity (eg. $5500 was paid for a '51 Grange in 1993) rather than quality. Hence, in any attempt to explain wine quality by weather related factors, such observations should be discarded from the sample. The Grange prices in the sample ranged from 1960 to 1987; the price for '50's Grange escalates rapidly and the volume traded declines. A plot of the price of each vintage by year of auction reveals the challenge. Why does the market think the 62, 66, 71 and 76 vintages were so good, and can the relatively poor standing of the 68-70 and 72-74 vintages be explained by weather related factors?

Figure 1

Price by Year of Auction 1960-1987



The '94 sales reflect only four months trading, which may explain why the '60 vintage is selling for less in '94 than it did at the '93 auctions. The '71 Grange has also increased substantially in the '94 auctions, and again it may be too early to judge if this is just an abnormality due to thin trading or overenthusiastic purchasing by a few individuals. The '94 data were excluded from the data used in the statistical calculations partly because they represent an incomplete year.

In any one year the price of Grange varies by vintage according to the market's perception of its quality. Obviously, as older wines become more scarce as the available stocks decrease[4], but even

[4] Information on the yearly production of Grange was not available, nor any assessment of the remaining stocks by vintage in any auction year. Langton's auction data included the quantity traded

then, year to year variations reflect perceived quality changes. It there was no year to year variation, Grange could be treated as a simple investment good and the returns could be assessed by plotting the price against time or, better still, by fitting a regression equation. The rate of return is calculated by fitting a regression line of the log of price against vintage (ie time).

The equation is specified as log price = $\beta_0 + \beta_1$ time + u, where u is a random disturbance. The derivative $\beta_1 = \frac{d \log price}{dtime} = \frac{d \log price}{dprice}\frac{dprice}{dtime} = \frac{dprice}{dtime}\frac{1}{price}$. The raw data in Figure 2 shows the variation in price, the fitted line (converted back from logs to actual predicted prices), shows how well a prediction would serve if based on age only. The fitted regression equation is

$$\log price_{91} = \underset{(37.98)}{3.65} + \underset{(7.92)}{.0392}\ Age \qquad R^2 = .73, \qquad F_{1,23} = 62.76$$

The result is much better than that of Ashenfelter et al, (the R^2 is .73 compared to .25) which could be interpreted as an indication that Grange varies far less in quality than the great wines of Bordeaux. The fitted equations based on the 92 and 93 auction data are

$$\log price_{92} = \underset{(37.01)}{3.91} + \underset{(6.83)}{.0351}\ Age \qquad R^2 = .65 \qquad F_{1,25} = 46.72$$

$$\log price_{93} = \underset{(34.03)}{4.04} + \underset{(5.79)}{.0326}\ Age \qquad R^2 = .56 \qquad F_{1,26} = 34.49$$

A plot of actual versus predicted (based on the actual 1991 auction data rather than the log of prices) is given in Figure 2. The figures are similar when based on the 92 and 93 auction data.

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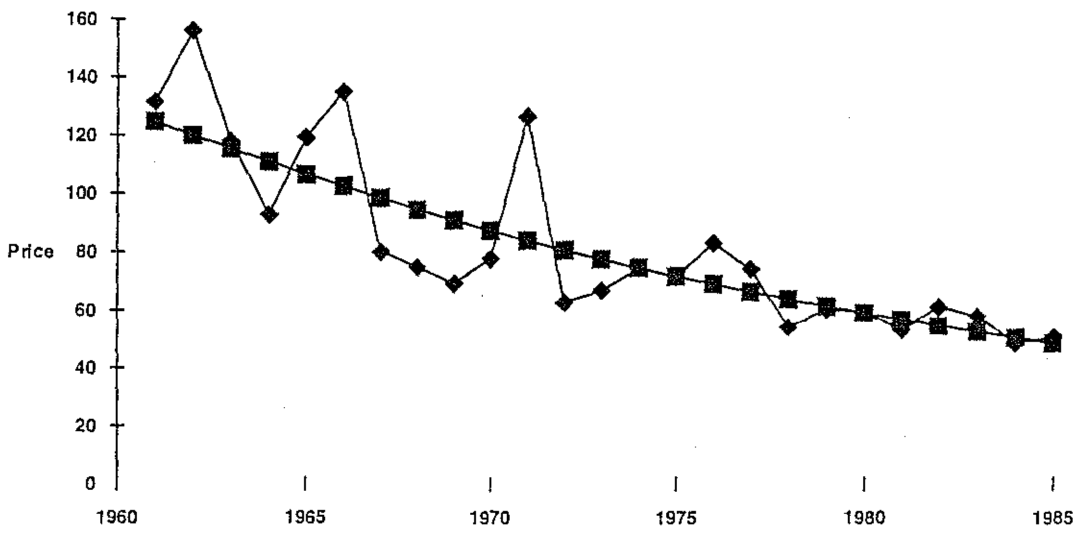
by vintage and while this was negatively correlated with price, it did not contribute significantly to the regression equations subsequently fitted. The quantity traded would not necessarily reflect the stocks outstanding anyhow.

Figure 2
Actual versus Predicted 1991 Auctions
regressor is Age of Wine



These results imply a real rate of return of 3.5% per annum. Allowing a rate of inflation of 10% per annum over the last decade, this suggests a nominal rate of return on capital of around 13.5%. If the entire data set is used, including the very high prices for early 1950's Grange, the return on capital is obviously much higher.

The rate of return appears reasonable, the question remains whether a better rate of return can be achieved by predicting quality at time of release (ie when 5 years old), eg. if the 1971 wine were correctly predicted at the time of release, the rate of return on capital would be more like 7% (real) per annum. Assuming it is more difficult to judge whether a Grange is good when young than when optimally aged, the price of young Grange should vary relatively less than mature Grange. A glance at Figure 2 reveals the variation around the trend line is much less for the young wine than the older wines in the sample, which supports this hypothesis.

III. Results

Monthly rainfall and temperature data are readily available for all the relevant regions. The three years of auction data used show an upward drift in prices from 1991 to 1993, which probably reflects underlying macroeconomic influences. The equations were estimated separately for each year and then combined with individual intercepts to allow for the expected annual upward shift in price. The equations were estimated using the log of actual prices as the dependent variable, the explanatory variables were the wine's age, rainfall and temperature in the vintage year. The implication, of course, is that the partial derivative of the change in price to the change in (say) temperature depends on the slope coefficient, which is constant, and the price variable. Thus the effect of temperature on price will increase in magnitude the more expensive (and older), the wine is. The semi-log specification is appropriate to the problem.

The example is more difficult than Ashenfelter's, because the Grange prices relate to an individual wine rather than the average of thirteen wines; nevertheless, the results are encouraging as goodness of fit (R^2) measures of .85 were observed. The winter rain effect, reported for Bordeaux, was not observed although it appears the best Grange vintages as measured by price, require a hot dry summer. The initial results are reported below in Table 1.

The explanatory variables are rainfall and temperature, the season is taken as from April of the previous year to March of the following (vintage) year. The data used were from 1961 to 1985 in the case of the 1991 auctions, 1960 to 1986 for the 1992 auctions and 1960 to 1987 for the 1993 auctions. One obvious idea is to explain the prices at the three auctions separately and then combine the data, include a shift variable for the change in price between years, and re-estimate the equation using the complete data set. The combined equations can be estimated more efficiently as a system, than the single equations can individually, using the correlations between the residuals of the equations and the assumption that the coefficients of the equations are identical. The approach, termed "seemingly unrelated regressions" or SUR is well known to econometricians {see , Green, ch. 17 [1990], for example}.

The weather data for the Barossa and Clare were very highly correlated - the monthly temperature and rainfall correlations typically being in the range .85-.95 so the introduction of the Clare data appeared to hold little benefit. The rainfall and temperature data relate to the Barossa only. Rainfall variables were included but were not found to be statistically significant.; ie. the positive effect of rain in the growing period, which Ashenfelter observed for Bordeaux, is absent for Grange. This suggests either that the rainfall is more reliable in South Australia or that blending effectively overcomes deficiencies due to rainfall variation. The results which emerge are that high January rainfall has a negative effect on quality, high March temperatures have a positive effect. The age of the wine is the dominant influence on price, winter rainfall does not appear to be important, too much rain in January is detrimental to price and the hotter the March temperature the higher the ultimate price of that vintage.

The fact that it is so difficult to relate the climatic variables to the ultimate price of the Grange suggests that pronouncements of the "wine of the century type", if solely based on the climatic characteristics of the vintage year, cannot be justified. Climate does play a part, as the results of the regression equations show, but it does not appear to play as strong a role as it does in Bordeaux. This could be part of the Australia Felix mythology; the winemaking conditions are much more favourable than Europe. It could also be that blending and skill more than compensates for tradition.

In Table 1 the estimated equation is of the form

$$\log price = \beta o + \beta 1 \text{ age} + \beta 2 \text{ rain(Jan)} + \beta 3 \text{ temp(Mar)}$$

and the same specification is applied to each year of auction data. The model is treated as if there are 29 vintage observations (1959-1987) for each auction year, but no 1960, 1986 or 1987 Grange was auctioned in 1991 and no 87 Grange was auctioned in 1992. These missing observations are handled by the introduction of 4 dummy variables. The result artificially inflates the R^2 of the '91 and '92 equations, to give a truer measure of the predictive power of the fitted model, the correlation between the observed and predicted, based on the actual data, is also given.

The initial least squares estimates (OLS) of the three price equations are improved by exploiting the correlation structure in the disturbances, ie. by the use of the "seemingly unrelated regressions" (SUR) technique. In addition, it appears reasonable to assume that the partial derivatives of price on age, rain and temperature will be the same, once a shift is allowed for between each auction year. Hence the coefficients on age, temperature and rain are constrained to be the same across the three equations. A Wald test on each of these restrictions was accepted, prior to the constrained estimation being performed. The interpretation of the constrained estimates is as follows: each additional year in age results in a 3.9% increase in price (in any one auction year, ie. in real terms); 1 millimetres of additional rain in January leads to a .00038 fall in the log of price, while a .1 degree centigrade increase in average maximum temperatures in March results in a .0086 increase in log of price (temperature was in hundreds, thus 26.2 degrees became 262). Converting this to easily interpreted numbers, since $\frac{\partial price}{\partial temp} = \frac{\partial \log price}{\partial temp} price$, if the price is \$100, a coefficient of .0086 means that a 1 degree increase in average March (maximum) temperatures results in an increase in price of \$8.60, other things being equal. If the price level is \$50, the effect of a 1 degree increase is \$4.30, and so on. January rainfall has a negative effect, too much rain depresses price. A 100 millimetre increase in January rainfall decreases the price of a \$100 bottle of Grange by \$3.80s. Given no other statistically significant weather variables (eg. winter rainfall) emerged, the only variable with any substantial impact is March temperature - the hotter the better.

Table 1

Regession Estimates

(t-values in parenthesis)

	OLS			SUR			constrained SUR		
dependent variable	price91	price92	price93	price91	price92	price93	price91	price92	price93
constant	2.174	1.584	2.058	1.977	1.678	2.058	1.566	1.720	1.803
	(2.93)	(2.49)	(2.52)	(2.97)	(2.71)	(2.45)	(2.87)	(3.14)	(3.29)
age	.0391	.0366	.0323	.0400	.0360	.0323		.0390	
	(8.49)	(9.14)	(6.36)	(9.62)	(9.27)	(6.18)		(11.36)	
rain(Jan)	-.00028	-.00037	-.00027	-.00032	-.00036	-.00027		-.00038	
	(1.53)	(2.10)	(1.16)	(1.79)	(2.01)	(1.13)		(2.53)	
temp(Mar)	.0060	.0092	.0080	.0068	.0089	.0080		.0085	
	(2.06)	(3.80)	(2.53)	(2.64)	(3.72)	(2.45)		(4.06)	
R^2	.99	.97	.67						
correlation	.86	.88	.80	.86	.88	.80	.86	.88	.81
DW	2,06	2.02	2.09	2.06	1.99	2,08	2,12	1,92	1,93

The graphs below give a better view of how well the estimated model performs. The constrained estimate forecasts are the same for all auctions, apart from the shift factor in the intercept term and the fact that the age variable is different in each of the three equations.

Figure 3
Actual versus Predicted: 1991 Auction

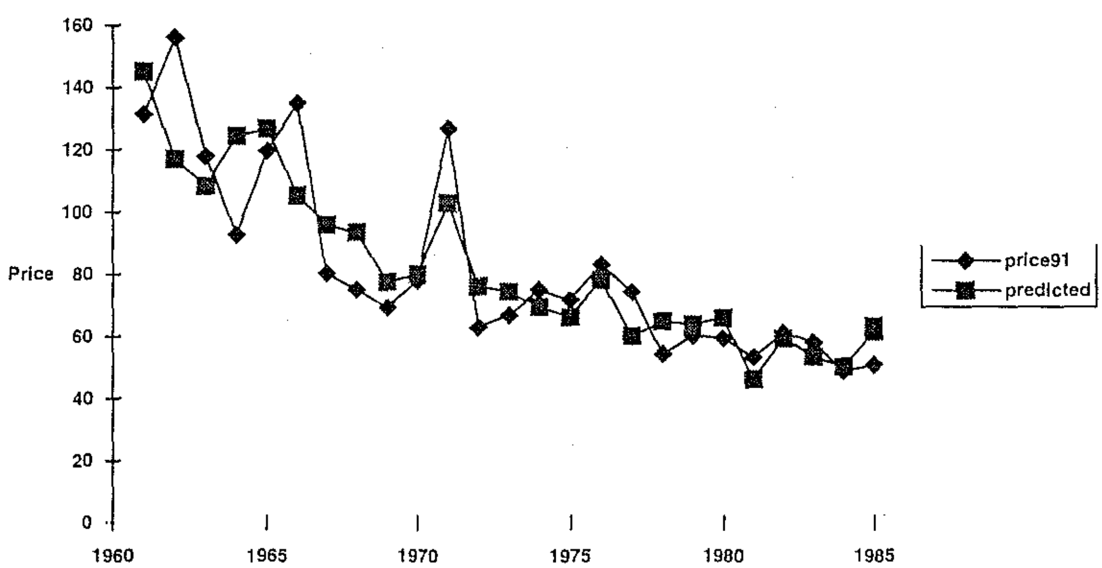


Figure 4
Actual versus Predicted: 1992 Auction

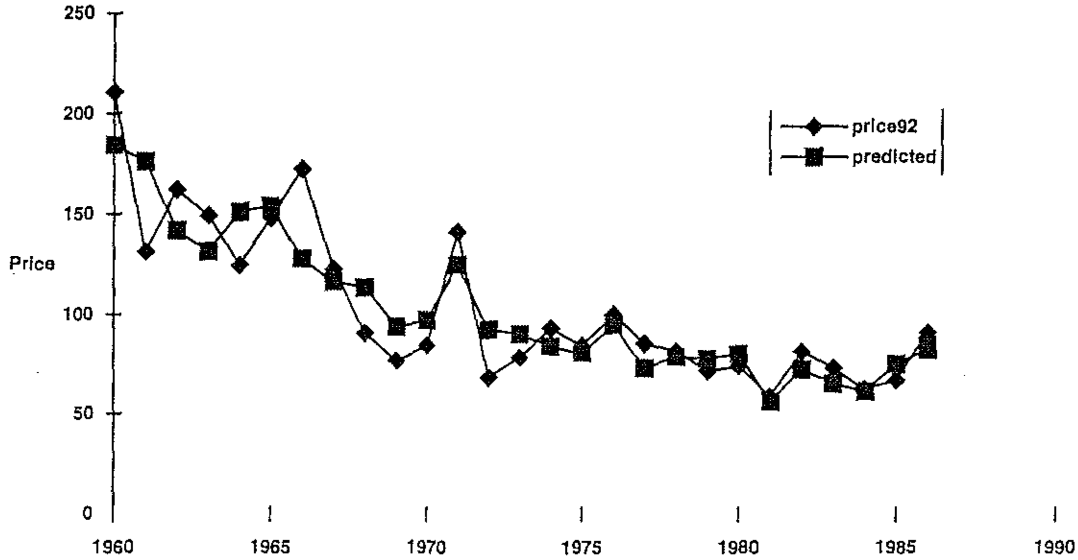
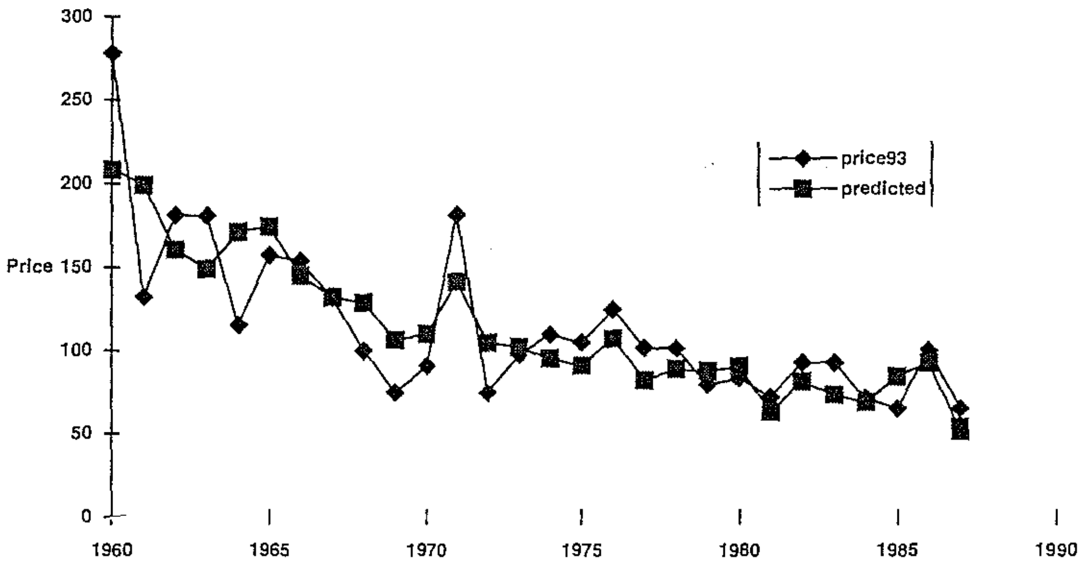


Figure 5
Actual versus Predicted: 1993 Auction



The graphs are essentially the same if based on the unconstrained OLS or SUR estimates. The forecasting model performs reasonably from 1970 to 1987, but it tends to miss the peaks and troughs in the early 1960's. One could conclude that weather does not play a strong part in determining the price (and quality) of Grange; but it may be that the price data is still inadequate, ie. that the auction trading is too thin. Support for this conclusion may be found in Table 2 of the data appendix. Note there are a number of data reversals from one auction year to the next. The '61 vintage is consistently beaten by the '60 and '62 vintages, the '78 vintage was dominated by the adjacent vintages in the 1991 auction, but has now overtaken them. The same is true of the '81 vintage. The market may be thin, or these reversals of orderings may just be an indication of how difficult it is to judge Grange when it is young.

The real puzzle with the results is the non-significance of the rainfall - no effect is established for winter rainfall and the spring/summer rainfall effect is weak. Likewise, although the March temperature effect is strong, why is there not a similar effect for February? The results are interesting, but they are a puzzle. Hopefully, this will not be the last word on the issue and Ashenfelter's work and this paper will induce others to look at the subject in greater detail.

IV. Conclusions

The role played by weather in determining the price (and quality) of Grange Hermitage does not appear to be strong. The only reliable weather variable appears to be the March temperature - a hot summer helps. The results are a complete contrast to those reported by Ashenfelter, Ashmore and Lalonde for Bordeaux. Three conclusions are possible; that auction trading in Australia is too thin for prices to accurately reflect quality, that blending is used to counteract the effect of weather variation or that Australia is indeed Australia Felix and climate is relatively unimportant here.

V. References

Ashenfelter,O., Ashmore,D. and Lalonde,R., "Wine Vintage Quality and the Weather: Bordeaux", paper presented at the *Second International Conference of the Vineyard Quantification Society*, Verona, Italy, February 18-19, 1993.

Greene, W.H., Econometric Analysis, MacMillan, 1990, 1st edn, New York.

Langton, S. and Caillard, A., *"Langton's Vintage Wine Price Guide"*, Unvin Pty Ltd, Melbourne, 1991-1993.

6. Data Appendix

The example is a nice one for demonstrating the advantages of multiple regression over univariate regression and the application is sure to capture the interest of students - so the data are provided in full. Two abbreviations need explanation: nt means "not traded", nr means "not yet released". NR refers to "Nuriootpa Rain in month 1 (January), NR2 to "Nuriootpa rain in February, NMA1 is Nuriootpa average maximum temperature in January, and so on. To construct the weather data for (say) the 1959 vintage take the months 3 to 12 from 1958 and combine them with months 1 to 3 from 1959; this then becomes the 1959 weather data input.

Table 2
Average Price at Auction

vintage	sale91	sale92	sale93	sale94
1959	218.09	223.29	450.33	405.75
1960	nt	210.50	277.67	219.33
1961	131.50	131.44	132.00	214.33
1962	156.00	162.15	180.91	258.40
1963	118.00	149.31	180.50	230.00
1964	92.78	124.79	115.05	147.00
1965	119.56	148.08	157.00	161.10
1966	135.08	172.31	153.46	197.70
1967	80.38	122.89	131.03	141.33
1968	75.06	90.74	99.57	114.15
1969	69.40	76.79	74.80	106.75
1970	78.06	84.64	90.61	107.33
1971	126.82	141.29	181.33	258.00
1972	63.15	68.17	74.67	72.29
1973	67.03	78.63	97.57	110.43
1974	75.00	93.36	109.77	119.08
1975	71.81	84.56	104.91	126.96
1976	83.34	100.20	124.67	150.27
1977	74.36	85.71	101.73	110.00
1978	54.28	81.60	101.30	115.00
1979	60.47	71.27	79.47	108.54
1980	59.46	73.89	83.40	97.00
1981	53.31	58.73	72.37	128.00
1982	61.35	81.26	92.77	110.19
1983	58.15	72.65	92.67	115.93
1984	48.75	62.00	71.16	93.77
1985	50.86	66.79	65.35	85.83
1986	nr	91.00	100.08	126.55
1987	nr	nr	65.00	74.00

Table 3
Nuriootpa Monthly Rainfall

year	NR1	NR2	NR3	NR4	NR5	NR6	NR7	NR8	NR9	NR10	NR11	NR12
1958	13	23	414	166	1023	86	771	748	775	742	123	117
1959	48	239	247	36	113	112	274	530	307	393	94	418
1960	66	491	252	702	1797	269	549	598	800	138	325	8
1961	16	187	81	1317	259	512	514	507	363	142	486	125
1962	343	67	403	18	890	456	447	505	232	991	129	472
1963	368	53	21	825	976	1138	1064	671	738	177	111	8
1964	154	257	97	533	253	384	924	431	812	815	502	223
1965	5	0	106	196	736	280	402	702	299	105	256	255
1966	96	295	300	51	405	608	883	351	814	279	287	723
1967	125	233	51	29	205	115	565	363	275	217	0	125
1968	335	340	286	316	1254	779	788	1019	334	831	438	359
1969	191	1016	238	252	607	235	1027	278	599	11	222	340
1970	270	0	72	307	451	533	487	874	643	64	264	344
1971	51	8	368	833	774	858	543	940	752	274	488	312
1972	419	205	0	389	250	191	733	898	255	179	206	127
1973	155	1001	274	455	288	758	689	784	638	1003	290	216
1974	874	510	540	808	832	358	1104	490	666	1253	40	86
1975	116	26	570	120	1052	122	674	380	742	1254	150	162
1976	144	494	24	92	164	350	198	350	572	646	260	158
1977	348	54	306	258	486	402	326	264	494	250	652	198
1978	318	34	68	306	542	822	938	648	1224	186	298	182
1979	296	348	89	516	392	102	422	976	1448	884	610	282
1980	94	0	42	912	404	1022	746	286	340	1048	306	162
1981	162	142	374	58	576	952	898	1136	432	312	340	44
1982	185	36	276	730	272	454	182	128	332	186	36	50
1983	48	32	1262	674	560	222	954	636	776	374	362	198
1984	172	26	216	392	300	331	700	1008	618	216	290	118
1985	56	0	482	676	372	380	276	1190	522	254	174	278
1986	48	44	2	312	398	236	926	900	718	788	144	292
1987	372	134	228	238	1068	640	650	330	178	788	82	212
1988	158	212	152	178	1208	1040	544	268	742	226	470	336
1989	16	8	304	52	706	572	692	890	548	406	344	382
1990	136	100	78	92	142	606	1030	814	408	420	136	374
1991	288	0	44	388	154	1368	758	916	548	34	320	18
1992	2	108	538	562	652	512	406	1250	1392	1037	686	1138

Table 4
Nuriootpa Average Maximum Temperature

year	NR1	NR2	NR3	NR4	NR5	NR6	NR7	NR8	NR9	NR10	NR11	NR12
1958	13	23	414	166	1023	86	771	748	775	742	123	117
1959	48	239	247	36	113	112	274	530	307	393	94	418
1960	66	491	252	702	1797	269	549	598	800	138	325	8
1961	16	187	81	1317	259	512	514	507	363	142	486	125
1962	343	67	403	18	890	456	447	505	232	991	129	472
1963	368	53	21	825	976	1138	1064	671	738	177	111	8
1964	154	257	97	533	253	384	924	431	812	815	502	223
1965	5	0	106	196	736	280	402	702	299	105	256	255
1966	96	295	300	51	405	608	883	351	814	279	287	723
1967	125	233	51	29	205	115	565	363	275	217	0	125
1968	335	340	286	316	1254	779	788	1019	334	831	438	359
1969	191	1016	238	252	607	235	1027	278	599	11	222	340
1970	270	0	72	307	451	533	487	874	643	64	264	344
1971	51	8	368	833	774	858	543	940	752	274	488	312
1972	419	205	0	389	250	191	733	898	255	179	206	127
1973	155	1001	274	455	288	758	689	784	638	1003	290	216
1974	874	510	540	808	832	358	1104	490	666	1253	40	86
1975	116	26	570	120	1052	122	674	380	742	1254	150	162
1976	144	494	24	92	164	350	198	350	572	646	260	158
1977	348	54	306	258	486	402	326	264	494	250	652	198
1978	318	34	68	306	542	822	938	648	1224	186	298	182
1979	296	348	89	516	392	102	422	976	1448	884	610	282
1980	94	0	42	912	404	1022	746	286	340	1048	306	162
1981	162	142	374	58	576	952	898	1136	432	312	340	44
1982	185	36	276	730	272	454	182	128	332	186	36	50
1983	48	32	1262	674	560	222	954	636	776	374	362	198
1984	172	26	216	392	300	331	700	1008	618	216	290	118
1985	56	0	482	676	372	380	276	1190	522	254	174	278
1986	48	44	2	312	398	236	926	900	718	788	144	292
1987	372	134	228	238	1068	640	650	330	178	788	82	212
1988	158	212	152	178	1208	1040	544	268	742	226	470	336
1989	16	8	304	52	706	572	692	890	548	406	344	382
1990	136	100	78	92	142	606	1030	814	408	420	136	374
1991	288	0	44	388	154	1368	758	916	548	34	320	18
1992	2	108	538	562	652	512	406	1250	1392	1037	686	1138