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At what price should Bordeaux wines be released?

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Abstract

This paper models optimal release prices of an experience good recurrently issued on markets. Using a sample of Bordeaux wines, we find that using a minimal number of intrinsic and extrinsic attributes is sufficient to explain a large proportion of release prices. We further observe a significant relationship between primary market prices and secondary market prices and general economic conditions. Release prices can deviate from secondary market prices in the short-run but remain aligned over the long-run. Finally, an out-of-sample analysis indicates that short-run mispricing directly affects the purchase behavior of customers.

Keywords: primary market; pricing; wine; experience good; customer behavior

JEL Classification: L11, Q11, Q14

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1 INTRODUCTION

The optimal pricing of goods and services upon their initial release is central to many industries and market participants in an economy. This ranges from the pricing of tickets for sporting and cultural events to the issuance of financial instruments such as stocks or bonds to the pricing of commodities. The release of an additional or modified version of the good on the market is even more complex as an interplay between the primary and secondary market exists. In this case, the issuer must not only predict customer's willingness to pay and demand for the good to maximize profits but also account for the already existing inventory and price behavior on the secondary market. Therefore, this interplay between the primary and secondary market is of interest to all issuers who do not want to leave money on the table while respecting demand for existing inventory or avoiding alienating existing customers. The price forecasting on primary markets and its effect on the secondary market is also of indirect importance. It will influence the market participant's investment decision process, budget allocation and risk management practices.

While this represents a complex task for any good, it is, even more, the case in the presence of an experience good[1]. In this case, companies need to credibly communicate the true quality of the product they intend to sell to customers who are not able to judge it by themselves. This becomes even more difficult for goods being released repeatedly on a market and for which a specific interrelationship exists between the primary and secondary market. The market for experience goods is broad. It covers agricultural products, cultural and sports services and many other central consumer needs. It has also strongly gained in importance in recent decades with the financialization of many of these goods and increased demand for experiences by consumers. Moreover, the increase in the number and speed of information makes customers more aware of

this interplay and potential mispricing issues. Therefore, the demand for accurate price forecasting techniques and the correct fixation of issue prices on all markets has strongly increased.

This paper studies such a market. It aims at better understanding the pricing of experience goods, recurrently issued on the market under uncertainty, varying quality and monopolistic competition. To do so, we use the Bordeaux wine market, which possesses attributes making it an ideal setting to study this essential economic question. Wine is considered an experience good as users can only evaluate it through consumption. This is not easy for most customers who do not have the opportunity to taste the wines before their release on the market. Only experts gain access to in-barrel tastings and publish their appreciation of the wines of the latest vintage before they are released during the *en primeur* campaign (primary market). Simultaneously, older vintages will still exist on the secondary market and be actively traded by customers. The release of the new vintage, and more specifically its price, will impact the existing inventory and price of an identical wine from a previous vintage. Likewise, economic conditions and existing stocks and prices of older vintages should influence the release price producers will set for their latest vintage on the primary market.

Economists have proposed multiple theoretical models on the optimal pricing of experience goods under different market structures. The main issue boils down to information and how customers can learn quickly and inexpensively about product quality. Shapiro (1983) shows that consumers' over- or underestimation of quality attributes will lead to differing outcomes. If consumers underestimate true product quality, companies have an incentive first to propose a discounted price followed by a higher price once true quality is revealed. However, if the quality is overestimated, it should exploit its corporate reputation. Milgrom and Roberts (1986) propose a model which confirms Shapiro's quality underestimation pricing path. Bagwell and Riordan (1991)

indicate that in equilibrium, monopolists should take the ratio of informed to uninformed consumers into account and how product information diffuses. High-quality producers will signal using prices above the full information monopoly price, which will drop to that level once quality information has spread. These, at times, strong information asymmetries can be mitigated in the case customers make repeat purchases as prior experience and the construction of seller reputation begins to serve as credible signals (Allen 1984; Klein and Leffler 1981; Shapiro 1982). The outcome will also depend on how effective producers are in communicating quality to customers. Ineffective signaling would lead to a classic lemons model (Akerlof 1970), while entirely effective information signaling to an unfolding model (Grossman 1981). For this later model, the existence of price premiums for high-quality products incentivizes producers to disclose true quality information, and a market for varying quality levels will exist.

The Bordeaux wine market is characterized by a situation in which information on quality is scarce but available at different levels. The existence of a rigid classification system since 1855[2], a regional appellation system and a rich and long history of most Bordeaux châteaux provide information on status (Malter 2014), collective (Gergaud et al., 2017) and individual reputation (Landon and Smith 1997; Landon and Smith 1998; Oczkowski 2018). [3] This allows customers to get a first and reliable signal on quality and reputation for most producers. However, like all agricultural goods, wine does not display a constant quality from one harvest to another. It will, for example, depend on improvements in winemaking techniques, the soil, and, more importantly, changing climatic conditions (climate change in the long run (Jones et al., 2005), but also sunshine and precipitation in the short-run (Ashenfelter 2008)). Wine quality, therefore, varies yearly, and customers need to regularly update their quality priors on past vintages and producers depending on these attributes. To this avail, each spring wine experts get to taste the latest vintage and publish

their appreciation of it. This essential quality signal has two consequences. It helps producers fix their release prices as it allows them to confront their quality perception of the vintage with a more objective signal by credible corporate outsiders. It also helps customers who cannot taste the wines and therefore rely on inexpensive, professional and objective information to make their purchase decisions. Thus, the evidence suggests that experts, especially those from *The Wine Advocate*, influence purchasing behavior and wine pricing (Masset, Weisskopf, and Cossutta 2015; Ali, Lecocq, and Visser 2008). Most of the evidence can model these more static, intrinsic and wine-related attributes driving wine prices. However, many omit extrinsic effects on wine prices. The fact that producers need to go back annually on the primary market to sell their latest vintage has profound repercussions on market participants' behavior on the secondary market and how these two markets interact.[4] Moreover, the economic environment will influence available customer income and wealth and consequently demand for wine (Masset and Weisskopf 2018; Faye, Le Fur, and Prat 2015).

Our article complements recent literature on the prediction of wine prices. A few authors have used various methods and markets to develop prediction models. They mostly build on early work by Ashenfelter (2008) and Oczkowski (2010). Paroissien (2020) forecasts the price evolution of bulk wine using leading economic indicators and finds that his approach outperforms a simple random walk. Bazen and Cardebat (2018) forecast prices on the generic Bordeaux wine market by applying state-space methods. In an out-of-sample analysis, their model appears to predict the evolution of future wine prices relatively well. Miller, Stone, and Stuen (2015) examine U.S. fine and non-fine wines reviewed and deemed bargains by the Wine Spectator. To analyze the bargain's true nature, they compare actual with predicted prices according to a hedonic model. Yeo, Fletcher, and Shawe-Taylor (2015) use machine learning models to forecast European fine wine returns.

They find superior predictability of wine returns for a Gaussian process regression and multi-task learning approach compared to a random walk. However, they do not test the forecast accuracy out-of-sample. Cardebat and Jiao (2018) examine the effect of emerging markets and their cointegration with the market for fine wines and suggest that their analysis may help forecast wine prices. Hekimoğlu, Kazaz, and Webster (2017) model the interrelation between primary and secondary markets under climate and market uncertainty. They show that for large distributors going for *en primeur* purchases is beneficial. Finally, Hekimoğlu and Kazaz (2020) examine Bordeaux *en primeur* fine wine prices and develop a predictive model based on climate, market conditions, and expert scores.

This paper proposes an empirical model that aims to determine how Bordeaux wine producers should fix their release prices and how these should evolve based on a set of relevant signals. These variables include extrinsic wine attributes such as the trend on the secondary wine market or the economic and financial environment. We also include intrinsic wine characteristics such as vintage and wine quality, reputation, and interactions among these various variables. We, herewith complement and expand Hekimoğlu and Kazaz (2020), who link release prices to weather-, market-, and expert-related attributes. We then determine the appropriate level of Bordeaux wines' release prices from the latest (2019) vintage based on our model and compare it to theirs.

Overall, our model appears accurate as it allows us to explain close to 85% of the variations in release prices over vintages 2004 to 2018 for the 69 most prestigious Bordeaux wine producers. Our model shows that it is important to account for both market-wide as well as individual-wine price dynamics. Vintage quality and conditions on the secondary wine market drive general trends. Individual wine scores and their sensitivity to market conditions explain differences in price dynamics among the various wines. Over the short-run, some wines may increase or decrease too

much and thus deviate from their fair value. We use the residuals from the regression to capture such instances of mispricing and relate them to wine consumers' purchasing decision. The results delineate a negative relation between mispricing and the number of bottles bought by end consumers.

In an out-of-sample analysis, our model predicted that prices for the 2019 vintage should decline by around 10% compared to vintage 2018. In effect, Bordeaux producers lowered prices by approximately 21% in 2019 due to the sanitary uncertainty during the *en primeur* campaign. These more substantial than expected price reductions led to a strong increase in customers' demand compared to the previous vintage (which was equally good). Moreover, in this out-of-sample analysis, we also find a clear negative relation between mispricing and wine consumers' purchasing decisions.

We further document an increase in release prices that exceeds the secondary market's price evolution over the past 15 years. This period of time has been characterized by a unique string of very good to outstanding vintages such as 2005, 2009, 2010, 2015, 2016, 2018 and now 2019. This increase in quality explains part of the upward trend in release prices. However, this situation is likely to occur regularly in the future, given how climate change affects weather patterns and, consequently, wine quality in the Bordeaux area. Therefore, over the long-run, prices on the primary and secondary markets cannot substantially diverge. All in one, the overpricing situation that emerged over the past 15 years seems to be due to excessive price increases under favorable conditions (e.g. vintages 2005 or 2015) and insufficient price declines when conditions were more complicated (e.g. vintages 2007 or 2017).

We contribute to the existing literature on three levels. First, we exploit the wine market and its specificities. In particular, we take advantage of a new wine's yearly release from an identical

producer but from a different vintage and quality to examine how an experience good should be optimally priced on primary markets. This is a key economic issue, which is challenging to study for traditional assets. We demonstrate the importance of using not only intrinsic asset factors but also external market factors. Second, we propose a step-by-step but relatively straightforward approach based on market observations. Thus our model is both accurate and relevant from a practical point of view. This should help market participants (producers, brokers, merchants, and end customers) to make better-informed decisions. Third, our work contributes to the literature in wine economics. More specifically, our approach is complementary to Hekimoğlu and Kazaz (2020) but presents certain advantages. It is a simple model build on a limited set of variables and follows an alignment with economic logic and market observations. Moreover, it has strong explanatory power and can predict all wine prices individually and not for homogeneous categories only.

This paper proceeds as follows. The next section analysis the relationship between the primary and secondary wine market. Section 3 presents the methodology and empirical results. Section 4 looks at out-of-sample tests and implications for the wine market, while section 5 concludes.

2 THE PRIMARY AND SECONDARY WINE MARKETS

In this study, we analyze the pricing of Bordeaux wines upon their release on the primary market. We use data from the secondary market as a benchmark to assess if price changes on the primary market appear economically realistic. Bordeaux wines account for more than 50% of the fine wines' overall market (Liv-ex 2020). Thus developing a model to determine if a wine is appropriately priced when released on the primary market represents an essential empirical issue.

2.1 Primary market

Bordeaux wines are initially released during the *en primeur* campaign representing the primary market for these wines. The term *en primeur* refers to wines sold in the spring of year *t+1* following the harvest in year *t*. The year of production is referred to as the *vintage*. For instance, wines from vintage 2018 have been released by their respective producers (called *Châteaux* in Bordeaux) between April and June 2019.

The release price depends on various considerations, but an essential role goes to wine experts who set informational signals to the entire market. They provide comments on the overall quality of a vintage and deliver scores and reviews on each wine. If a vintage has the reputation of being very good or outstanding, it will spark the demand of a variety of customers (consumers, collectors and investors) from all over the world – and prices will go up. Likewise, the wines getting the best scores in a given vintage will trigger enough demand to support higher price increases than lesser wines from the same vintage.

We retrieve data for the primary market from bordoverview.com. This website tracks the release prices and the scores of major Bordeaux wines since 2005 (release of vintage 2004). It is generally considered that there are around 50 to 80 fine or investment-grade red wines in the Bordeaux region. These are composed of wines from the Médoc (1855 classification), Saint-Emilion (first classified growths A and B), and famous wines from the Pomerol appellation (no existing classification). Our dataset also includes the second wines of the first classified growths as they are as actively traded on the secondary market as other non-first growth fine wines. Our final dataset consists of the release prices and expert scores for 69 Bordeaux wines[5] for vintages 2004 to 2018 (released in 2005 to 2019).[6]

2.2 Secondary market

Fine wines can be traded on the secondary market through various channels. Historically, auctions represented the archetypal way to buy and sell fine wines. With the advent of the Internet, the situation has evolved. Notably, London-based company, Liv-ex has developed a dedicated trading platform. Liv-ex is now the market leader. In addition to the trading platform, they have developed a series of wine indices that are computed and published every month. We gather price level data for three Liv-ex wine indices (Liv-ex 50, Liv-ex 100 and Liv-ex 500) over the period 2004 to 2020 from Thomson Reuters DataStream and use them as benchmarks of the price evolution on the secondary wine market. More specifically, we use the index price levels at the end of April of each year to calculate returns as this normally marks the beginning of the *en primeur* campaign in Bordeaux, lasting from April to June.

2.3 The relation between primary and secondary market

Like any other asset, prices on the primary market must be consistent with their secondary market counterparts. In the short-run, for instance, if an outstanding vintage is released, prices on the primary market may increase faster. If the wines sell particularly well, this may even send a signal to the secondary market that there is enough demand to support higher prices. Similar relationships exist the other way around. That is, if demand for older vintages increases, their prices will go up, thereby indicating to wine producers that they should be able to release their latest vintage at a higher price. Alternatively, this phenomenon can be explained with a classic arbitrage argument between the two markets. A price that is too high on the primary market will cause a demand shift to the less expensive secondary market and thus cause price increases there or vice versa. However, over the long-run, price dynamics on both markets need to follow a similar trend.

To illustrate this, we compute an *en primeur* (primary market) price index and compare it to the Liv-ex wine indices (secondary market). To compute the index, we run a multivariate regression in the form of:

$$p_{i,v} = \alpha + \sum_{i=1}^{N} \beta_i D_i + \sum_{v=2004}^{2018} \theta_v D_v + \mu R_{i,v} + \gamma R_{i,v}^2 + \varepsilon_{i,v}, \quad [1]$$

where $p_{i,v}$ is the log(release price) of wine i in vintage v. The independent variables include wine D_i and vintage D_v dummies. To control for quality, we include expert scores in the regression model. This variable enters in a linear ($R_{i,v}$) and a quadratic ($R_{i,v}^2$) form to account for the fact that highly rated wines may trigger an additional premium (Masset, Weisskopf, and Cossutta 2015). We run this specification for (A) First Growths only, (B) all châteaux in our sample, and with or without the score variables. We report all results in Table 1. For the First Growths (columns I and I(q)), we find very similar results for both specifications. Scores only have a non-significant impact as these wines' status dominates the pricing. Furthermore, in the *en primeur* market, the price differences between the châteaux remain weak. Only Lafite Rothschild is frequently and significantly more expensive than the other First Growths.

Analyzing all châteaux (columns II and II(q)) allows us to obtain a clearer picture of the Bordeaux market's pricing hierarchy. The historic 1A wines in St-Emilion (i.e. those classified as such over the entire period; Angelus and Pavie only accessed this rank in 2012) are more expensive than the First Growths of the Médoc. Besides, scores have a significant effect on non-First Growths wines. Finally, the respective coefficients are similar in columns I(q) and II(q) and only nuanced by the availability of scores for all First Growths (hence the absence of the variable *score?* for the

latter in Table 1). However, taking into account the intercept and the three score variables, we obtain similar coefficients. Controlling for classification, scores display a more heterogeneous effect. For scores below 93 points, the relationship is relatively limited. It then increases, and above 95 points becomes very pronounced. Finally, the four models explain prices precisely, with R-squared ranging between 0.95 and 0.98.

< Insert Table 1 about here >

In a second step, we construct *en primeur* indices by setting a starting value of 100 for our first sample year (vintage 2004 in the year 2005) and by multiplying it by the exponential of the vintage coefficients θ_v, i.e.:

$$Index_v = 100 \times \exp(\theta_v) \quad [2]$$

A few salient facts emerge from Figure 1, which reports the evolution of prices on both the primary and the secondary wine markets. First, when comparing panels (A) and (B), First Growths appear to be more volatile than other Bordeaux wines. They are considered high beta wines in financial terms, implying that they amplify overall market movements with prices increasing very rapidly when market conditions are favorable and dropping equally quickly under worsening conditions. Second, the primary market's release prices depend on secondary market dynamics and vintage quality. For instance, in 2010 and 2011, Bordeaux producers released their wines from the 2009 and 2010 vintages at exceptionally high prices. This was unsurprising given that the two

vintages got outstanding scores and the wine market was booming. Third, over the long-run, prices have to evolve at a similar pace in both markets. Indeed, the wines released in a given year on the primary market will be traded on the secondary market a few years later. Thus, short-term deviations can be justified if the latest release is particularly good or poor. But, over a decade or more, one would expect the average returns to be roughly equivalent on both markets. Figure 1 shows that this is not the case. Bordeaux wines and First Growths, in particular, have seen their *en primeur* prices increasing by more than 200% and 330%, respectively, whereas over the same period, the three Liv-ex indices have posted returns of 130% to 170% only.[7]

< Insert Figure 1 about here >

There are three possible ways to justify the divergence between the returns on the primary and secondary markets. First, vintage 2004 was underpriced and is consequently a weak reference point for benchmarking the primary market with the secondary market. This explanation does not hold. Indeed, most wines from the 2004 vintage have remained available at their initial release prices for more than a year. If they had been underpriced, prices would have increased rapidly, and wines would have been sold out quickly. Second, Bordeaux producers may have adopted an excessively aggressive pricing policy over the fifteen years. This explanation is in line with anecdotal evidence. For instance, Rand (2019) notes that "Consumers also know, from experience, that buying Bordeaux *en primeur* no longer necessarily gets them the best deals. […] The Chinese have largely steered clear of *en primeur* since getting their fingers burnt with 2009 and 2010 […] The 2011 and 2012 vintages were overpriced *en primeur*. 2016 was expensive, and only a few have risen in price since; many have fallen". Finally, changes in economic conditions (e.g., lower interest rates) or a

general improvement in quality over recent years may justify higher release prices. This explanation is equally plausible. To disentangle these two concurrent explanations, one needs to use an econometric modelling approach to determine how *en primeur* prices should evolve over time – this is the main objective of this paper.

3 EMPIRICAL ANALYSIS

This section first presents our model and then reports and analyses the results from its estimation using data for 69 châteaux and vintages from 2004 to 2018 (released one year later from 2005 to 2019).

3.1 Econometric modelling

Our empirical approach is based on modelling relative price changes, not prices themselves. We do so for three reasons. First, it reflects the market logic as practitioners tend to think in terms of relative rather than absolute prices. For instance, the leading wine merchant in the United Kingdom, Farr Vintners, notes about the 2019 vintage that "If wines are priced correctly, they can offer great value to buyers […]. To that end, we have made the lower estimates for 2019 releases the equivalent of the 2014 release prices […]. Our top estimates are 10% below the 2018 release prices" (Farr Vintners 2020). Second, it reduces potential statistical issues related to the non-stationarity of some variables. Third, our model becomes unaffected by the repositioning policies implemented by some châteaux. Thus, if a château decides to strengthen its brand by increasing prices, the model will identify an overpricing situation in the first year. If this strategy works well, the model will conclude that the price evolution is fair in the following years.

The dependent variable is thus defined as the log-return between the prices of two subsequent vintages

$$r_{i,v} = p_{i,v} - p_{i,v-1}, \quad [3]$$

Where $p_{i,v}$ is the log release price of wine i in vintage v.

The model takes the form of the following multivariate regression:

$$r_{i,v} = \alpha + \beta^{L} LIVEX_{v} + \beta^{\mathrm{V}} \mathrm{VINT}_{v} + \beta^{\mathrm{E}} \mathrm{ECO}_{v} + \theta^{S} SCORES_{i,v} + PRICE.LEVEL_{i,v-1} + \epsilon_{i,v} \quad [4]$$

For ease of interpretation, we grouped some variables under common labels. For example, VINT_{v} refers to three complementary variables associated with the qualitative reputation of a vintage. We present below the different independent variables and explain the motivation for including them in the model:

- $LIVEX_{v}$ corresponds to the yearly log-returns of the Liv-ex 100 index. It is widely used as the reference index on the wine market and includes mostly Bordeaux wines and can thus be considered a relevant benchmark for this study. The motive for having this variable in the model is that prices on the primary market are affected by the demand for fine wines, which can be gauged by analyzing the evolution of secondary market prices represented by the Liv-ex indices.
- VINT_{v} encompasses three variables. The first is the change in qualitative reputation between two subsequent vintages. We here use vintage charts of wine experts as published in *Vinous* and *The Wine Advocate*. We then standardize the vintage charts to obtain the following categories: 0.5 indicates a mediocre vintage, 1.0 is average, 1.5 good, 2.0 very good, 2.5 excellent and 3.0 an outstanding vintage. If vintage v has a better qualitative reputation than

vintage $v-1$, this should translate into more demand and, consequently, positive price changes. To further account for the fact that outstanding vintages may attract dramatically more demand (e.g., from investors or collectors) than other vintages, we also include two dummies taking the value 1 if vintage v or $v-1$, respectively were considered as outstanding.

- ECO_v reflects changes in the financial and economic environment. We consider the following three variables: 1) changes in the (bond yield) term spread – to account for changes in economic conditions; 2) returns to the exchange rates between EUR and USD and GBP – to account for the fact that release prices are expressed in euros and that many buyers are located in countries that use the USD or the GBP as a reference.[8]
- $SCORES_{i,v}$ controls for each wine's quality and is likely to be used as an important signaling device for prices. We include four variables built on *The Wine Advocate* expert scores, which is widely regarded as the reference for Bordeaux wines. Robert Parker has delivered these scores from 2004 until 2013, Neal Martin for vintages 2014 to 2016, and Lisa Perrotti-Brown since 2017. The first variable captures the changes in individual wine scores between two subsequent vintages. It accounts for some wines performing better than others in certain vintages. Wines strongly improving between two subsequent vintages may witness a disproportional price increase. We, therefore, also add the interaction terms between the change-in-score variable and the ranking (in terms of scores) of the wine in the previous vintage. Finally, it is documented that people are willing to pay higher prices for wines perceived as potentially perfect, i.e. which have a score close to 100 points (Hekimoğlu and Kazaz 2020). We, therefore, augment the regression model with two dummy variables, taking the value 1 if the score of a wine in vintage v, respectively in

vintage $v-1$, is equal to or above 98.5. We use 98.5 as a threshold as *en primeur* scores are reported using an interval to consider that the wines are not yet finished, and their quality may still vary. The interval is generally 2 points (e.g., 98-100) but can sometimes be 3 points (e.g., 97-100), when the uncertainty about the final quality is greater. We take the average of the lower and higher estimates to compute an expected score.

- $PRICE.LEVEL_{i,v-1}$ allows controlling for high-beta wines, which are the most speculative and most expensive wines on the market. These wines tend to increase disproportionally in vintages with a strong demand, and vice-versa. To account for that, we use an interaction term to account for the joint influence of the Liv-ex 100 index and the rank in the price hierarchy of a wine in the previous vintage $v-1$.[9]

The model is fully causal, meaning that only variables whose values are known *before* releasing the wine on the primary market are used to estimate each wine's expected return. For example, the release and price discovery by market participants of wines from vintage 2018 took place in May and June 2019. At that moment, wine experts had tasted all wines in Bordeaux (March and April)[10] and published their scores and vintage charts. All economic and Liv-ex related data was also publicly available as we use the levels as of April in equation [4]. Our model, to a large extent, follows the intuition encountered in the bond market. Bond issuers will use the yield-to-maturity of bonds on the secondary market (the change in Liv-ex levels in our setting) as a benchmark to fix the yield-to-maturity and thus the issue price (release price of new wines) before a bond issuance. They will also gather additional information from rating agencies (wine experts) who regularly publish scores (expert scores) on the creditworthiness (wine quality metric) of the issuer and which will impact the yield investors may expect to receive and, therefore, the issue price.

3.2 Descriptive statistics and baseline results

Table 2 presents descriptive statistics for all variables used in specification [4]. We observe that the EUR-denominated *en primeur* prices increased at the same rate as the GBP-denominated Liv-ex 100 index. However, over the period, the EUR appreciated by approximately 2% p.a. [x7], indicating that *en primeur* prices outpaced those on the secondary market as discussed above. Wines have also improved in quality over time, as witnessed by the positive ΔQR_v coefficient. A large number of outstanding vintages confirm this finding. The expert scores are further consistent with the ΔQR_v coefficient at the vintage level and point towards a generalized quality increase.

< Insert Table 2 about here >

Table 3 presents a cross-correlation matrix for all variables used in specification [4] and offers additional insights. First, a significant correlation exists between the dependent variable [y] and all quality measures [x2 to x4]. Secondary market levels approximated by the Liv-ex 100 index [x1] also display a positive linkage with *en primeur* prices. On the other hand, the economic variables, except for the term spread, are only weakly correlated [x5 to x7] with wine prices. However, their interaction with the evolution of the Liv-ex index adds interesting insights and justifies their inclusion in the model. Thus, while the Liv-ex index proxies the London market, the *en primeur* market is geared towards a global clientele. We further observe that the quality variables tend to be correlated with the other explanatory variables. This may hint at a potential source of multicollinearity. However, the correlates remain below 0.5 except for two coefficients. It nevertheless remains economically relevant to investigate the price effect of qualitative variations

at both the vintage and wine level. Finally, the strong correlation between the price levels [x12] and [y] illustrates the importance of taking into account a high-beta effect when capturing the interaction between the situation on the wine market and the quality of the latest vintage. The moderate correlation between QR_{v-1} and the Liv-ex index further suggests that the last vintage may act as a signal and that a weak endogeneity problem may occur. To control for this possibility, robustness tests are proposed in the next section.

< Insert Table 3 about here >

Table 4 presents the results from the estimation of equation [4].[11] Specifications I to III do not include variables specific to individual wines. They, therefore, aim at modelling the general market dynamics, i.e. the average return between two consecutive vintages. The Liv-ex 100 is an important determinant, as is the qualitative reputation of the vintage. This confirms earlier results by Hekimoğlu and Kazaz (2020). This indicates that when market conditions and quality are both excellent, it allows Bordeaux producers to increase their prices excessively. Finally, all three economic variables are significant and appear to be complementary: the term spread (the difference between 10- and 1-year French government bond yields) captures the economic condition in France – an improvement leads to higher wine prices; the exchange rate with the U.S. dollar seems to capture the economic situation in Europe – here too an improvement pushes wine prices up; finally the exchange rate with the pound sterling is negatively associated with wine prices. The United Kingdom is a major marketplace for Bordeaux wines, so a rise in the euro has to be compensated by a fall in release prices.

< Insert Table 4 about here >

Specifications IV and V add variables specific to each individual wine. An increase in the score between two subsequent vintages leads to higher prices. The interaction with the previous year's quality ranking (defined as rank over number of observations and taking the value 0 for the best and 1 for the worst wines) is also significant and negative. This confirms that progress from a (very) low-quality level is not perceived as positively as progressing from an already high level. Finally, there is a premium for wines that are close to perfection in a specific vintage. If they are not as outstanding in the following vintage, their prices decline, but not enough to fully compensate for the increase in the previous vintage. It thus seems that producing a wine that is close to perfection once has a lasting effect on future release prices. It is also necessary to take into account the high-beta nature of some wines, which tend to react more strongly to changes in the Liv-ex 100 index than other wines. These are usually the most speculative and expensive wines. Specification V, therefore, includes a price level variable whose value equals 1 for the most expensive wines from the previous vintage and 0 for those that were the cheapest (defined as rank over number of observations). As the results show, this variable positively interacts with the Liv-ex 100 index, all the more so if the vintage is better than the previous one. This provides evidence that some wines are more sensitive to the movements in the overall market than others. Taking this high-beta effect into account thus appears important. This is reflected in the high R-squared, which reaches a level of 0.84 for this specification. The explanatory power of the model is remarkable, given the limited number of independent variables considered. This is because the Bordeaux wine market has functioned in a rather mechanical and stereotyped way for decades.

3.3 Robustness tests

Table 5 presents robustness tests to mitigate two potential concerns that may bias the baseline analysis. First, it may be argued that TWA scores may suffer from endogeneity. As it reflects the opinion of a single expert, it may capture the true quality of a given wine and the taste and preference of the expert. Both may display a significant relationship with wine prices and thus lead to confounding effects. We replace all score data that were initially gathered on TWA website by scores collected on the Global Wine Scores (GWS) website to address this issue. GWS has the advantage of aggregating and standardizing the scores of many different wine experts and thus should be less prone to biases induced by the use of TWA scores alone. As Cardebat and Paroissien (2015) state, Global Wine Scores are unbiased estimates of quality due to the aggregation of scores from several wine experts. In contrast, a single expert's score measures wine quality and the preference or even bias of that expert.

To better understand the relationship between TWA and GWS scores, we first examine their characteristics.

	Δ TWA	**=**	**α**	**+**	**β**	**×**	**Δ GWS**	**+**	**ε**
Average	0.37						0.32		0.00
Standard deviation	3.11						2.25		1.99
Coefficient			0.02		1.06				
p-value			0.73		0.00				

We observe that GWS displays a lower standard deviation and thus are more stable due to an aggregation and consequently smoothing effect of considering multiple scores. The positive average for both TWA and GWS point to an increase in quality over the sample period. The higher average for TWA scores can be explained by its higher standard deviation which enhances the positive trend in wine scores over the period. This larger variability of the TWA scores is also

reflected in the regression coefficient. On the other hand, overall, the differences are similar as observed in the insignificant and close to 0 intercept.

Table 5 reports that the explanatory power and coefficients are not sensitive to the use of the GWS. All R-squared remain at a high level of 0.84. Some slight variations are observed in the coefficients as GWS data are smoother than TWA scores due to the aggregation process of several expert opinions. However, the GWS results also indicate that having a score above a threshold of 97.5^{12} leads to insignificant coefficients. This reflects the strong influence TWA has on the Bordeaux market and its massive use as a reference point by wine market participants, whereas this is less the case for the less known and more recent GWS. Therefore, we also consider a specification mixing the advantages of TWA and GWS scores. In this case, GWS measures the objective wine quality while the variable $S_{i,v} \geq$ threshold on TWA scores captures the influence of a very high TWA score on prices. Overall, the R-squared improves slightly (0.841 to 0.844), but more importantly, coefficients become statistically significant, indicating the importance of not only controlling for quality (GWS) but also for the individual impact of the most influential Bordeaux wine expert (TWA). Finally, the intercept remains positive, demonstrating that prices evolved more rapidly on the primary than on the secondary market.

As a further robustness test, we run a Two-Stage least squares (2SLS) specification to alleviate another potential endogeneity concern. It may be argued that the primary and secondary market may not be entirely independent of each other. For example, the *en primeur* prices in a given year may influence the secondary market (Liv-ex) prices in the subsequent year. To alleviate this concern, we use three instruments as a substitute for the evolution of the Liv-ex. All three have been shown to be strongly correlated with price movements on the secondary market. These include the gold price and the currency risk factors *RX* and *HML* proposed by Lustig, Roussanov, and

Verdelhan (2011). Prior literature has shown that all three instruments strongly influence wine prices on the secondary market (Masset et al., 2021; Bouri 2014). We further find that these three variables explain 78% of Liv-ex returns over our sample period. The results in column 4 indicate that the Liv-ex index and thus, our results are not affected by an endogeneity issue. As in previous specifications, specification V also includes an interaction term with the Liv-ex index. It is not considered a potentially endogenous variable and therefore falls within the set of variables modelling the Liv-ex (alongside the instrumental variables). To ensure that this does not influence the results, we rerun the 2SLS analysis based on specification IV. The R-squared and coefficients remain unchanged, and the instrumentalized Liv-ex coefficient remains similar and strongly significant. Again our results do not appear to be affected by endogeneity.

< Insert Table 5 about here >

3.4 Analysis of the mispricing

Panel A of Figure 2 confirms the model's high explanatory power as realized and expected returns are very close to each other. Panel B focuses on the analysis of the residuals. The upper and lower quartiles show that, even though the average residuals per vintage are close to zero, there are nevertheless wines for which the residuals are moderately positive or negative. Stated differently, some wines still appear too expensive or too cheap based on the model. These discrepancies are more pronounced for vintages deemed speculative, such as 2005 (huge demand, especially from the USA), 2009 and 2010 (massive purchases by investment funds and soaring Asian demand). If we add the positive intercept (which is entirely independent of market conditions – and thus specific

to the primary market) to the residuals, we can see that over the entire period, an economically significant cumulated mispricing has emerged. The results also indicate that significant differences occur in a given vintage. While most wines display moderate mispricing, some are more extreme.

It is important to interpret the average residuals per vintage correctly. The fact that they are negative for the 2018 vintage does not indicate that it was released at too low prices. It indicates that considering the better quality of the vintage compared to the previous one and the improvement in economic conditions, it would have been reasonable to increase the prices of the 2018 vintage by 2% more as compared to 2017 if the latter had been reasonably priced. But this is not the case, as 2017 was already far too expensive. So the slightly lower than expected price increase in 2018 only marginally reduced the overpricing situation that had gradually built up between the 2005 and 2018 vintages.

< Insert Figure 2 about here >

Figure 3 reports findings on the linkage between mispricing and purchase decisions for each vintage in the sample. It shows the slope of the relationship between mispricing (x) and purchase decisions (y) estimated in a regression with mispricing variables for each vintage (i.e., interaction terms between a vintage dummy and mispricing, which allows us to test whether the linkage has remained constant. The mispricing is defined as the residuals from "Specification V GWS & TWA" proposed in Table 5. To measure purchase decisions, we use the vintage-by-vintage log-changes in quantities held by the Cellar Tracker Community. Cellar Tracker (CT) represents, by far, the largest community of wine consumers in the world. Its primary purpose is to allow its users to

manage their cellar through a dedicated website/application. This means that it has information on all the bottles bought by its members. To illustrate the relevance of using this data, one can note that as of June 2020, the CT community as a whole owned more than 10% of the overall production of Château Pontet-Canet 2009.

Overall, the figure suggests that mispricing negatively influences customers' purchase decisions, confirming that the mispricing is economically significant and not due to omitted variables. In the latter case, overpriced wines would not be less frequently found in the cellars of the CT community than less expensive wines, according to the model. More specifically, we observe an average slope coefficient of -0.62 over the entire sample period. Thus, a wine that was overpriced by 10% saw its purchase volume by the Cellar Tracker community drop by around 6.2%. However, the relationship is not constant through time. The slope appears more negative at the end of the sample period than at the beginning. This can either be due to more aggressive pricing by the château in recent years or the fact that the prices of older vintages have long since had time to adjust to market conditions. Thus, the initial mispricing may have reduced over time, and the purchases may have been made gradually. Since 2010 all coefficients are negative except for two vintages. In 2014 we generally had attractive prices due to a very good vintage following four year crisis period. In 2017 low and above all, strongly varying quantities were put on the market due to frost affecting château in different ways. Finally, the most negative coefficient corresponds to 2013, a year with a combination of complicated *en primeur* conditions, the worst wine quality since the beginning of the 1990s, a price correction period for Bordeaux wines and unrealistic asking prices by many châteaux. In short, a large number of overpriced wines and a limited purchase volume resulted in a very negative relationship.

< Insert Figure 3 about here >

4 OUT-OF-SAMPLE ANALYSIS AND IMPLICATIONS

Table 6 presents the results of an out-of-sample analysis on vintage 2019. We first compare the effective release price for vintage 2019 with the predictions made by our model. We then compare these predictions and the deviations from the effective price with those provided by the model proposed by Hekimoğlu and Kazaz (2020)[13]. Both models aim to predict the prices at which wine prices should be issued on the Bordeaux market. To allow for a correct comparison, we adjust both samples. First, we only use those 29 wines that are common to both papers. Hekimoğlu and Kazaz (2020) derive their forecasts using Lisa Perrotti-Brown (TWA), Neal Martin and James Suckling scores. As we do not have James Suckling scores, and they have fewer forecasts for Lisa Perrotti-Brown than Neal Martin, we use the forecasts based on the latter in the analysis. Hekimoğlu and Kazaz (2020) also report discrete deviations that we translate into log-returns as in our study. Finally, Hekimoğlu and Kazaz (2020) use *ex-negociant* prices while we use end-customer prices. However, as we look into relative price changes and given that margins have been relatively stable for several years, we can reasonably assume that the comparison is valid.

Overall, we find that our model and the one used by Hekimoğlu and Kazaz (2020) yield close results. Table 5 shows that the Mean Squared Error (MSE) is lower for our forecast, and the more significant declines are more rightly anticipated. However, if we use Hekimoğlu and Kazaz forecasts based on Lisa Perrotti-Brown scores, the gap narrows to almost similar MSE. Interestingly, our model leads to more variable forecasts, which seems to be more in line with market reality. This is due to the consideration of high-beta wines in our model. However, in

general, the two models could not anticipate the extent of the COVID-induced decline. This may, however, represent an extraordinary situation encountered in 2020. The problem is less the economic and financial conditions that the models take into account but the conditions on the wine market and, in particular, the difficulty to communicate, organize tastings, or in short, to come up with a normal *en primeur* campaign.

The last column of Table 6 reports the 2018-2019 variation in the number of bottles of the CT community. On average, the community bought more of the sample wines in 2019 than in 2018, but there are strong variations. That is, some producers understood the market in 2020 while others have not. The linkage with the CT community purchase decisions provides several interesting insights. The wines with the largest price drops or with the smallest expected price drop by our model were also the most demanded wines. These two points combined result in a very strong negative correlation (-0.5) between the deviations (mispricing) and purchase decisions. This indicates that wines that were released too expensive were less in demand. Finally, the results on the linkage between the Hekimoğlu and Kazaz model and purchase decisions are less pronounced than our results. In complement to the MSE analysis, it seems that our forecasts are better able to capture the economic logic of Bordeaux futures pricing and thus correlate better with the behavior of potential buyers.

< Insert Table 6 about here >

5 CONCLUSION

Upon their initial release, the optimal pricing of goods and services is central to many industries in an economy. The release of an additional or modified version of the good on the market is even more complex as an interplay between the primary and secondary market exists. In this case, the issuer must predict a customer's willingness to pay and demand for the good to maximize profits and account for the existing stock and price behavior on the secondary market. The price forecasting on primary markets and its effect on the secondary market is also of indirect importance in corporate decision-making and will be crucial in the presence of experience goods.

Thus, this paper aims to better understand the pricing of experience goods, which are recurrently issued on the market under uncertainty, varying quality, and monopolistic competition. To do so, we use the Bordeaux wine market to determine how issuers should fix their release prices and how these should evolve based on a set of relevant variables.

We document an increase in release prices over the past 15 years which can be explained by an increase in wine quality but also Bordeaux producers having increased their prices at a sometimes excessive pace. Our analysis further suggests that over the short-run, and when there is an outstanding vintage, prices on the primary wine market may increase and thus deviate significantly from their secondary market counterparts. In the short-run, consumers also react to mispricing by adjusting their positions and purchase decisions as indicated for vintage 2019 in the out-of-sample analysis. However, over the long-run, prices on the two markets cannot substantially diverge.

Though our model has a high explanatory power of 84%, it can nevertheless be further improved. To this avail, it would be useful to gain access to more fine-grained secondary market price data for individual wines and not only an aggregate reference index such as the Liv-ex 100. This would help to determine prices (rather than returns) for individual wines. But this kind of data

is challenging to obtain. Liv-ex now offers sufficient liquidity for a set of representative wines but only in recent years. The historical prices of wine retailers are rarely available and are not necessarily representative because we do not know if there were a transaction at the published price. Auction hammer prices would be best-suited, but it is difficult to obtain reliable historical data for a full sample of wines. A related issue is that the forecasted price changes for all producers depend on their release prices for vintage 2004. As explained above, several pieces of evidence suggest that the vintage as a whole was reasonably priced. But this does not prevent some châteaux from having been too expensive or too cheap in this vintage. A more robust approach would be to directly model the *en primeur* prices using recent (almost contemporaneous) data from the secondary market. Therefore, the current model works very well to identify general trends on the Bordeaux wine market and price changes of wines from subsequent vintages. However, it is more difficult to determine the cumulated mispricing of individual wines as the result would be too dependent on the 2004 reference point.

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[1] The term experience good was proposed by Nelson (1970). This is opposed to search goods, for which customers can learn about product quality before buying and experiencing them or credence goods for which even after experiencing them quality cannot be determined. Many goods display both features from the experience and search good spectrum (Wilde 1981).

[2] The 1855 classification in the Medoc region was established in 1855 for the Exposition Universelle de Paris to showcase the quality of Bordeaux wines and has only seen one modification since then with the ascension of Mouton Rothschild to the rank of First Growth in 1973. Interestingly, the ranking was established on the then current market prices and producer's reputation.

[3] See Oczkowski and Doucouliagos (2015) for an in-depth analysis of the linkage between wine quality and prices.

[4] Literature on Initial Public Offerings on financial markets (Daily et al., 2003) or on ticketing in sports and cultural economics (Courty 2016, 2003) explicitly take these features into account.

[5] We select the wines entering our dataset based on two criteria: the reputation of the wine and data availability. A complete list of wines in the sample can be found in Table 1. The only major wines to be absent from the sample are those of the Moueix family (Pétrus, Trotanoy, Fleur-Pétrus, and Belair-Monange). These wines are normally sold through an allocation scheme, which implies that very few people can actually buy them at the release price. This leads to a lack of transparency which makes it difficult to determine their release prices. Moreover, the fact that most market players are not able to buy these wines at their release prices further implies that the latter are of little relevance from the perspective of the market as a whole. We also exclude wines from Latour and Forts de Latour as this producer has stopped using the *en primeur* market to release its wines in 2012.

[6] For an out-of-sample analysis we also retrieve data for vintage 2019 released in 2020.

[7] Another possibility to examine the linkages between primary and secondary market would be to use a co-integration analysis. However, this would produce results which may lack robustness due to the low number of 15 annual observations available.

[8] We also considered changes in the VIX and returns to stock market indices (CAC 40, FTSE, S&P 500 and MSCI World) but these variables do not appear significant once the other variables are included in the model.

[9] This variable directly refers to the microstructure of the Bordeaux market and the importance of status and rank between the châteaux. This implies that during the *en primeur* campaign some strategic behavior amongst châteaux from the same rank may exist. The first to release its wine will give an overall price dynamic to other châteaux. However, this dynamic may be broken in the case of new information appearing during the campaign. This should be especially true in the absence or delay of expert scores such as for vintages 2008 or 2019.

[10] The wine tastings in 2020 constitute a notable exception. Due to the Covid-19 pandemic wine tastings and the *en primeur* campaign were delayed. The *en primeur* campaign was well under way before expert scores were released.

[11] In unreported tests we computed Variance Inflation Factors (VIF) for all variables and do not find multicollinearity issues.

[12] In the case of TWA we had a cut-off of 98.5 points. However, due to the aggregation only very few GWS scores could be found above this threshold. We therefore lowered it to 97.5 points to obtain an equivalent number of occurrences in this category for GWS.

[13] The data and information for the forecast can be found in https://news.syr.edu/wp-content/uploads/2020/07/BDX-2019-final-report-2020-07-20-reducedfile.pdf.

Table 1:

Results from regression model 1

This table reports the results from the estimation of regression 1. Specifications I and II include respectively first classified growth wines only and all 69 châteaux considered in this study; (q) indicates whether quality-related variables are included or not in the specification. The reference in all specifications is Haut-Brion 2004. Information about appellation and classification is in brackets next to the name of each château. S-Em. stands for St-Emilion, S-Ju. for St-Julien, Marg. for Margaux, S-Est. for St-Estèphe, P-L for Pessac-Léognan, Pauil. for Pauillac and Pom. for Pomerol. 1A and 1B stand for first classified growth A and B respectively, 1GCC to 5GCC for first to fifth classified growth, 2nd for second wine, CC for classified growth, and NC for not classified. *, ** and *** indicate significance at the 90%, 95% and 99%-levels.

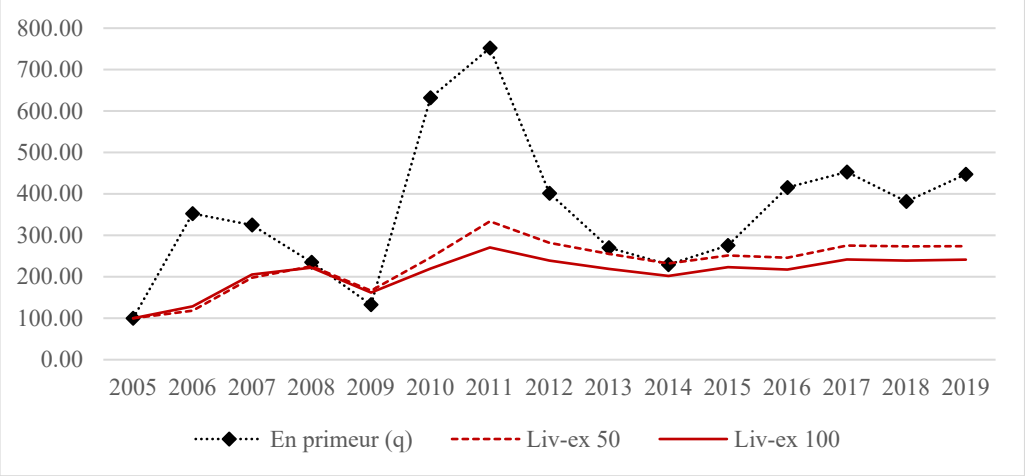
Wine	I	I(q)	II	II(q)	Wine	I	I(q)	II	II(q)
Intercept	4.87***	31.6	5.3***	5.28***	Lagrange (S-Ju., 3GCC)			-2.36***	-2.22***
Lafite-Rothschild (Pauil., 1GCC)	0.15***	0.16***	0.15**	0.15**	Larcis-Ducasse (S-Em., 1B)			-2.06***	-1.99***
Margaux (Marg., 1GCC)	0.04	0.04	0.04	0.05	Lascombes (Marg., 2GCC)			-1.9***	-1.79***
Mouton-Rothschild (Pauil., 1GCC)	0.01	0.02	0.01	0	Léoville-Barton (S-Ju., 2GCC)			-1.84***	-1.73***
Angélus (S-Em., 1A)			-0.62***	-0.59***	Léoville-Las-Cases (S-Ju., 2GCC)			-0.92***	-0.9***
Ausone (S-Em., 1A)			0.46***	0.42***	Léoville-Poyferré (S-Ju., 2GCC)			-1.82***	-1.74***
Beau-Séjour Bécot (S-Em., 1B)			-2.09***	-1.98***	Lynch Bages (Pauil., 5GCC)			-1.62***	-1.53***
Beauséjour Duffau-Lagarrosse (S-Em., 1B)			-1.73***	-1.65***	Malartic-Lagravière (P-L, CC)			-2.38***	-2.26***
Beychevelle (S-Ju., 4GCC)			-2.04***	-1.91***	Malescot-Saint-Exupéry (Marg., 3GCC)			-2.15***	-2.06***
Branaire (Ducru) (S-Ju., 4GCC)			-2.22***	-2.1***	la Mission Haut-Brion (P-L, CC)			-0.33***	-0.33***
Brane-Cantenac (Marg., 2GCC)			-2.15***	-2.05***	la Mondotte (S-Em., 1B)			-0.78***	-0.76***
Calon-Ségur (S-Est., 3GCC)			-1.92***	-1.81***	Montrose (S-Est., 2GCC)			-1.4***	-1.37***
Canon (S-Em., 1B)			-1.74***	-1.66***	Palmer (Marg., 3GCC)			-0.65***	-0.6***
Canon-La-Gaffelière (S-Em., 1B)			-1.85***	-1.74***	Pape Clément (P-L, CC)			-1.51***	-1.45***
les Carmes Haut-Brion (P-L, NC)			-2.08***	-1.96***	Pavie (S-Em., 1A)			-0.54***	-0.54***
Carruades de Lafite Rothschild (Pauil., 2nd)			-1.32***	-1.18***	Pavie-Macquin (S-Em., 1B)			-1.94***	-1.87***
Cheval Blanc (S-Em., 1A)			0.34***	0.36***	Pavillon Rouge du Château Margaux (Marg., 2nd)			-1.59***	-1.46***
Clerc Milon (Pauil., 5GCC)			-2.16***	-2.03***	le Petit Cheval (S-Em., 2nd)			-1.17***	-1.04***
Clinet (Pom., NC)			-1.77***	-1.7***	le Petit Mouton de Mouton-Rothschild (Pauil., 2nd)			-1.46***	-1.31***
Clos Fourtet (S-Em., 1B)			-1.79***	-1.72***	Petit Village (Pom., NC)			-2.06***	-1.92***
Clos l'Eglise (Pom., NC)			-1.61***	-1.51***	Pichon-Longueville Baron (Pauil., 2GCC)			-1.41***	-1.36***
la Conseillante (Pom., NC) Cos d'Estournel (S-Est., 2GCC)			-1.29***	-1.22***	Pichon-Longueville Comtesse (Pauil., 2GCC) Pontet-Canet (Pauil., 5GCC)			-1.34***	-1.26***
Domaine de Chevalier (P-L, CC)			-2.15***	-2.04***	Rauzan-Gassies (Marg., 2GCC)			-2.39***	-2.26***
Ducru-Beaucaillou (S-Ju., 2GCC)			-1.19***	-1.15***	Rauzan-Ségla (Marg., 2GCC)			-1.84***	-1.75***
Duhart-Milon-Rothschild (Pauil., 4GCC)			-2.02***	-1.91***	Saint-Pierre (S-Ju., 4GCC)			-2.17***	-2.07***
l'Eglise-Clinet (Pom., NC)			-0.81***	-0.82***	Smith Haut Lafitte (P-L, CC)			-1.84***	-1.78***
l'Evangile (Pom., NC)			-0.95***	-0.89***	Talbot (S-Ju., 4GCC)			-2.28***	-2.13***
Figeac (S-Em., 1B)			-1.33***	-1.27***	Troplong-Mondot (S-Em., 1B)			-1.54***	-1.49***
la Gaffelière (S-Em., 1B)			-2.04***	-1.93***	Valandraud (S-Em., 1B)			-0.93***	-0.85***
le Gay (Pom., NC)			-1.56***	-1.47***	Vieux Château Certan (Pom., NC)			-1.05***	-1.03***
Gazin (Pom., NC)			-2***	-1.89***	Rated?				20.32***
Giscours (Marg., 3GCC)			-2.22***	-2.09***	Rating		-0.56		-0.46***
Grand-Puy-Lacoste (Pauil., 5GCC)			-2***	-1.9***	Rating^2		0.0029		0.0026***
Gruaud-Larose (S-Ju., 2GCC)			-2.07***	-1.96***	Vintage dummies	Yes	Yes	Yes	Yes
Haut-Bailly (P-L, CC)			-1.75***	-1.7***					
d'Issan (Marg., 3GCC)			-2.21***	-2.1***	Number of observations	60	60	1018	1018
Kirwan (Marg., 3GCC)			-2.37***	-2.23***	R-squared	0.98	0.98	0.95	0.96

Figure 1:

Primary versus secondary market prices

This figure contrasts the evolution of release prices of Bordeaux wines on the *en primeur* (primary) market for vintages 2004 (released in 2005) to 2018 (released in 2019) with Liv-ex indices (secondary market). Liv-ex indices and release prices are expressed in Euros. Panel (A) focuses on first growths only (the top 5 Châteaux from Bordeaux), while Panel (B) considers a sample of 73 investment-grade wines from Bordeaux. The *en primeur* index includes dummies and variables to control for quality.

Panel A: First Growths



Panel B: Bordeaux

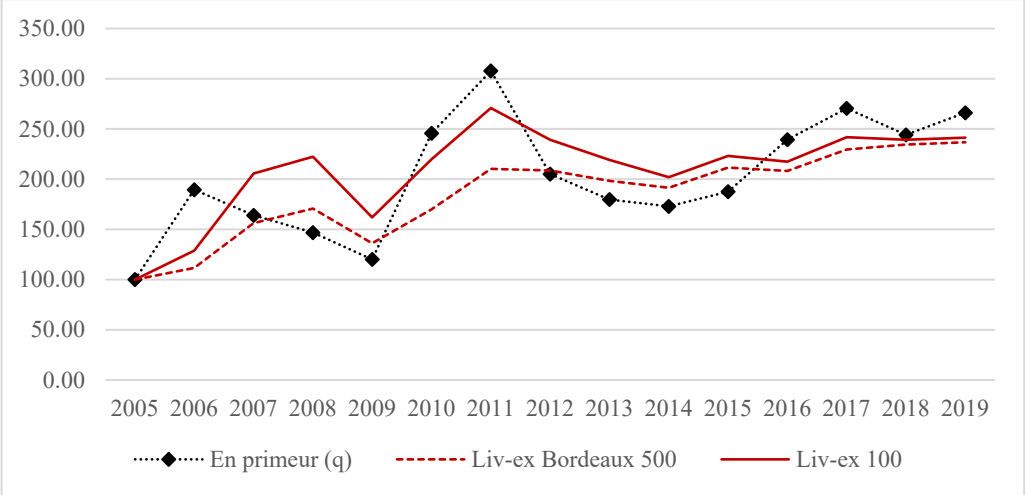


Table 2:

Descriptive statistics

This table reports descriptive statistics for variables used in the estimation of regression model [4]. The columns report average (Avg.), the standard deviation (Std. Dev.), the skewness (Skew) and kurtosis (Kurt.) for the different variables. $R_{i,v}$, $R_{Liv-ex\,100}$ and ΔQR_v denote the yearly return to wine *i*, the Liv-ex 100 and the difference in qualitative reputation between vintage *v-1* and *v*. $QR_v = Outstanding?$ is a dummy variable taking the value 1 if vintage *v* is outstanding and zero otherwise. $R_{USD/EUR}$, $R_{GBP/EUR}$ and $\Delta Term\ spread$ are the yearly returns to the USD/EUR and GBP/EUR exchange rates and the change in the term spread (defined as the difference between the yield on 10-year and 1-year French government bonds). $\Delta S_{i,v}$, $SRk_{i,v-1}$ and $S_{i,v} \geq 98.5$ are the change in score of wine *i* between two subsequent vintages, the ranking of wine i in terms of scores in the previous vintage (from 0 for the highest score to 1 for the lowest) and a dummy variable that takes the value 1 if a wine is potentially perfect. Finally, $PLev_{i,v-1}$ captures the price level of wine i in the previous vintage (from 0 for the cheapest to 1 for the most expensive wines). *, ** and *** denote significance at the 10%, 5% and 1% level.

Category	Variable	Avg.	Median	Std. Dev.	Skew.	Kurt.
Log-return	[y] $R_{i,v}$	0.08	0.00	0.39	0.95	5.02
LIVEX $_v$	[x1] $R_{Liv\text{-}ex\ 100}$	0.08	0.04	0.19	0.16	2.05
VINT $_v$	[x2] ΔQR_v	0.09	0.50	1.13	-0.25	2.15
	[x3] QR_v = Outstanding?	0.43	0.00	0.50	0.29	1.08
	[x4] QR_{v-1} = Outstanding?	0.37	0.00	0.48	0.56	1.31
ECO $_v$	[x5] ΔTerm spread	-0.05	-0.19	0.82	2.01	7.01
	[x6] $R_{USD/EUR}$	-0.01	0.00	0.10	-0.43	2.27
	[x7] $R_{GBP/EUR}$	0.02	0.03	0.07	-0.06	2.46
SCORES $_{i,v}$	[x8] $\Delta S_{i,v}$	0.36	0.50	3.14	0.00	2.67
	[x9] $SRk_{i,v-1} \times \Delta S_{i,v}$	0.36	0.00	1.69	0.80	6.53
	[x10] $S_{i,v}$ >= 98.5	0.06	0.00	0.23	3.88	16.02
	[x11] $S_{i,v-1}$ >= 98.5	0.05	0.00	0.21	4.34	19.86
PRICE.LEVELS $_{i,v-1}$	[x12] $R_{Liv\text{-}ex\ 100} \times (\Delta QR_v > 0) \times PLev_{v-1}$	0.02	0.00	0.07	1.24	5.88

Table 3:

Cross-correlation coefficients

This table reports a cross-correlation matrix of all variables used in the estimation of regression model [4]. $R_{i,v}$, $R_{Liv-ex\ 100}$ and ΔQR_v denote the yearly return to wine *i*, the Liv-ex 100 and the difference in qualitative reputation between vintage *v-1* and *v*. $QR_v = Outstanding?$ is a dummy variable taking the value 1 if vintage *v* is outstanding and zero otherwise. $R_{USD/EUR}$, $R_{GBP/EUR}$ and $\Delta Term\ spread$ are the yearly returns to the USD/EUR and GBP/EUR exchange rates and the change in the term spread (defined as the difference between the yield on 10-year and 1-year French government bonds). $\Delta S_{i,v}$, $SRk_{i,v-1}$ and $S_{i,v} \geq 98.5$ are the change in score of wine *i* between two subsequent vintages, the ranking of wine i in terms of scores in the previous vintage (from 0 for the highest score to 1 for the lowest) and a dummy variable that takes the value 1 if a wine is potentially perfect. Finally, $PLev_{i,v-1}$ captures the price level of wine i in the previous vintage (from 0 for the cheapest to 1 for the most expensive wines).

Category	Variable	[y]	[x1]	[x2]	[x3]	[x4]	[x5]	[x6]	[x7]	[x8]	[x9]	[x10]	[x11]	[x12]
Log-return	[y] $R_{i,v}$	1.00	0.43	0.66	0.69	-0.35	-0.13	0.01	-0.02	0.57	0.36	0.37	-0.07	0.70
$\boldsymbol{LIVEX_v}$	[x1] $R_{Liv\text{-}ex\ 100}$		1.00	0.11	0.40	0.22	-0.51	0.55	0.13	0.04	0.03	0.14	0.08	0.49
$\boldsymbol{VINT_v}$	[x2] ΔQR_v			1.00	0.51	-0.61	0.08	-0.41	0.16	0.69	0.53	0.14	-0.11	0.30
	[x3] QR_v = Outstanding?				1.00	-0.04	-0.14	0.05	0.06	0.42	0.32	0.27	0.09	0.57
	[x4] QR_{v-1} = Outstanding?					1.00	-0.11	0.25	-0.13	-0.45	-0.35	-0.06	0.28	-0.01
$\boldsymbol{ECO_v}$	[x5] ΔTerm spread						1.00	-0.37	0.41	0.18	0.13	0.00	-0.07	-0.28
	[x6] $R_{USD/EUR}$							1.00	0.35	-0.36	-0.27	0.01	0.15	0.13
	[x7] $R_{GBP/EUR}$								1.00	0.05	0.05	-0.05	-0.01	-0.13
$\boldsymbol{SCORES_{i,v}}$	[x8] $\Delta S_{i,v}$									1.00	0.83	0.27	-0.20	0.26
	[x9] $SRk_{i,v-1} \times \Delta S_{i,v}$										1.00	0.11	-0.06	0.14
	[x10] $S_{i,v}$ >= 98.5											1.00	0.08	0.35
	[x11] $S_{i,v-1}$ >= 98.5												1.00	-0.02
$\boldsymbol{PRICE.LEVELS_{i,v-1}}$	[x12] $R_{Liv\text{-}ex\ 100} \times (\Delta QR_v > 0) \times PLev_{v-1}$													1.00

Table 4:

Return attributes on the en primeur market

This table reports the results from the estimation of regression model [4]. Five specifications are considered. $R_{Liv-ex\ 100}$ and ΔQR_v denote the yearly return to the Liv-ex 100 and the difference in qualitative reputation between vintage *v-1* and *v*. $QR_v = Outstanding?$ is a dummy variable taking the value 1 if vintage *v* is outstanding and zero otherwise. $R_{USD/EUR}$, $R_{GBP/EUR}$ and $\Delta Term\ spread$ are the yearly returns to the USD/EUR and GBP/EUR exchange rates and the change in the term spread (defined as the difference between the yield on 10-year and 1-year French government bonds). $\Delta S_{i,v}$, $SRk_{i,v-1}$ and $S_{i,v} \geq 98.5$ are the change in score of wine *i* between two subsequent vintages, the ranking of wine i in terms of scores in the previous vintage (from 0 for the highest score to 1 for the lowest) and a dummy variable that takes the value 1 if a wine is potentially perfect. Finally, $PLev_{i,v-1}$ captures the price level of wine i in the previous vintage (from 0 for the cheapest to 1 for the most expensive wines). *, ** and *** denote significance at the 10%, 5% and 1% level.

Dependent variable: $r_{i,v}$ = difference in log-price of wine *i* between vintage *v-1* and *v*

		Market-wide variables only			Market-wide & individual-wine	
		I	**II**	**III**	**IV**	**V**
	Intercept	0.01	-0.05***	0.02**	0.03***	0.04***
LIVEX $_v$	$R_{Liv\text{-}ex\ 100}$	0.88***	0.57***	0.57***	0.47***	0.27***
VINT $_v$	ΔQR_v		0.09***	0.2***	0.19***	0.17***
	QR_v = Outstanding?		0.34***	0.26***	0.23***	0.15***
	QR_{v-1} = Outstanding?		-0.19***	-0.15***	-0.11***	-0.1***
ECO $_v$	ΔTerm spread			0.16***	0.14***	0.12***
	$R_{USD/EUR}$			1.68***	1.73***	1.54***
	$R_{GBP/EUR}$			-2.71***	-2.46***	-1.94***
SCORES $_{i,v}$	$\Delta S_{i,v}$				0.04***	0.04***
	$SRk_{i,v-1} \times \Delta S_{i,v}$				-0.05***	-0.04***
	$S_{i,v}$ >= 98.5				0.17***	0.08***
	$S_{i,v-1}$ >= 98.5				-0.07**	-0.02
PRICE.LEVELS $_{i,v-1}$	$R_{Liv\text{-}ex\ 100} \times (\Delta QR_v > 0) \times PLev_{v-1}$					1.57***
Observations		938	938	938	916	916
R-squared		0.18	0.68	0.76	0.80	0.84

Table 5:

Robustness tests

This table reports the results from the estimation of regression model [4]. Column 1 is identical to specification V in Table 4 and serves as benchmark. Column 2 replicates it substituting TWA scores for GWS scores and column 3 uses both TWA (measuring an expert effect) and GWS (measuring quality variations) scores together. The last column shows results for a Two-Stage least squares regression with gold prices, the RX and HML currency risk factors instrumenting the Liv-ex index. $R_{Liv-ex\ 100}$ and ΔQR_v denote the yearly return to the Liv-ex 100 and the difference in qualitative reputation between vintage *v-1* and *v*. $QR_v = Outstanding?$ is a dummy variable taking the value 1 if vintage *v* is outstanding and zero otherwise. $R_{USD/EUR}$, $R_{GBP/EUR}$ and $\Delta Term\ spread$ are the yearly returns to the USD/EUR and GBP/EUR exchange rates and the change in the term spread (defined as the difference between the yield on 10-year and 1-year French government bonds). $\Delta S_{i,v}$, $SRk_{i,v-1}$ and $S_{i,v} \geq 98.5$ are the change in score of wine *i* between two subsequent vintages, the ranking of wine i in terms of scores in the previous vintage (from 0 for the highest score to 1 for the lowest) and a dummy variable that takes the value 1 if a wine is potentially perfect. Finally, $PLev_{i,v-1}$ captures the price level of wine i in the previous vintage (from 0 for the cheapest to 1 for the most expensive wines). *, ** and *** denote significance at the 10%, 5% and 1% level.

Dependent variable: $r_{i,v}$ = difference in log-price of wine *i* between vintage *v-1* and *v*					
		V (OLS)			**V (2SLS)**
		TWA	**GWS**	**GWS & TWA**	**GWS & TWA**
	Intercept	0.04***	0.04***	0.03***	0.03***
LIVEX $_v$	$R_{Liv\text{-}ex\ 100}$	0.27***	0.31***	0.29***	0.28***
VINT $_v$	ΔQR_v	0.17***	0.13***	0.15***	0.15***
	QR_v = Outstanding?	0.15***	0.15***	0.15***	0.15***
	QR_{v-1} = Outstanding?	-0.1***	-0.13***	-0.11***	-0.11***
ECO $_v$	ΔTerm spread	0.12***	0.13***	0.13***	0.13***
	$R_{USD/EUR}$	1.54***	1.55***	1.59***	1.59***
	$R_{GBP/EUR}$	-1.94***	-1.97***	-1.98***	-1.98***
SCORES $_{i,v}$	$\Delta S_{i,v}$	0.04***	0.06***	0.06***	0.06***
	$SRk_{i,v-1} \times \Delta S_{i,v}$	-0.04***	-0.07***	-0.06***	-0.06***
	$S_{i,v}$ >= threshold	0.08***	-0.01	0.09***	0.09***
	$S_{i,v-1}$ >= threshold	-0.02	0.03	-0.06**	-0.06**
PRICE.LEVELS $_{i,v-1}$	$R_{Liv\text{-}ex\ 100} \times (\Delta QR_v > 0) \times PLev_{v-1}$	1.57***	1.69***	1.59***	1.6***
Observations		916	938	938	938
R-squared		0.84	0.84	0.84	0.84

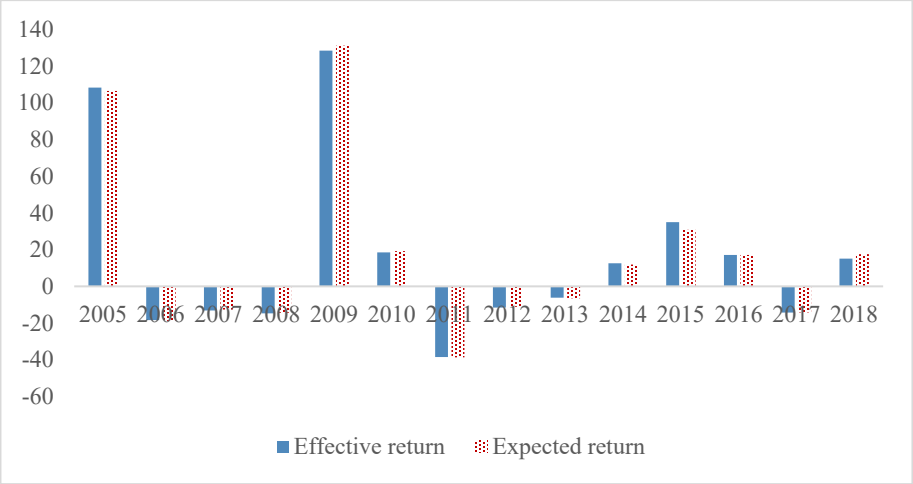
Notes: the threshold is defined as 98.5 for TWA and 97.5 for GWS (to ensure a similar number of observations for the TWA and GWS dummy variables). In the GWS & TWA specification, GWS is used to capture variations in scores and TWA scores are used to identify wines that have been particularly succesful in a given vintage (i.e. whose scores exceed the threshold of 98.5).

Figure 2:

Expected vs effective returns

This figure reports in panel (A) the average realized and expected (according to the model) returns in percentage per vintage. Panel (B) shows a candlestick chart of residuals in percentage for each vintage. The diamond shapes indicate the median value. For readability purposes the lower and upper bars represent the bottom and top 5%.

Panel A: Realized vs effective returns (in percentage)



Panel B: Residuals (in percentage)

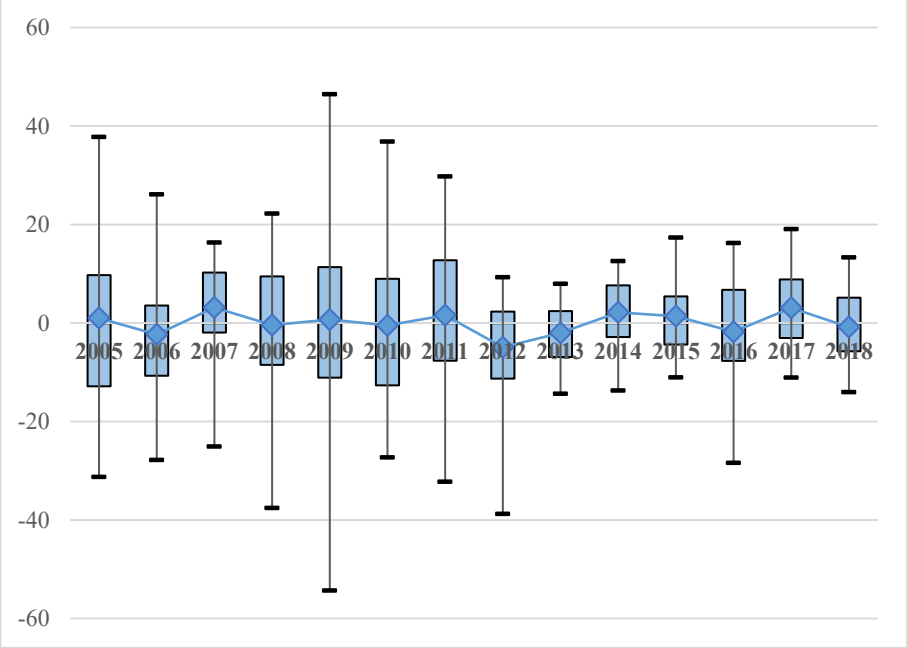


Figure 3:

Relation between mispricing and Cellar Tracker

The figure shows the slope of the relationship between Mispricing (x) and CT (y) estimated in a regression with mispricing variables for each vintage (i.e. the interaction between vintage dummy and Mispricing). The mispricing (x) is defined as the residuals from "Specification V GWS & TWA" (in Table 5). The variable CT (y) is defined as the vintage-by-vintage log-changes in the number of bottles held by the Cellar Tracker Community.

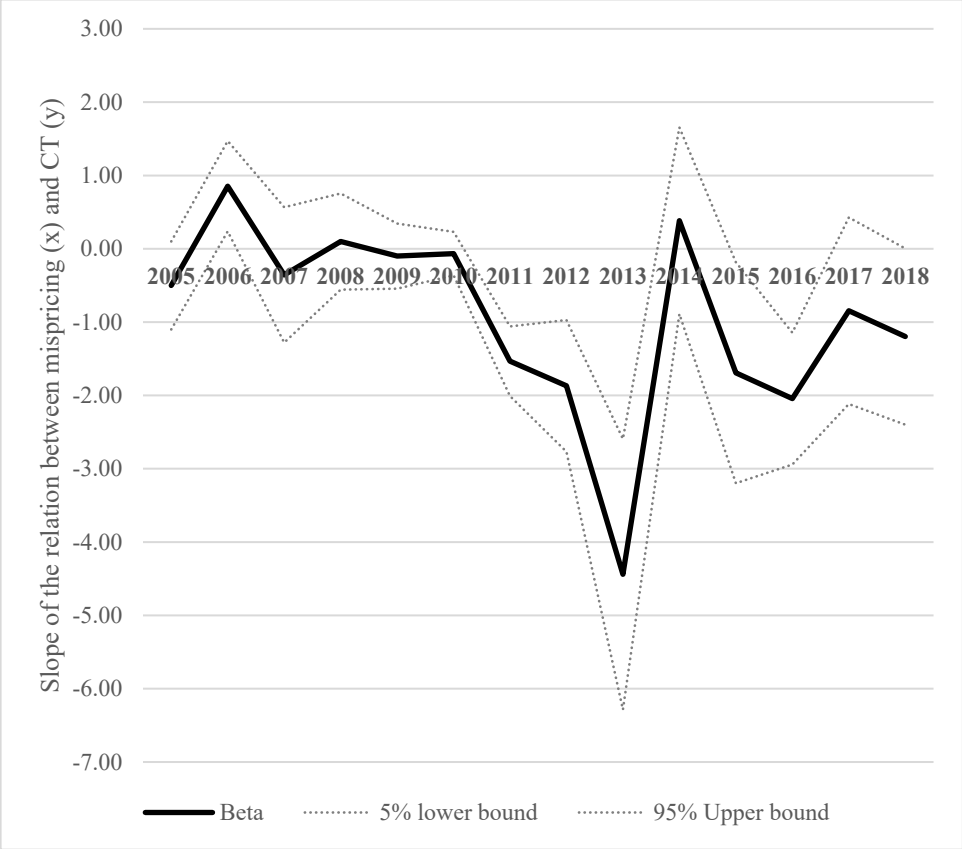


Table 6:

Forecasts, mispricing and purchase decisions

This table reports the results from an out-of-sample analysis. The column "effective" denotes the effective relative release price change for individual châteaux between vintage 2018 and 2019. "Forecasts" and "Forecasts HK" indicate the relative release price change forecasted by the model in this paper and by Hekimoğlu and Kazaz (2020). "Deviations" and "Deviations HK" represent the difference between the forecasted and effective price change. "Relative change CT" shows the log-change in bottles owned by the Cellar Tracker community between 2018 and 2019.

	Relative price change (2019 vs. 2018)					Relative
Wine	**Effective**	**Forecasts**	**Deviations**	**Forecasts HK**	**Deviations HK**	**change CT**
Angélus	-9.2%	-19.1%	9.9%	-4.7%	-4.5%	3.2%
Beychevelle	-12.5%	-12.6%	0.1%	-4.4%	-8.1%	-65.4%
Calon-Ségur	-13.6%	-14.9%	1.2%	0.0%	-13.6%	-41.0%
Carruades de Lafite Rothschild	-20.0%	-11.2%	-8.9%	-6.4%	-13.6%	-5.9%
Clinet	-20.7%	-8.7%	-11.9%	2.1%	-22.8%	96.6%
Clos Fourtet	-20.2%	-10.1%	-10.0%	-3.6%	-16.6%	-30.9%
la Conseillante	-29.5%	-8.3%	-21.2%	-4.1%	-25.4%	104.4%
Cos d'Estournel	-26.5%	-21.7%	-4.8%	-4.2%	-22.3%	11.9%
Ducru-Beaucaillou	-19.7%	1.6%	-21.2%	-4.3%	-15.3%	69.0%
Duhart-Milon-Rothschild	-12.3%	-11.6%	-0.7%	-3.3%	-9.0%	-35.3%
l'Eglise-Clinet	-2.1%	0.0%	-2.1%	-8.8%	6.7%	91.9%
l'Evangile	-27.5%	-13.9%	-13.6%	-13.3%	-14.1%	149.2%
Figeac	-36.7%	0.1%	-36.8%	0.0%	-36.7%	74.5%
Grand-Puy-Lacoste	-23.0%	-9.8%	-13.1%	-0.1%	-22.8%	135.3%
Haut-Bailly	-23.6%	-10.9%	-12.7%	-0.8%	-22.8%	70.3%
Haut-Brion	-36.5%	-8.8%	-27.7%	-0.9%	-35.6%	57.5%
Lafite-Rothschild	-16.6%	-18.0%	1.4%	-4.1%	-12.5%	-13.1%
Léoville-Barton	-17.3%	-10.8%	-6.5%	-7.3%	-10.1%	-9.1%
Léoville-Las-Cases	-25.6%	-21.1%	-4.5%	-3.7%	-21.9%	-48.9%
Léoville-Poyferré	-29.5%	-9.8%	-19.7%	0.0%	-29.5%	84.4%
Lynch Bages	-30.1%	-11.5%	-18.6%	-0.4%	-29.7%	29.3%
Margaux	-19.8%	-5.7%	-14.1%	-3.2%	-16.6%	19.5%
Mouton-Rothschild	-36.5%	-0.5%	-36.0%	-4.2%	-32.3%	61.8%
Pape Clément	-13.7%	-9.7%	-3.9%	2.0%	-15.6%	-26.6%
Pavie	-15.3%	-8.0%	-7.3%	-10.4%	-4.8%	24.1%
le Petit Mouton de Mouton-Rothschild	-18.9%	-11.1%	-7.8%	-0.6%	-18.4%	119.7%
Pichon-Longueville Baron	-18.4%	-0.3%	-18.0%	2.1%	-20.5%	46.7%
Pichon-Longueville Comtesse	-22.2%	-9.4%	-12.7%	-0.1%	-22.1%	27.9%
Troplong-Mondot	-21.1%	-12.2%	-8.9%	-7.6%	-13.6%	77.3%
Average	-21.3%	-9.9%	-11.4%	-3.2%	-18.1%	37.2%
Standard Deviation	8.2%	6.0%	10.7%	3.8%	9.7%	58.4%
Correlation with CT	-0.36	0.40	-0.50	-0.06	-0.29	
Mean Squared Error			0.0241		0.0418	