Bordeaux Wine Vintage Quality and the Weather

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Statistical prediction of wine prices based on vintage growing-season characteristics produces consternation among wine "experts."

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"Nor let thy vineyard bend toward the sun when setting."

—Virgil

In this article we show that the quality of the vintage for red Bordeaux wines, as judged by the prices of mature wines, can be predicted by the weather during the growing season that produced the wines. Red Bordeaux wines have been produced in the same place and in much the same way for hundreds of years. When young, the wines from the best vineyards are astringent, and many people find them unpleasant to consume. As these wines age, they lose their astringency, and many people find them very pleasant to consume. Because Bordeaux wines taste better when they are older, there is an incentive to store the young wines until they are mature. As a result, there is an active market in young wines (similar to "new issues" in the securities markets) and an active market in older wines (similar to the secondary markets in securities).

Surprisingly, the weather information that is so useful in predicting the prices of the mature wines plays little or no role in setting the prices of the young wines. We show that young wines are usually overpriced relative to what we would predict based on the weather and the price of the old wines. As the young wines age, however, their prices usually converge to our predictions. This implies that

"bad" vintages are overpriced when they are young and that "good" vintages may sometimes be underpriced when they are young. Rational buyers should avoid bad vintages when they are young, but they may sometimes wish to purchase good vintages.

Although the evidence suggests that the market for older wines is relatively efficient, it implies that the market for younger wines is very inefficient. Why don't the purchasers of young wines wait and buy them when they are mature? Why do purchasers ignore the weather that produced the vintage in making their decisions? Although there are no simple answers to these questions, we discuss one possible explanation in the final section.

Vineyards and Vintages

The best wines of Bordeaux are made from grapes grown on specific plots of land and the wine is named after the property (or chateau) where the grapes are grown. In fact, knowledge of the chateau and vintage provides most of the information about the quality of the wine; that is, if we imagine 10 vintages and 6 chateaux, there are, in principle, 60 different wines of different quality. Knowing the reputations of the 6 chateaux and the 10 vintages, however, is sufficient to determine the quality of all 60 wines; that is, good vintages produce good wines in all vineyards and the best wines in each vintage are usually produced by the best vineyards (see "Vineyards").

Although this point is sometimes denied by those who produce the wines, and especially by those who sell the young wines, it is easy to establish its truth by reference to the prices of the mature wines. To demonstrate the point, Table 1 indicates the 1990–1991 market price in London of 6 Bordeaux chateaux from the 10 vintages from 1960 to 1969. These chateaux were selected because they are large producers and their wines appear frequently in the secondary (auction) markets. (A blank in the table indicates that the wine has not appeared in the market during the time period. Lower-quality vintages are typically the first to leave the market.) The vintages from 1960 to 1969 are selected because, by the 1990s, these wines are fully mature and there is little remaining uncertainty about their quality.

From Table 1 it is obvious that knowledge of the row means and the column means is sufficient to predict most of the prices in the table. (The explained variance from a regression of the logarithm of the price on chateau and vintage dummies is over 90%.) A ranking of the chateaux in order of

Table 1—London Auction Prices for Selected Mature Red Bordeaux Wines, 1990–1991 (per dozen bottles in $US)

Vintage	Chateaux (Vineyards)						Average
	Lafite	Latour	Cheval Blanc	Cos d'Estournel	Montrose	Pichon Lalande	
1960	494	464	486				479
1961*	4335	5432	3534	1170	1125	1579	4884
1962*	889	1064	821	521	456	281	977
1963	340	471		251			406
1964*	649	1114	1125	315	350	410	882
1965	190	424				258	307
1966*	1274	1537	1260	546	482	734	1406
1967*	374	530	441	213	236	243	452
1968	223	365	274				294
1969	251	319		123	84	152	285
Average	1504	1935	1436	553	530	649	

NOTE: Column averages are calculated only for vintages indicated by an asterisk, where a market price exists for every chateau. Row averages are calculated using only Chateau Lafite and Chateau Latour, where prices are available for all vintages. Sterling prices are converted to dollars at the exchange rate on November 30, 1992.

SOURCE: Average prices from *Liquid Assets: The International Guide to Fine Wines* Issue 8 (October 1991) and Issue 9 (December 1992).
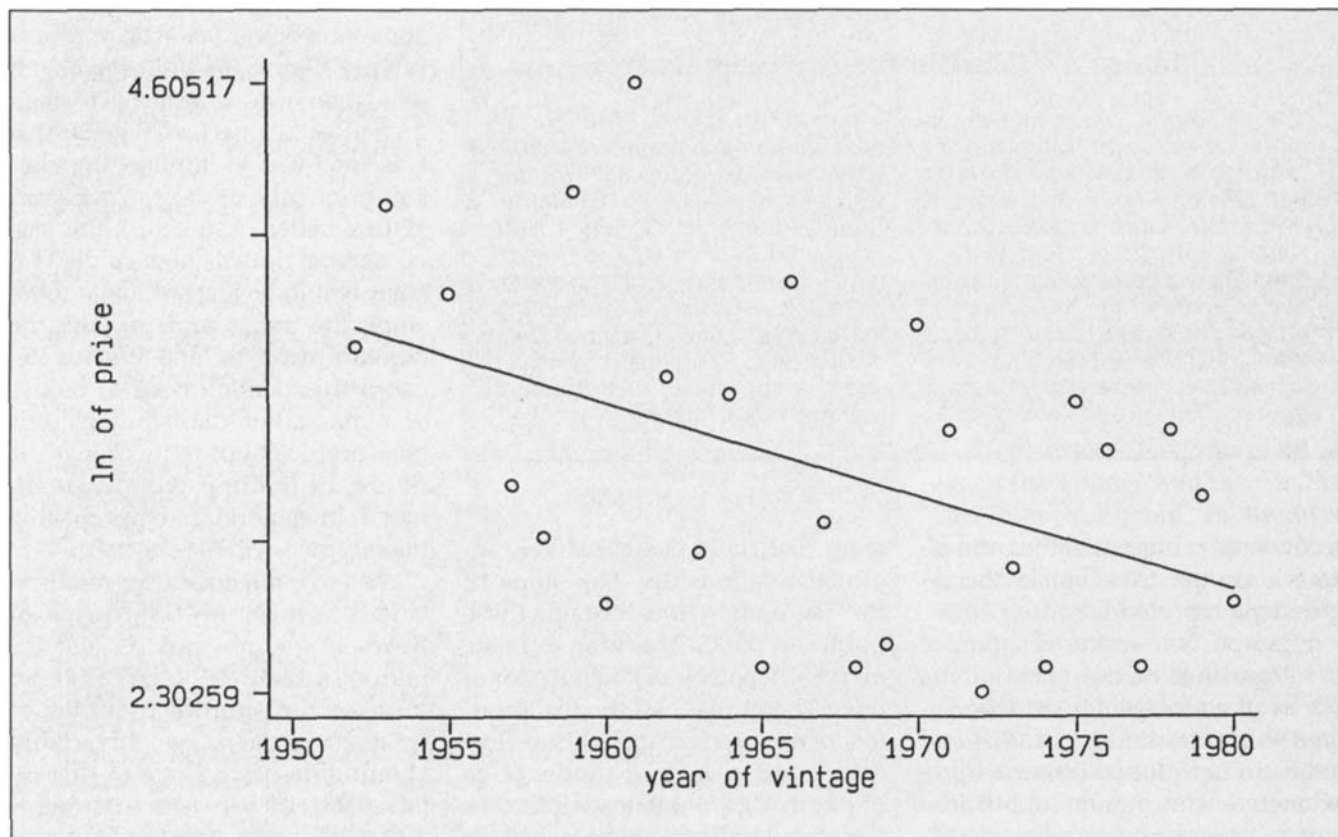
Figure 1. Red bordeaux wines, price relative to 1961 vintage year.

quality based on their prices would be Latour, Lafite, Cheval Blanc, Pichon-Lalande, Cos d'Estournel, and Montrose. In fact, as Edmund Penning-Rowsell pointed out in his classic book *The Wines of Bordeaux* (1985), the famous 1855 classification of the chateaux of Bordeaux into quality grades was based on a similar assessment by price alone. Surprisingly, the 1855 classification ranks these chateaux in only a slightly different order—Lafite, Latour, Pichon-Lalande, Cos d'Estournel, and Montrose. (Cheval Blanc was not ranked in 1855.) Likewise, a ranking of the quality of the vintages based on price alone would be 1961, 1966, 1962, 1964, and 1967. The remaining vintages (1960, 1963, 1965, 1968, and 1969) would be ranked inferior to these five, but, perhaps because of this fact, many of the wines from these inferior vintages are no longer sold in the secondary market.

Real Rate of Return to Holding Bordeaux Wine

It is natural to ask why the prices of mature wines from a single chateau, made in the same way from grapes grown in the same place by the same winemaker, would differ so dramatically from vintage to vintage, as is indicated by Table 1. There are two obvious explanations for this vintage variability. First, the older wines have been held longer, and so they must bear a normal rate of return. This fact alone would make the older wines more expensive than the younger ones. Second, the quality of the wines of different vintages may vary because the quality of the grapes used to make the wines varies.

Figure 1 provides a test of the hypothesis that the price of the wines varies because of their age. In this figure (and throughout the remainder of the article), we use as a measure of the price of a vintage an in-

dex based on the wines of several chateaux. The chateaux are deliberately selected to represent the most expensive wines (Lafite, Latour, Margaux, and Cheval Blanc) as well as a selection of wines that are less expensive (Ducru Beaucaillou, Leoville Las Cases, Palmer, Pichon Lalande, Beychevelle, Cos d'Estournel, Giscours, Gruaud-Larose, and Lynch-Bages). We construct the index of vintage price from a regression of the logarithm of the price from several thousand auction sales on dummy variables indicating the chateau and the vintages. (The precise composition of the sample has very little effect on the results.) The regression coefficients for the vintage dummies are then used to construct the vintage index. This provides a simple way to construct a vintage index in the presence of an unbalanced sample design. (We compute the antilogarithm of these coefficients and then express the price relative to the index price for 1961. This is merely

a convenient normalization and affects only the intercept in the regressions reported later.)

Figure 1 is a scatter diagram of the logarithm of the price of the wines of a vintage against the vintage year. (The vintages of 1954 and 1956 are not plotted because these wines are now rarely sold. These two vintages are generally considered to be the poorest in their decade.) It is apparent from the diagram that there is a negatively inclined relationship. The slope of the regression line through these points is −0.035. This is an estimate of (the negative of) what economists sometimes call the real product rate of return to holding Bordeaux wines. A "real product rate of return" is a number such that its reciprocal indicates how many bottles of wine one would have to keep in the cellar to be able to consume one bottle per year in perpetuity. These data indicate that it would be necessary to have about 28 bottles in a perpetual cellar that was intended to support the consumption of one bottle per year. With a cellar of this size, the proceeds from the sale of the older vintages would be just sufficient to restock the cellar and provide the consumption of one bottle. Because it is denominated in bottles of wine rather than dollars, this measure does not tell us what the return to holding wine denominated in generalized purchasing power (money) is.

We have analyzed the relationship between the (log) price of Bordeaux wine and its age for many individual chateaux. So long as the sample includes at least 20 vintages, we invariably obtain a negative slope to this relationship of between −.02 and −.04. It is notable that the study of the various vintages of wine provides so reliable and simple a
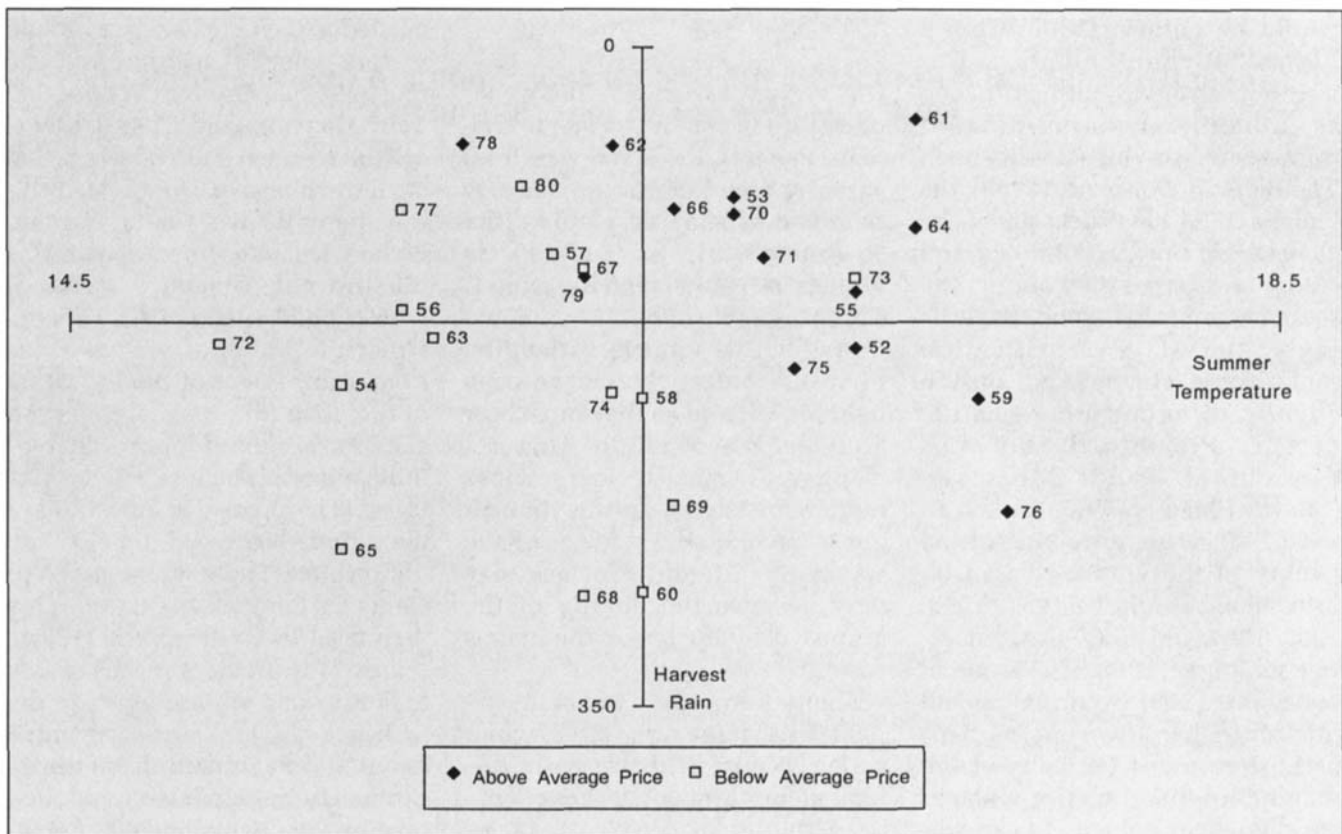

Figure 2. Bordeaux: 1952–1980, summer temperature and harvest rain related to price.

Table 2—Regressions of the (Logarithm of) Price of Different Vintages of a Portfolio of Bordeaux Chateau Wines on Weather Variables

Independent variables

Age of vintage	0.0354 (0.0137)	0.0238 (0.00717)	0.0240 (.00747)
Average temperature over growing season (April–September)		0.616 (0.0952)	0.608 (0.116)
Rain in September and August		−0.00386 (0.00081)	−0.00380 (0.000950)
Rain in the months preceeding the vintage (October–March)		0.001173 (0.000482)	0.00115 (0.000505)
Average temperature in September			0.00765 (0.0565)
R^2	0.212	0.828	0.828
Root mean squared error	0.575	0.287	0.293

NOTES: All regressions use as data the vintages of 1952–1980, excluding the 1954 and 1956 vintages, which are now rarely sold; all regressions contain an intercept, which is not reported; the data (and a readme file) are also available by anonymous ftp in the pub/wine directory of irs.princeton.edu.

Standard errors are in parentheses.

measure of the real rate of return. As we shall see, most of the remaining variation in the price of the wine of different vintages is due to variation from vintage to vintage in the weather that produced the grapes.

Vintages and the Weather

It is well known that the quality of any fruit, in general, depends on the weather during the growing season that produced the fruit. What is not so widely understood is that in some localities the weather will vary dramatically from one year to the next. In California, for example, it never rains in the summer, and it is always warm in the summer. There is a simple reason for this. In California, a high-pressure weather system settles each summer over the California coast and produces a warm, dry growing season for the

grapes planted there (see "California's Climate for Growing Grapes"). In Bordeaux, this sometimes happens—but usually it does not. Great vintages for Bordeaux wines correspond to the years in which August and September are dry, the growing season is warm, and the previous winter has been wet.

Figure 2 establishes that it is hot, dry summers that produce the vintages in which the mature wines obtain the higher prices. This figure displays for each vintage the summer temperature from low to high as you move from left to right, and the harvest rain from low to high as you move from top to bottom. Vintages that sell for an above-average price are displayed with black triangles, and vintages that sell for a below-average price are displayed in open squares. If the weather is the key determinant of wine quality, then the dark points should be in the northeast quadrant

of the diagram and the light points should be in the southwest quadrant of the diagram. It is apparent that this is precisely the case. Even anomalies, like the 1973 vintage, tend to corroborate the fact that the weather determines the quality of the wines. The wines of this vintage, which are of somewhat above-average quality, have always sold at relatively low prices; insiders know that they are often bargains.

Table 2 contains a regression of the (log) price of the vintage on the age of the vintage and the weather variables indicated. In practice, the weather variables are almost uncorrelated with each other and with the age of the vintage. As a result, the regression equation is remarkably robust to the addition of other variables. The second column of the table contains the basic "Bordeaux equation," and the third column shows the effect on the regression of adding the temperature in September as an additional variable. It is obvious that this variable does not have a statistically significant coefficient, and, indeed, in further experimentation we have not found any other statistically significant variables to add to the regression.

It is possible, of course, to predict the relative price at which the new vintage should be sold as soon as the growing season is complete. In fact, we have been doing this for several years and publishing the results in the newsletter *Liquid Assets: The International Guide to Fine Wines*. The basic idea for these predictions is displayed in Fig. 3. Here we have added to Fig. 2 the data for the vintages from 1981 to 1992. Two things are immediately apparent from the figure. First, all but one of these recent vintages (1986) was produced by a growing season that was warmer than what is historically "normal." It is no accident that many Europeans believe global warming may already be here! This unusual run of extraordinary weather has almost certainly resulted in a huge quan-
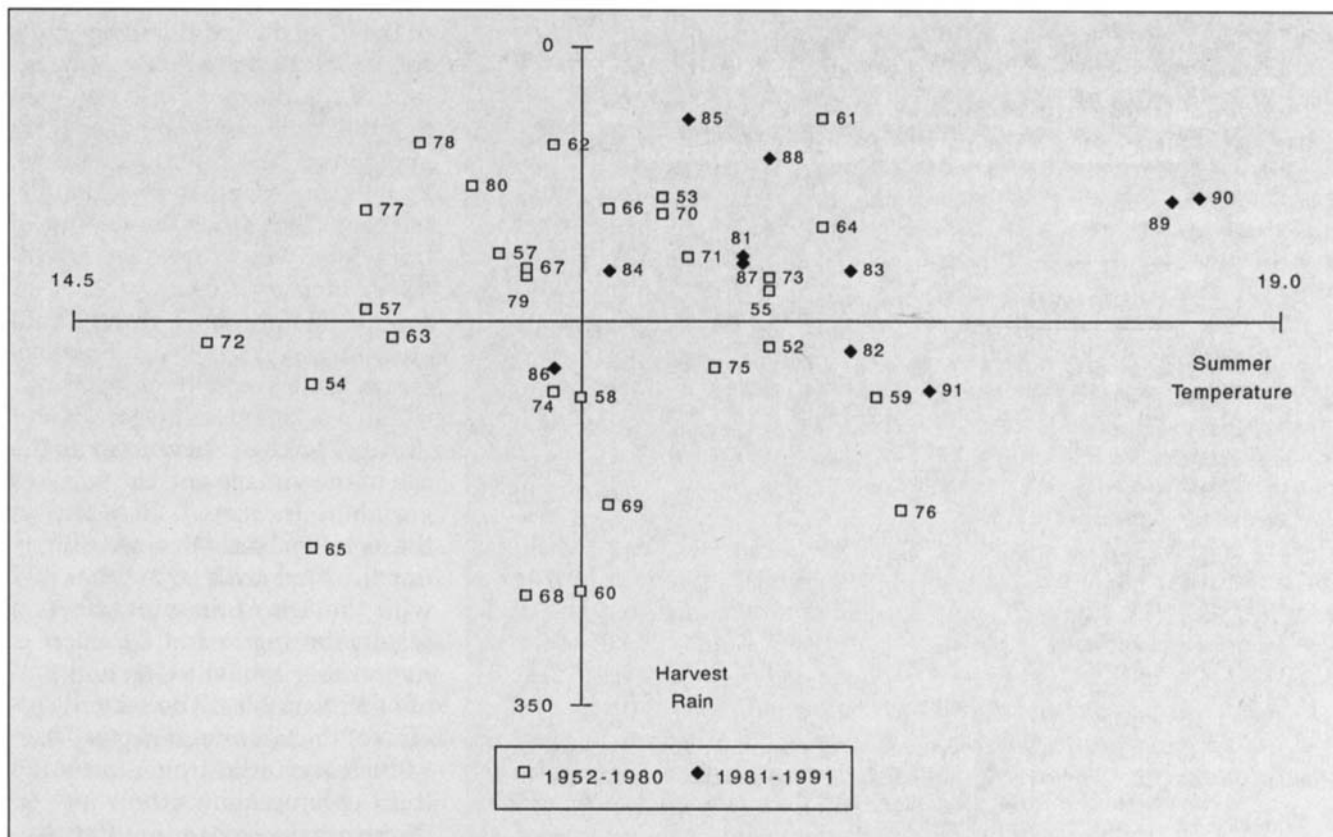
Figure 3. Bordeaux: 1952–1991, summer temperature and harvest rain related to price.

tity of excellent but immature red Bordeaux wine. Second, the weather that created the vintages of 1989 and 1990 appears to be quite exceptional by any standard. Is it appropriate to predict that the wines of these vintages will be of outstanding quality when the temperature that produced them is so far outside the normal range? Before making the prediction for 1989, we did, in fact, turn to Lincoln Moses (of Stanford University) for informal advice. Moses suggested two informal tests. (1) Would the last major "out-of-sample" prediction have been correct? The idea here is to use the past to indirectly test the ability of the relationship to stretch beyond the available data. In fact, the last major out-of-sample prediction for which all uncertainty has been resolved is the vintage of 1961, which had the lowest August–September rainfall in Bordeaux history. Just as the unusual weather predicted, the market (see Table 1),

and most wine lovers, have come to consider this an outstanding vintage. (2) Is the warmth of the 1989 and 1990 growing seasons in Bordeaux greater than the normal warmth in other places where similar grapes are grown? The idea here is to determine whether the temperature in Bordeaux is abnormal by comparison with grape-growing regions that may be even warmer. In fact, the temperature in 1989 or 1990 in Bordeaux was no higher than the average temperature in the Barossa Valley of South Australia or the Napa Valley in California, places where high-quality red wines are made from similar grape types.

Based on these two informal tests, we are convinced that both the 1989 and 1990 vintages in Bordeaux are likely to be outstanding. Many wine writers have made the same predictions in the trade magazines. Of course, it is still too early to determine whether the wines will fulfill their promise.

Market Inefficiency

It is natural to inquire as to the prices at which the wines listed in Table 1 were sold when the wines were first offered on the market. In particular, were the relative prices of the young wines good forecasts of the relative prices the mature wines now fetch? It is difficult to answer this question because the young wines were all sold in different time periods and at prices that are not generally known. Instead, we have explored a closely related question: Were the relative prices of the vintages when they were first sold in the auction market good forecasts of the relative prices of the mature wines? Were the prices of the young wines, viewed as forecasts of the prices of the mature wines, as good as the predictions made using the data on the weather alone?

Table 3 reveals the answer to both of these questions. In this table, we have listed, for each calen-

dar year from 1971 to 1989, the price of the portfolio of wines from each vintage relative to the price of the portfolio of wines from the 1961, 1962, 1964, and 1966 vintages. The benchmark vintage portfolio is a simple average of the 1961, 1962, 1964, and 1966 vintage indexes. The second column gives the value of the benchmark portfolio in pounds sterling in the year indicated and provides a general measure of the overall inflation in wine prices in the London auction markets. The entries for each of the vintages in the remaining columns are simply ratios of the prices of the wines in each vintage to the benchmark

portfolio in column 1 of the table. The 1961, 1962, 1964, and 1966 vintages were selected for the benchmark because the weather data in Fig. 2 predict they would be good, and the wines from these vintages are, no doubt as a consequence, still widely traded. The vintages that are studied in the table include all those between 1961 and 1972. Listed in the bottom row of the table is the predicted relative price of the vintage as taken from the "Bordeaux equation" in Table 2.

The data in Table 3 confirm two remarkable facts. First, most of these older vintages began their lives in the auction markets at

prices that are far above what they will ultimately fetch. For example, the bottom row of the tables indicates that, based on the weather, the wines of a vintage like 1967 would have been expected to sell for about one-half the price of an average of the wines from the 1961, 1962, 1964, and 1966 vintages. In fact, the wines entered the auction markets in 1972 at about 50% more than expected and slowly drifted down in relative price over the years. Second, the predicted prices from the "Bordeaux equation," which is fit from an entirely different set of data, are remarkably good indicators of the prices at which the

Table 3—Price per Case of a Portfolio of Bordeaux Chateaux Relative to the Price of the Portfolio for the Vintages of 1961, 1962, 1964, and 1966

Year of Sale	Benchmark portfolio[a]	Vintage											
		1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1971	£54	1.66	0.79	0.41	0.76		0.79						
1972	£97	1.58	0.76	0.26	0.70	0.27	0.96	0.77		0.75			
1973	£119	1.62	0.71	0.28	0.74	0.24	0.93	0.62	0.28	0.70	0.83		
1974	£85	1.31	0.77	0.39	0.84		1.08	0.78	0.30	0.70	0.88		0.30
1975	£76	1.65	0.77	0.29	0.78	0.35	0.80	0.57	0.31	0.41	0.84	0.61	0.44
1976	£109	1.67	0.83	0.30	0.65	0.29	0.85	0.51	0.23	0.36	0.69	0.54	
1977	£165	1.67	0.83	0.26	0.63	0.26	0.87	0.50	0.23	0.36	0.70	0.51	0.32
1978	£215	1.67	0.76	0.26	0.65	0.18	0.91	0.45	0.25	0.31	0.70	0.53	0.25
1979	£274	1.61	0.73	0.20	0.66	0.23	1.00	0.49	0.24	0.29	0.71	0.50	0.23
1981	£296	1.75	0.62	0.22	0.70	0.04	0.93	0.47	0.25	0.29	0.82	0.52	0.22
1982	£420	1.80	0.71	0.15	0.60	0.18	0.89	0.39	0.17	0.24	0.77	0.55	0.19
1983	£586	1.77	0.53	0.10	0.59	0.18	1.11	0.36	0.18	0.21	0.91	0.48	0.20
1985	£952	2.19	0.53	0.12	0.50	0.21	0.78	0.30	0.11	0.14	0.68	0.46	0.13
1986	£888	2.10	0.56	0.25	0.54	0.17	0.80	0.30	0.15	0.19	0.65	0.46	0.14
1987	£901	2.11	0.56		0.53		0.80	0.32	0.19	0.20	0.64	0.49	0.18
1988	£854	2.01	0.56	0.21	0.61	0.14	0.82	0.34	0.23	0.20	0.67	0.58	0.17
1989	£1,048	2.09	0.61	0.28	0.53	0.19	0.77	0.27	0.24	0.18	0.66	0.43	0.15
Predicted price[b]		1.74	0.72	0.29	0.76	0.16	0.78	0.49	0.21	0.29	0.60	0.53	0.14

NOTE: A portfolio (for a vintage) consists of the wines from 15 leading chateaux. The chateaux used are the same for all vintages. The "benchmark" portfolio consists of the portfolio of leading chateaux and wine from the vintages of 1961, 1962, 1964, and 1966.

[a] Absolute price of benchmark portfolios.

[b] Predicted relative price from the "Bordeaux equation."

mature wines will ultimately trade.

One interesting way to see the inefficiency in this market is to compare the prices of the vintages of 1962, 1964, 1967, and 1969 in calendar year 1972. As the weather data in Fig. 2 indicate, and the prediction in the bottom row of Table 3 confirms, we should have expected (in 1972) that the 1962 and 1964 vintages would sell for considerably more than the vintages of both 1967 and 1969. In fact, in 1972 these four vintages fetched nearly identical prices, in sharp contrast to what the weather would have indicated. By around 1979, the prices of the 1969s and 1967s had fallen to around what would have been predicted from the weather.

It is apparent from Table 3 that most vintages are overpriced when the wines are first offered on the auction market and that this state of affairs often persists for 10 years or more following the year of the vintage. The overpricing of the vintages is especially apparent for those vintages that, from the weather, we would predict are the poorest. This suggests that, in large measure, the ability of the weather to predict the quality of the wines is ignored by the early purchasers of the wines.

An interesting recent example of this phenomenon is the 1986 vintage. As Fig. 3 indicates, this is a vintage that, based on the weather, we should expect to be "average." Compared to the other vintages of the last decade, this vintage should fetch a considerably lower price. In fact, the vintage was launched with great fanfare as among the finest two vintages of the decade. The wines were sold at similar, and sometimes higher prices to initial buyers than the wines of the other vintages of the past decade. The enthusiasm for these wines has dampened somewhat because they have not fetched auction prices higher than those of the other vintages in the decade. We should expect that, in due course, the prices of these wines will decline relative to the prices of most of the other vintages of the 1980s.

Conclusion

Why does the market for immature red Bordeaux wines appear to be so inefficient when the market for mature wines appears to be so effi-

cient? We think there may be several related explanations. The current Bordeaux marketing system has the character of an agricultural income stabilization system, and this may be its purpose. Complete income stabilization for the growers would require that the price of the young wines be inversely related to the quantity produced and independent of the quality. Although the actual pricing of young Bordeaux wines falls short of this ideal, it is clearly closer to it than would occur if purchasers used the information available from the weather for determining the quality of the wines. The producers do attempt to raise prices when crops are small, despite the evidence that the quantity of the wines (determined by the weather in the spring) is generally unrelated to the quality of the wines. Moreover, it is common for the proprietors to claim that each vintage is a good one, independent of the weather that produced it. Indeed, there is no obvious incentive for an individual proprietor to ever claim anything else!

A more fundamental question arises about the motives of the early purchasers of the wines. Why have they ignored the evidence that the weather during a grape-growing season is a fundamental and easily measured determinant of the quality of the mature wines? Will they continue to do so as the evidence for the predictability of the quality of new vintages accumulates?

Additional Reading

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