Initial mispricing of experience goods and subsequent price adjustments: evidence from a status- and reputation-oriented market[*]

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Abstract

Economists have long been puzzled on how best to price goods and services upon their release on the primary market and the occurrence of underpricing. We use data on the market for fine wine to gain a better understanding of these issues and identify situations of both initial under- and overpricing on this market. We observe that fine wine is frequently mispriced and yields stronger price adjustments for overpriced wines. We further show that strategic considerations of producers during the primary market release play a non-negligible role in the initial mispricing of fine wine.

JEL Classification: D45, L11, L21, Q11, Q14

Keywords: mispricing, experience good, status, reputation, fine wine

1 Introduction

Determining the correct price of an asset upon its release on the primary market is of crucial importance for both issuers – who want to maximize the funds collected, and buyers – who do not want to overpay. Unfortunately, assessing the fairness of the initial price is rendered difficult by a number of factors. First, buyers suffer from information asymmetry. As a consequence, they fear to overpay for an asset they do not perfectly understand and for which they can only obtain incomplete information. For sellers, this translates into substantial uncertainty regarding demand and the price at which the newly issued assets should be put on the market. In addition, the success of an offering is not only reflected in its short-term performance but also in its long-term evolution. An attractive release price may help build trust in the issuer and positively influence its reputation on the market, which is beneficial when it goes back on the market at a later stage. Other factors which may affect the release price include strategic considerations (signaling), ownership and control issues (control retention or agency cost reduction) or the institutional environment (legal liabilities, price support or tax regimes).

A vast body of literature examines the pricing of initial offerings in the context of traditional assets such as stocks and bonds. The evidence shows that the various issues discussed above lead to almost systematic underpricing of initial public offerings (see Ljungqvist (2007) for a recent survey/analysis). More recently, literature has started to investigate the situation for more exotic assets such as sports and cultural goods. As for traditional assets, uncertainty plays a substantial role as issuers want to minimize the risk of not selling out while maximizing their profit. Similarly, the willingness to build customer confidence and loyalty in a long-term perspective may result in underpricing. Other aspects nevertheless make the pricing of these assets distinctively more complex than stocks and bonds. First, they do not pay any cash-flow and are thereby highly sensitive to the perceived utility and experience they provide to customers. Second, the markets on which they trade give a predominant role to brokers who are responsible to find final customers. The proximity of brokers to both issuers and customers should reduce information asymmetry and thereby mitigate the underpricing issue. This organization may, however, lead to cases of temporary overpricing as brokers may have to purchase from issuers, even if they consider the price too high, to signal their loyalty. Third, the pervasiveness of considerations related to reputation may result

in both underpricing and overpricing. Attractive pricing may convey a signal of fairness and ultimately lead to goodwill, a good reputation and loyalty from customers therefore offsetting the initial loss in wealth. On the other hand, high prices may convey a signal of scarcity and exclusiveness which boosts the reputation and buzz of an issuer on its market. Finally, the status of the issuer on its market and in respect to its competitors (measured, for instance, by its rank in a particular hierarchy or classification system) may hinder it to fully determine its pricing policy and to adjust it to demand swings in the short-run.[3] Despite all these considerations, it appears that underpricing is no less common for culture and sports goods than for more conventional assets (see Courty (2000) or Krueger (2001)).

In this paper, we examine the pricing of an alternative asset class that has experienced a tremendous development over the last two decades: fine wines. We focus on Bordeaux, which represents around 70% to 80% of the market for fine wine according to the Liv-ex.[4] The primary and secondary markets for Bordeaux wines are organized in a specific way. The primary market is centered around the *en primeur* campaign that runs every year in spring and during which wines from the latest vintage are offered while they are still in barrel.[5] Brokers and *négociants* have a prominent role in this process. They not only provide information about the expected demand to wine producers to help them set an appropriate release price but also sell the wines to merchants. The ageing process then takes an additional 12 to 18 months. Once in bottle, about two years later, the wines are delivered to their owners. For instance, in spring 2015, customers have paid for the wines from the 2014 vintage and will physically obtain them in early 2017. The secondary market is more fragmented and opaque compared to the primary market. Bordeaux wines can indeed be traded through a variety of channels and it is difficult to get information about transaction volumes and prices.[6]

Fine wines offer a unique environment to investigate initial mispricing and its consequences. This asset retains features that are likely to distort prices in a direction which is a priori unclear. Wine prices depend on various factors such as status or individual and collective reputation that interact in a complex fashion and which may result in significant market frictions (Malter 2014). Quality also appears as a crucial determinant of wine prices but is difficult to precisely assess,

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[3] A less frequent issue affecting prices is related to the willingness of an issuer to support the demand for associated products (e.g., merchandising) by maintaining low prices on its flagship product/service.

[4] Liv-ex is widely regarded as the most important source of information about the market for fine wines. The company, founded in 1999, offers a marketplace where producers, merchants, and buyers can trade fine wines. It also provides valuation tools and computes a series of reference indices.

[5] The terminology "wine futures" is often used in the US in place of "*en primeur* wines". Apart from the fact that an upfront payment is required, buying wines *en primeur* is similar to entering into a futures contract (price fixed today for a future delivery).

[6] See Masset and Weiskopf (2013) for a detailed presentation of the primary and secondary markets for fine wines.

especially for young wines. Wine can therefore be considered as an archetypal experience good (Nelson 1970). This explains the influence of wine experts, and in particular of Robert Parker, who play, to some extent, a similar role to rating agencies on traditional markets (see Friberg and Grönqvist (2012), Masset *et al.* (2015)). The various price determinants and the uncertainty surrounding their estimation combined with the very organization of the wine market suggest that mispricing is likely to be common. There is some limited evidence that young wines may be too expensive (Ashenfelter 2008), but a formal and detailed investigation of the initial pricing and its implication on subsequent returns is still lacking. This paper aims at filling this gap, and thereby at improving the understanding of the causes and consequences of mispricing.

We model the prices on the primary market to identify cases of initial mispricing, and then analyze subsequent price adjustments on the secondary market. To do so, we make use of a very exhaustive and comprehensive dataset, containing detailed information on *en primeur* and in-bottle prices and scores for the 106 most important producers from the Bordeaux region over the period 1996-2016. In a first step, we derive a hedonic regression model to assess the influence of economic conditions, status, reputation, and quality on *en primeur* prices. We use this model to identify mispriced wines. We then evaluate the effects of quality, and strategic behavior on the deviations observed between the effective release price and the fundamental value estimated on the basis of the model. In a second step, we compare prices on the primary and secondary market and examine the consequences of an initial mispricing on the returns from an investment in fine wines. Again, we consider the various factors that are at the origin of mispricing and study their relation with subsequent price adjustments.

Our results show that wine prices are fixed in accordance with the vintage quality, the status and collective and individual reputation of a producer and to a lesser extent with expert scores. Findings further indicate that cases of mispricing are common in Bordeaux but their sign and magnitude strongly depend on the appellation and the vintage from which a wine originate. The consequences of mispricing are nevertheless unambiguous: inappropriate initial prices lead to subsequent price adjustments. These adjustments, however, appear stronger for overpriced wines than for underpriced wines and are independent of changes in quality as proxied by Robert Parker scores. We further observe a strategic behavior of producers concerning the timing and release price on the primary market. Late followers appear to have some informational advantage and overprice their wines more than first movers.

This paper proceeds as follows. The next section reviews the literature on mispricing for various types of assets. Sections 3 and 4 present the dataset and the methodology used to study

mispricing on the wine market. Section 5 is devoted to results and their analysis while section 6 concludes.

2 Literature review

The underpricing phenomenon has a longstanding history on different markets and has led academics to study the reasons for the underpricing of goods or securities. Underpricing in the primary market may further influence prices on the secondary market and therefore be a deliberate strategy by an issuer wanting to capture gains at the intersection of these two markets. The occurrence and reasons of underpricing as well as the interplay between primary and secondary markets have been widely researched in the financial, cultural and sports economics literature. While the financial economics literature primarily seeks to model underpricing on stock and bond markets during initial public offerings (IPO), cultural and sports economists have tried to model the underpricing of tickets and the impact of resellers on the secondary market. In the following, we draw from these two fields which both contain characteristics and reasoning which may apply to the wine market.

2.1 Underpricing on financial markets

Asymmetric information is proposed as the main reason for the occurrence of underpricing on financial markets. It is assumed that the parties involved in an IPO process have a divergent access to information. Rock (1986) shows that underpricing counteracts the winner's curse on such markets. For the most attractive IPO informed investors will potentially receive the entire or a large part of the allocation. For less attractive IPO uninformed investors will receive all shares they bid for as informed investors step out of the bidding. Thus to keep uninformed investors in the IPO market and to ensure that on average all shares find buyers companies have to underprice to ensure that all investors enter the market with positive return expectations. Collectively, companies profit from underpricing, as funds of uninformed investors are needed to keep the IPO market running. However, individually, issuers have an incentive to minimize underpricing and to free-ride. Benveniste and Wilhelm (1990) extend Rock's framework to study the effect of bookbuilding procedures on the reduction of information asymmetries. They suggest that revisions in the offer price and the number of shares offered should reflect investor interest and reveal the aggregate nature of their information. Habib and Ljungqvist (2001) further model the point until which it is interesting for a company to fill the informational gap to reduce uncertainty and the underpricing.

Other models, such as Allen and Faulhaber (1989), Grinblatt and Hwang (1989), or Welch (1989) reverse Rock's framework by looking into company- instead of investor behavior. These

models generally result in the following logic. High-quality and low-quality companies which are initially indistinguishable to investors exist in the IPO market. Both groups want to raise funds through an IPO and an SEO at a later stage. High-quality firms have incentives to signal their higher quality, to reduce their cost of equity and raise funds more easily. Low-quality firms have incentives to imitate high-quality firms. If investors can determine the true quality of a company before its IPO, and the probability of getting caught with its ensuing loss in reputation and proceeds is large enough, low-quality firms should refrain from imitating high-quality firms. Thus, companies having more information on their value and future risk may convey a signal of their true value to investors by underpricing their issue. While in the short term this is costly to the company it is beneficial in the longer run if it intends to go back on the markets. While these explanations clarify part of the underpricing puzzle they are not enough to fully describe it. Academics have therefore turned to behavioral economics and psychology to further analyze this phenomenon.

Behavioral explanations have become popular after IPO underpricing strongly increased during the dot com bubble. Behavioral biases of investors may be of interest on IPO markets due to the low information and relatively limited track-record of most companies going public. This leads investors to build up different priors, expectations and behaviors. Welch (1992) looks into information cascading when investors can chose to join the IPO process at different moments of time. In this case bids by late investors may be build and shaped on bids by early investors. This framework leads to two outcomes. Successful initial bids will induce a positive snowball effect, while unsuccessful bids will remain meager throughout the entire process. Accordingly, early investors will want some underpricing as a compensation for being first-movers and triggering the snowballing effect. Other authors have tried to model IPO underpricing as a function of investor sentiment. Ljungqvist *et al.* (2006), for example, propose a model in which regular and sentiment investors are present on the market. In a hot market regular investors will sell their stock to sentiment investors once the company has gone public. However, as sentiment investors may quickly disappear, regular investors will ask for underpriced stocks as they face the risk of being stuck with the stock in a market cooling down. Combining prospect theory (Thaler 1980, 1985) with the notion of mental accounting, Loughran and Ritter (2002) offer a third explanation of IPO underpricing related to investor behavior. They document that issuing companies are not upset about leaving money on the table as the funds collected may already be higher than initially anticipated before the IPO process. Thus while these companies will be unhappy to leave some money on the table, they will be happy to discover that they are wealthier than expected. Combining both the loss and the gain, makes them happy victims.

2.2 Underpricing on the culture and sports market

Economists have also tried to understand the underpricing phenomenon which is present on the market for concert and sports tickets. Happel and Jennings (2010) put several economic and psychological arguments forward to describe the occurrence of rationing and underpricing on these two markets.

From an economic perspective, the uncertainty surrounding concert demand is the main reason for underpricing as prices have to be set before knowing many of the variables influencing demand. Even for popular artists and sports teams it is difficult to exactly evaluate the number of fans willing to attend an event or a series of events in a given city. Furthermore it is nearly impossible to lower ticket prices once put on sale without alienating early buyers. Uncertainty, however, cannot explain why some artists and sports events systematically sell out within minutes of tickets being put on the market. Swofford (1999) thus looks at both the maximization of profits from an artist and reseller perspective and argues that ticket underpricing on the primary market occurs for multiple reasons. Promoters not only face uncertainty over ticket demand, but are also risk averse, face scalpers with lower operational costs and are more fixated on long-term revenues than short term profits.

There is, however, a logical business explanation for underpricing linked to risk transfer between agents. At lower prices tickets sell out to resellers who obtain profits from offering tickets at prices reflecting real demand. In the event of shifting demand it is no longer the artist or sports team but the secondary market which carries the risk of an event not selling out (Geloso 2014). Advance purchases by the secondary market further provide early money collection and leaves resellers with the cancellation risk of an event. Resellers also insulate sports teams from low ticket sales in off years as resellers may need to invest in season tickets regardless of the team's performance. They will need to buy tickets in years when the team underperforms to profit from significant returns when the team outperforms.

Artists also care about their reputation. Half-empty concert or sports halls may divulge negative information about the event which damages reputation and future capacity to sell tickets and ancillary items. Thus, if fans systematically abandon performers not selling out, it may be rational to underprice tickets to avoid negative information spillovers. These social externalities show that the demand for an event by a consumer will depend on the demand (Becker 1991) or characteristics of other consumers (De Serpa & Faith 1996).

A final reason for underpricing in the primary market is due to the active presence of primary sellers operating anonymously in the secondary market. If underpricing has to be conducted due

to economic or psychological reasons primary sellers are trapped with lower revenues. These can be partly compensated if primary sellers participate in the secondary market and profit from real-demand pricing without enduring the consumer heat for overpricing on the primary market.

A second group of explanations is grounded in the psychology and social component of fans and its influence on pricing and market structure. As Walker (2011) points out "what appears as underpricing of tickets in a basic supply and demand model is in fact a profit maximization behavior once consumer psychology is taken into account".

Social constraints and fairness explain why artists cannot easily react to positive demand shocks justifying underpricing (see Kahneman *et al.* (1986) and Roth (2007)). In order to build loyalty from a large fan base (who will attend events in the future and buy ancillary items), the performer wants to avoid overcharging and consequently sets prices below the profit maximizing level. To build long-run popularity, the artist provides fans with a larger share of consumer surplus than would be the case if the performer was to maximize short-run profit. If, however, scalpers capture some of the surplus both performers and customers lose out. The artist could in this case increase ticket prices to reduce the surplus for scalpers but will refrain to do so to maintain an image of well-treating fans. Artists violating these fairness norms may face lower demand in the future or trigger consumer boycotts (Courty & Pagliero 2010). Gielissen *et al.* (2008) suggest some dimensions regarding price and fairness. Among others, customers work with reference prices, are willing to pay according to a cost-plus pricing technique, or pay more if a social goal or poor counterparty is present.

Becker (1991) and Happel and Jennings (1989) propose another behavioral argument. A buzz related with rationing may produce an impression of scarcity driving fear of exclusion. The existence of scalpers becomes a visual representation of this phenomenon. Artists hence have to find a balance between too underpriced tickets destroying the scarcity and buzz of an event and setting it too high leading to empty seats or media criticism. Artists may gain in the long run from creating such psychological pressure as consumers want to be among the happy few with tickets.

There is little doubt to the presence of performers underpricing and selling out their events. Consumers have to queue, tickets sell out in less than an hour and are subsequently offered on the secondary market at inflated prices. This suggests that some artists effectively leave surplus to consumers or resellers. The fact that scalpers make large profits is consistent with the underpricing hypothesis. But there are also arguments against systematic underpricing. Courty (2003) argues that artists may not be able to capture the profits made by scalpers and departs from the classic underpricing explanation for customers with time-varying preferences. In his model "diehard fans"

secure their tickets early, while "busy professionals," display a higher willingness to pay but cannot commit in advance. Ticket resellers cater to these busy professionals and consequently reallocate tickets to this group as the show approaches. Depken (2007) extends the model by Courty (2003), by adding a third group: speculators. He suggests that from a theoretical perspective scalping can raise, lower, or have no effect on prices on the primary market, depending on the buyers' reservation prices for seats.

The debate on underpricing is still open due to the challenge of proving that artists charge prices that are effectively lower than the profit maximizing prices (Connolly & Krueger 2006) but the reasons having put forward above explain a large part of the puzzle concerning underpricing and economic agents leaving money on the table.

3 Data

3.1 Sample

The dataset contains price information for a representative sample of 106 wines from Bordeaux.[7] These wines represent more than 80% of the trading activity on the Liv-ex trading platform. We have information on both primary and secondary market prices over the period January 1996 to June 2016. The so-called *en primeur* market can be considered as the primary market where new wines are released. In Bordeaux, Châteaux usually do not sell their wines directly to final customers. They sell them to *négociants* (known as the wine trade in English), which then sells them to wine merchants from all over the world which eventually sell the wines to final customers. *Négoce* prices are the prices at which the wines are sold by the *négociants* to wine merchants. Customer prices reflect the prices at which customers can purchase fine wines once the merchants have taken a margin, ranging between 15% and 20%, depending on the demand for each specific wine. We have compiled a comprehensive set of release prices on the primary market (one observation per wine and per vintage).[8] To track the value of those wines on the secondary market, we have gathered hammer prices from two major Chicago-based auction houses, The Chicago Wine Company (TCWC) and Hart Davis Hart (HDH).

We have also hand-collected *en primeur* and *in-bottle* (i.e. final) scores of Robert Parker for all wines and vintages included in the analysis. Every March, R. Parker tastes (i) barrel samples of wines from the latest vintage (these wines are still in their maturing process and not yet finished) and (ii) recently bottled wines from the latest physically available vintage. His scores are published

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[7] The complete list can be found in the appendix.
[8] We are particularly grateful to Bertand Le Guern, Vogel Vins and Alain Bradfer who have kindly accepted to share with us their data on *en primeur* prices.

at the end of April. For instance, in March 2013, R. Parker has tasted wines from vintages 2012 *(en primeur)* and 2010 (in-bottle). As a benchmark, we also collect the scores of Neal Martin and Wine Spectator for the same producers and vintages.[9] R. Parker, N. Martin and Wine Spectator use a comparable rating system: the scale goes from 50 to 100 points; scores of in-bottle wines are given by a single number (e.g. 93), while scores of *en primeur* wines are expressed using an interval (e.g. 92-94) to reflect the uncertainty about the quality of the final product.

3.2 Preliminary regressions

In order to get an estimate of the overall quality level of vintage v (Q_v), and the surprise-in-quality of wine i in vintage v ($E_{i,v}$), we run a series of auxiliary regressions in which we use Robert Parker scores as a proxy for the unknown quality of the various wines. The choice to rely on Parker scores is grounded on two reasons. First, he is regarded as the most knowledgeable and influential wine expert in the world.[10] Second, he is the only expert to have tasted all wines from our sample both before their release on the primary market and just before their trading starts on the secondary market. The regression takes the form

$$Score_{i,v\prime} = \theta_0 + \sum_{v\prime=1}^{V\prime} \theta_{v\prime} V_{v\prime} + \sum_{i\prime=1}^{N} \omega_{i\prime} C_{i\prime} + e_{i,v\prime} \tag{1}$$

Where $Score_{i,v\prime}$ corresponds to the *en primeur* score of wine i from vintage $v\prime$. $V_{v\prime}$ and $C_{i\prime}$ are dummy variables taking the value 1 for a wine from vintage $v\prime$ and produced by Château $i\prime$. The coefficients $\theta_{v\prime}$ and $\omega_{i\prime}$ attached to these variables thus capture the quality of a particular wine. This regression is estimated on the basis of the scores from the last 10 vintages traded on the secondary market. We thus have $v\prime = v$-12, ... , $v - 3$, as there is a gap of three years between the harvest and the moment at which a wine starts being traded on the secondary market. The coefficients $\widehat{\omega_{i\prime}}$ are subsequently used to determine the overall quality level of vintage v (Q_v) and estimate the surprise-in-quality of wine i for the same vintage ($E_{i,v}$):

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[9] Data comes from www.erobertparker.com and www.winespectator.com. For vintages 2013 to 2015 we only have *en primeur* scores. For the other vintages, we have *en primeur* and in-bottle scores.
[10] Several papers have examined his influence on wine prices. See for example Jones and Storchmann (2001), Dubois and Nauges (2010), Masset *et al.* (2015) or Cardebat *et al.* (2014).

$$\widehat{Q_v} = \frac{1}{N}\sum_{i=1}^{N}\left(Score_{i,v} - \hat{\theta}_0 - \widehat{\omega_{i'}}\right) \tag{2a}$$

$$\widehat{E_{i,v}} = Score_{i,v} - \widehat{Q_v} - \hat{\theta}_0 - \widehat{\omega_{i'}} \tag{2b}$$

To estimate wine i's current level of individual reputation and the expected return between the release on the primary market and the trading on the secondary market, we resort to a second auxiliary regression:

$$\ln(P'_{i,v'}) = \alpha_0 + \alpha_1 Q_{v'} + \alpha_2 A_{i,v'} + \sum_{i'=1}^{N} \vartheta_{i'} C_{i'} + \epsilon_{i,v'} \tag{3}$$

Where $P'_{i,v'}$ is the secondary market price of wine i from vintage v'. As for equation [2a], we estimate this regression using the last 10 vintages available on the market. $A_{i,v'}$ is the age of the wine at the time it is traded. The coefficient $\widehat{\alpha_2}$ thus provides an estimate of the annual real rate of return to storing wine, i.e. R_t in equation [4]. In order to determine the current individual reputation of each wine, we follow an approach similar to the one used to construct the original Bordeaux classification. Back in 1855, brokers ranked the wines on the basis of their prices on the secondary market: the four most expensive were classified as first growth, the next 12 as second growth, etc. We infer an updated classification on the basis of the coefficients $\widehat{\vartheta_{i'}}$ and use it as a proxy for the current individual reputation of each wine.

3.3   Descriptive statistics

Table and Figure 1 both provide descriptive statistics on scores and prices per vintage on the primary and secondary market.

[Insert Table & Figure 1 about here]

Results indicate that wine quality varies across vintages but remains very much in line with the opinion of wine market participants and throughout the different measures used (adjusted quality, *en primeur* and in-bottle scores). The best vintages upon their release on the primary market are 2010, 2009, 2015, 2005 and 2000, while 1997 and 2013 are considered the weakest. It is further

noticeable that release prices on the primary market are correlated with quality. The better the vintage quality the higher release prices are on average. This phenomenon and its variation from one vintage to another has however become more accentuated over the last 10 years of the sample. This can be explained by the increasing popularity for wine since the mid-2000 and the appearance of new customer segments which nearly exclusively purchase the best vintages and tend to neglect the weaker ones (see Masset *et al.* (forthcoming)). This is further evidenced by the evolution of the overall wine market proxied by the Liv-ex index which became more erratic and strongly increased over the same time period. It has shown a steady increase between 1995 and 2005 when it really took off strongly until 2007. This was followed by a decline due to the financial crisis in 2008 and a fast and strong recovery in 2009 and 2010. Since then the market has further cooled off and on average lost around 30% in value.

Market prices of previous vintages thus may have had an influence on release prices through an informational loop pushing producers to better "mark to market" their releases to profit from the increase in demand and popularity for wine. Alternatively, higher release prices may have pushed market prices up as an alignment effect between vintages took place. Finally, this led to a negative correlation between release prices and some vintages selling, on average, at lower prices on the secondary market as upon their initial release. While many vintages do witness a price increase it is the best vintages (2005, 2009, 2010) that tend to perform relatively poorly. This is due to those wines being issued on the market at already high prices, especially in comparison to other vintages which may already be drinkable and of similar quality.

[Insert Table 2 about here]

Table 2 looks at the same variables for each respective wine in the sample. The reputation of the different wines calculated based on equation [3] appears to remain relatively stable through time as changes remain rather contained and switches occur from one category to a contiguous one. The only exception is for Pomerol for which an official classification does not exist. Here some wines such as Clos l'Eglise or Hosanna have seen a sharp increase in reputation over the sample period. The lack of official classification appears to simplify price movements for single chateaux due to a less prominent anchoring effect to a specific status which exists in other appellations.

While the official classification on the left bank remains an anchor in terms of reputation which is difficult to completely neglect some producers nevertheless are positioned higher today

than in 1855. This is especially the case for wines which are commonly named *super seconds* meaning that they officially belong to a lower category but are generally considered as just under par with the five 1GCC in today's terms. These, for example, include Palmer or Lynch Bages. The reputation of the very best wines, however, (1GCC on the left bank, 1GCCA in St. Emilion and those commonly considered the best in Pomerol) remain the most reputable in our ranking.

Turning to the median scores it appears that wines with the best reputation and highest prices on average have the best scores. It is especially the 1GCC and the *super seconds* on the left bank and the 1GCC A on the right bank which achieve the highest scores. This is complemented with unclassified wines from Pomerol (Le Pin, Lafleur, Petrus) which are widely considered as the best producers in this appellation. Scores between *en primeur* and in-bottle tastings change but in most cases these changes remain small. 20 median scores do not change at all while another 31 vary by no more than 0.5 points. Overall, 44 scores see decreases, 42 increases and 20 remain unaltered between the *en primeur* and in-bottle tasting

Considering median prices we observe that 1GCC and Pomerol wines are released at the highest prices which is in line with their reputation and quality while unranked or lower ranked wines are on average the cheapest. On the secondary market those wines with the highest price levels on the *en primeur* market tend to remain the priciest. However, their price evolution is not uniform and it is not necessarily the priciest wines which display the strongest price changes. Generally, left bank wines appear to trigger the highest price changes and here it is especially 3GCC performing the best. We further note that only one wine (Lafleur) displays a lower market price on average than upon release. All others have seen increases with 51 wine prices more than doubling in value. The highest increase comes from Carruades de Lafite which has strongly gained by the association to and high price of Lafite Rothschild in the second half of the sample period.

4 Methodology

4.1 Modeling prices on the primary market

We model wine prices on the primary market within a hedonic regression framework. The functional form of our model is the following:

$$\ln(P_{i,v}) = \beta_0 + \sum_{m=1}^{M=5} \beta_m Q_{v,m} + \beta_6 \ln(M_t) + \beta_7 D_t + \sum_{j=1}^{J=5} \gamma_j S_{i,j,t} + \sum_{k=1}^{K=9} \gamma_{5+k} CR_{i,k} + \sum_{l=1}^{L=5} \gamma_{14+l} IR_{i,l,t} + \gamma_{20} R_{i,v} + \varepsilon_{i,v} \quad [4]$$

Where $P_{i,v}$ is the price of wine i ($i = 1, \ldots, 106$) from vintage v ($v = 1995, \ldots, 2015$) when it is released on the primary market in the spring of year t ($t = 1996, \ldots, 2016$). With the one-year gap between the harvest and the sale of vintage v, we obtain $t = v + 1$. Our model consists of two parts, which respectively aim at capturing the average price level at which wines from vintage v are sold on the primary market, and the price premium (or discount) attached to each particular wine i in vintage v.

The first part controls for general characteristics with Q_v relating to the overall quality level of vintage v, while M_t and D_t control for market conditions prevailing when it is released on the market. The second part captures the influence of wine-specific attributes. Variables $S_{i,t}$, CR_i, $IR_{i,t}$ and $R_{i,v}$ control for the effect of wine i's status, its collective- and individual reputation, and its quality rating on its price. We hereafter give more details on these variables and their estimation:

- **Market conditions:** we consider two related variables to account for wine market dynamics. We first use a wine market index to track the overall price level of fine wines (M_t). To this avail, we resort to the Liv-ex 100 Index and use its value just before the last vintage is released on the primary market. This index is widely considered as the reference benchmark for the wine market.[11] There is a gap of close to two years between the moment a wine is sold on the primary market and its physical delivery. A rational economic agent would thus expect the price on the primary market to be lower than the price at which a wine will eventually trade once it arrives on the secondary market. We estimate this discount at the beginning of each year by running equation [3] and add it to the model (D_t).

- **Status:** literature commonly measures a wine producer's status through its ranking in an official classification (Malter 2014). In Bordeaux, two classification systems coexist. For the wines from the Médoc region (the "left bank" of the Gironde), the 1855 classification is regarded as the ultimate reference. It ranks all producers from 1st to 5th Growth. On the "right bank", only the appellation of St-Emilion has an official classification but, contrary to its 1855 counterpart, it is regularly reviewed in order to reflect the current level of quality achieved by the various producers. We model the status of the various wines using a set of dummy variables ($S_{i,t}$). We time-index this variable as the classification can be revised and thus the status of a wine change.[12]

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[11] Reuters calls it the "fine wine industry's leading benchmark".

[12] Over the last 50 years, the 1855 classification has experienced only one change with the upgrade of Château Mouton Rothschild from 2nd to 1st Growth in 1972. In Saint-Emilion, however, both Angélus and Pavie have been upgraded from 1st Growth B to 1st Growth A status in 2012.

- **Reputation:** following existing literature (see, e.g., Landon and Smith (1997) or Ali and Nauges (2007)), we use a set of dummy variables (CR_i) that refer to the "Appellation d'Origine Controlée" (AOC, controlled designation of origin in English) from which a wine originates to account for collective reputation effects. A Château cannot move from one appellation to another and thus CR_i is time-invariant. In order to estimate the current individual reputation of a wine, we follow the same approach as the one used in 1855 to design the eponymous classification system: at the beginning of each year, we rank the wines into five reputation tiers according to the prices at which they trade on the secondary market using equation [3]. We subsequently use this five-tier classification to construct a set of dummy variables ($IR_{i,t}$). This approach rests on the assumption that differences in individual reputation should be reflected in market prices and is consistent with common practice in the wine industry.[13]

- **Quality:** the wine economics literature relies on expert ratings to proxy for unobservable quality (see, e.g., Ali *et al.* (2008) or Dubois and Nauges (2010)). We follow a similar path and use a panel of wine experts to determine if a vintage is deemed as weak, average, good, excellent or great.[14] This ranking leads to the construction of a set of five dummy variables (Q_v). In order to estimate the quality achieved by a particular wine, we rely on the scores delivered by Robert Parker Jr., who is widely regarded as the most influential expert in the world (Masset *et al.* 2015). A substantial part of a wine's quality and score can be explained by factors such as the overall quality of a vintage, natural endowments (the so-called *terroir*) and winemaking techniques that are related to the status and reputation of a wine. As variables related to these dimensions are already included in the model and in order to avoid multicollinearity problems, we use a measure of surprise-in-score ($R_{i,v}$) instead of the original Parker score (see Cardebat and Paroissien (2015) or Masset *et al.* (2015)). This variable captures the difference between the effective level of quality achieved by a particular wine compared to what may be expected on the basis of its *pedigree* using the specifications found in equation [2b].

4.2 Modelling returns between the primary and the secondary market

In order to examine the difference between the initial prices on the primary market and subsequent prices on the secondary market, we calculate returns as

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[13] For instance, the terminology "super seconds" is very frequently used to refer to the most expensive non-1st Growth wines. Château Cos d'Estournel (officially a 2nd Growth) but also Palmer (3rd Growth), Lynch-Bages (5th Growth) and Trotanoy (not classified) are often considered to belong to this non-official category.

[14] As a robustness test, we replace expert opinion by weather data to control for quality. This later approach is similar to the one used by Ashenfelter (2008) to model wine prices at auctions.

$$r_{i,v}(t) = \frac{P'_{i,v}(t)}{P_{i,v}} - 1 \qquad\qquad [5]$$

Where $r_{i,v}(t)$ is the return of wine i from vintage v measured at date t. $P'_{i,v}(t)$ is the secondary market price of wine i from vintage v and $P_{i,v}$ the primary market price of wine i from vintage v.

5 Results

5.1 Wine prices

We first examine the different determinants of wine prices as exposed in equation [4]. This initial stage is useful to better understand the drivers of wine prices in general but is also crucial to estimate the mispricing of wine in the later stages. Our different specifications appear to describe the wine prices well with most R2 situated above 0.8.

[Insert Table 3 about here]

We find that the evolution of the overall wine market as proxied by the Liv-ex has an influence on release prices. This interplay between the primary and secondary market is expected as better market conditions and interest in wine allows producers to raise their price level to tap into this increased demand. On the opposite, high *en primeur* prices may have driven prices of anterior vintages on the secondary market. We further indicate a negative relation between wine prices and expected return. The initially highest priced wines will have relatively more difficulties to increase in price than those which can be considered bargains or which start at more affordable price levels.

In line with previous literature, we also observe that the status of a wine as proxied by its classification has an influence on prices due to a collective reputation effect which allows higher classified wines to sell at higher prices than lower ranked wines. This is especially visible for the 1GCC and 1GCCA wines which are at the top of their respective classification. Interestingly, second wines by a given producer appear to strongly profit from the reputation and branding power of their first wine counterparts. These results are confirmed by our own reputation categories. We further find a positive effect of Robert Parker on wine prices which is, however, limited as compared to other variables such as the collective or individual reputation of a producer. On average, a one point surprise in score by Robert Parker has a 1.7% price impact on wines. We

further show evidence that right bank wines go for higher prices as witnessed by the high coefficients for Pomerol and St. Emilion wines. This can partially be explained by the lack of a rigorous and historically fixed classification system on the right bank and the relatively smaller size of wineries in these two appellations which drives scarcity as compared to the left bank.

5.2 Mispricing and returns

On the primary market, châteaux sell their wines to *négociants*, who then sell them on to wine merchants. When it comes to renowned Châteaux, *négociants* have a very strong incentive to buy their wines, whatever the price, in order to secure future allocations. This means that the selling price, set by the Châteaux, can substantially deviate from an equilibrium price. Châteaux indeed determine the *en primeur* prices on the basis of a variety of elements: they not only take into account wine intrinsic quality and economic conditions but also the quantity produced and strategic considerations. For instance, in 2012, many Châteaux have decided to only slightly decrease their prices due to a small harvest and not because of quality. Some Châteaux have even decided to increase their prices in order to reinforce their status. This is the case of Pavie and Angélus in St-Emilion, who have increased their prices by 58% and 30% respectively. This decision has more to do with reputation building than with quality or Parker scores. In the short-run, renowned Châteaux can thus sell their wines in such a way that their prices deviate from their equilibrium. Over the long-run, however, there are the other market players (*négociants*, merchants, customers and investors) who will drive the prices. Of course, if a vintage is initially much too expensive, it will take time before prices converge towards their equilibrium levels.[15]

In Table 4 we look into the mispricing of fine wine from Bordeaux. To perform the different specifications we use the residuals of equation [4] to identify possibly mispriced wines and analyze the returns on the secondary market. We further include different variables related to age, status, reputation, and "mispricing" of a wine yielding a satisfactory explanatory power with an R2 of more than 0.55.

[Insert Table 4 about here]

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[15] For instance, 1997 has long been considered as grossly overpriced. This vintage arrived just after two very good vintages and in a context of rising prices. Although quality was average, châteaux nevertheless decided to sell their wines at very high prices as quantities were relatively small. As a consequence, most wines have seen their prices either stagnating or even declining over more than 10 years.

Specification 1 gives us a first insight into the return and characteristics of fine wines. According to our model wine prices increase by around 3.8% a year as evidenced by the age coefficient. We further observe that it is especially the best wines such as the 1GCC of the left bank and the 1GCC A which yielded the highest returns. Lower ranked wines were performing rather poorly as they were put at too high prices on the wine market. The exception are second wines of prestigious estates which yielded excellent returns due to a spillover effect of the brand of their famous first wine counterparts. Considering appellations we observe that wines from the right bank and Pessac Léognan have rather poorly performed with negative returns and thus some indication of initial overpricing. Finally the individual reputation of wines appears to have a limited impact on returns.

Looking into the mispricing in specifications 3 and 4 we find evidence of a negative relationship between the residuals of equation [4] and wine returns. This clearly indicates that the higher the overpricing of wines was on the primary market, the lower the subsequent return on the secondary market has been. Inversely, wines which were underpriced by the producer on the *en primeur* led to a subsequent positive return. Columns 3b and 3c examine if the impact of an over- or underpricing shows a similar influence on subsequent returns. It appears that initial overpricing leads to a stronger readjustment of prices than an initial underpricing though both show a significant impact. Finally, columns 4a to 4c show that wine returns are due to a true mispricing on and not due to a change in quality as proxied by the change in Parker scores.

5.3 Parker score revisions

Robert Parker Jr. revises his scores when he considers that he has been too optimistic or pessimistic about a wine's quality. Such revisions can have an important impact on market prices. For instance, in 2012, Parker released his final scores for the 2009 vintage and quite a few wines saw their scores being substantially altered compared to the ones they initially got during the *en primeur* tastings. In particular, Smith Haut-Lafitte and Clos Fourtet were both awarded a perfect score of 100 points. In just one day, these two wines saw their prices almost doubling.

One may however wonder if these spectacular examples can be generalized to all Bordeaux wines or if they merely have to be considered as exceptions. Players in the wine market would most probably support the first viewpoint. Notably, Farr Vintners, a major English merchant, always provides estimated prices for *en primeur* wines to their customers and explains that "estimated prices are liable to change at the end of April when the all-important Robert Parker scores are released because, as we all know, a good or bad Parker score makes a significant difference to the price and

demand".[16] However academics would probably disagree (see the discussion in the literature review).

Specifications 4a to 4c use Parker scores. It becomes visible that Robert Parker has an impact on wine returns. Using the surprise in score measure introduced under equation [2b] or the absolute difference between final and *en primeur* scores it becomes visible that overall Parker has a positive impact on wine returns. A one point revision of his scores leads on average to a significant price increase of around 2.2%.

5.4   Role of strategical behavior on mispricing

The release of wine on the primary market by producers is not performed on a fixed date but gradually over a period of time between April and June of a given year. This has strong implications on the strategical behavior producers may adopt concerning the timing and the pricing of their release. The earlier a producer releases the more money is still available on the market to invest. Moreover, less comparison points with other producers are available and any future shock to the wine market and in the economy in general has less impact. This may constitute an advantage to early movers. On the other hand, late movers can build on customers having more information about the state of the market and the price hierarchy of a given vintage. This may allow them to adapt prices to respond to customer feedback which early movers cannot incorporate without alienating early buyers if prices have to be adjusted downwards. It is a priori not clear which of the two strategies is more favorable.

[Insert Figure 2 about here]

Figure 2 has a look into these considerations during the *en primeur* campaign for vintage 2015. The horizontal axis tracks time over the *en primeur* campaign while the left axis looks into the price change as compared to vintage 2014 and the right axis into the mispricing of wines for vintage 2015. It is observable that wine prices for vintage 2015 are higher than for 2014 which can be explained by a generally higher quality level of the former over the latter vintage. However, the price variation is not uniform across time. It appears that late movers (June 2016) were able to raise their prices much more as compared to the previous campaign than early movers (April 2016). The reason for this is linked to the gap which is visible on the graph over the two last weeks of May 2016. During this period the largest wine and spirits exhibition in the world (Vinexpo) took place

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[16] Source: http://www.farrvintners.com/en_primeur.php (retrieved on June, 1, 2013).

in Hong Kong. This gathering of all major market participants allowed for an important exchange of opinions on the wine market and the latest vintage which allowed producers to gain valuable insights on the perceived quality and pricing of the vintage from customers. These did not seem too critical about the price increases of the producers which had already released their wines and saw the vintage as fairly- to underpriced in relation with quality and wines available on the secondary market. The late movers, consequently, used this information to increase their prices even more.

The trend in the mispricing of wines during the *en primeur* campaign displays a similar trend than for release prices. Orange circles denote negatively mispriced or underpriced wines while red circles denote overpriced wines. It appears that wines released before Vinexpo were mainly underpriced and thus represent good value for money and may generate future returns when prices converge to their equilibrium levels. After Vinexpo the situation is somewhat reversed. Some released wines remained underpriced however many producers increased their prices excessively and thus are overpriced as compared to the fair value of our model.

6 Conclusion

This article analysis the market for Bordeaux fine wine and more specifically its mispricing. The long tradition of Bordeaux wine producers to sell their wines on the market while still in barrels allows for an interesting setting. The long period between the initial price and the effective release on the market some 18 months later and the effect of the current price on previous vintages induces a lot of uncertainty amongst producers which must therefore find an equilibrium to not only maximize their profits but also make sure that most of the harvest is sold. It therefore lets us understand how Bordeaux wine producers price their wines under great uncertainty and how much money they leave on the table in doing so.

Our results show that wine prices are fixed in accordance with the vintage quality, the status and collective and individual reputation of a producer and to a lesser extent with expert scores. Findings further indicate that cases of mispricing are common in Bordeaux but their sign and magnitude strongly depend on the appellation and the vintage from which a wine originate. The consequences of mispricing are nevertheless unambiguous: inappropriate initial prices lead to subsequent price adjustments. These adjustments, however, appear stronger for overpriced wines than for underpriced wines and are independent of changes in quality as proxied by Robert Parker scores. We further observe a strategic behavior of producers concerning the timing and release price on the primary market. Late followers appear to have some informational advantage and overprice their wines more than first movers.

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8 Tables and figures

Table 1: Information and descriptive statistics per vintage

Vintage	General information			Primary market		Secondary market		
	Adjusted quality	Liv-ex Index	Expected return	Median score	Median price	Median score	Median price (on release)	Median price (Q1-2016)
1995	5.1	100.0	1.7%	89 (95)	16.3 (86)	90 (89)	58 (82)	79.2 (106)
1996	3.8	161.7	4.0%	89.3 (84)	24.6 (90)	89 (87)	59.1 (87)	84.3 (106)
1997	0.9	164.4	2.2%	87.5 (98)	29.9 (92)	87 (94)	45.5 (89)	57.8 (106)
1998	1.4	148.6	2.9%	89 (91)	29.3 (92)	90 (99)	63.2 (86)	82.2 (106)
1999	1.1	155.2	6.4%	88 (92)	28.1 (94)	89 (100)	49 (88)	74.3 (106)
2000	7.1	154.3	4.5%	91.5 (99)	37.2 (94)	92 (103)	80.7 (94)	108.5 (106)
2001	2.0	164.3	5.5%	89 (98)	32 (98)	90 (105)	45.6 (95)	68.1 (106)
2002	3.6	171.9	1.7%	90 (93)	25.1 (92)	89 (99)	39.3 (94)	57.6 (106)
2003	1.2	206.5	4.4%	90.5 (102)	32 (101)	90 (104)	67.6 (94)	78.8 (106)
2004	5.1	211.3	-0.1%	92 (42)	26 (106)	90 (83)	39.9 (92)	52 (106)
2005	7.3	236.6	1.3%	93 (94)	51.5 (106)	93 (105)	123.8 (92)	102.2 (106)
2006	4.9	396.4	-1.0%	92.5 (85)	43.2 (106)	92 (101)	58.1 (102)	67 (106)
2007	2.9	521.4	0.7%	90 (99)	38.1 (106)	90 (85)	42.8 (98)	39.8 (106)
2008	4.2	321.6	0.1%	93 (101)	35.3 (106)	92 (105)	82.2 (97)	67.4 (106)
2009	7.5	445.5	-1.2%	95 (101)	67.8 (106)	95 (104)	167 (89)	106.6 (105)
2010	9.3	644.2	2.3%	94 (104)	81.3 (106)	95 (104)	119.9 (97)	109.5 (104)
2011	4.0	540.4	1.7%	91.5 (104)	56 (106)	91 (105)	68 (94)	63 (101)
2012	1.4	492.6	-0.4%	91.5 (103)	48.2 (102)	93 (103)	67.9 (94)	67.9 (94)
2013	-0.4	493.5	0.4%	89 (95)	45.8 (96)			
2014	6.7	424.1	0.7%	92 (102)	51.7 (100)			
2015	7.5	427.9	0.5%	95 (102)	64.3 (100)			

This table reports descriptive statistics on the median Robert Parker score and price for each vintage between 1995 and 2015. It also reports the adjusted quality (estimated on the basis of equation [4a]) and the yearly expected return on release of each vintage on the primary market (estimated on the basis of equation [5]). The Liv-ex Investable index has been standardized to a value of 100.00 in 1996 (i.e., when the 1995 vintage has been released on the primary market). The number of observations used to calculate the various statistics is reported in brackets.

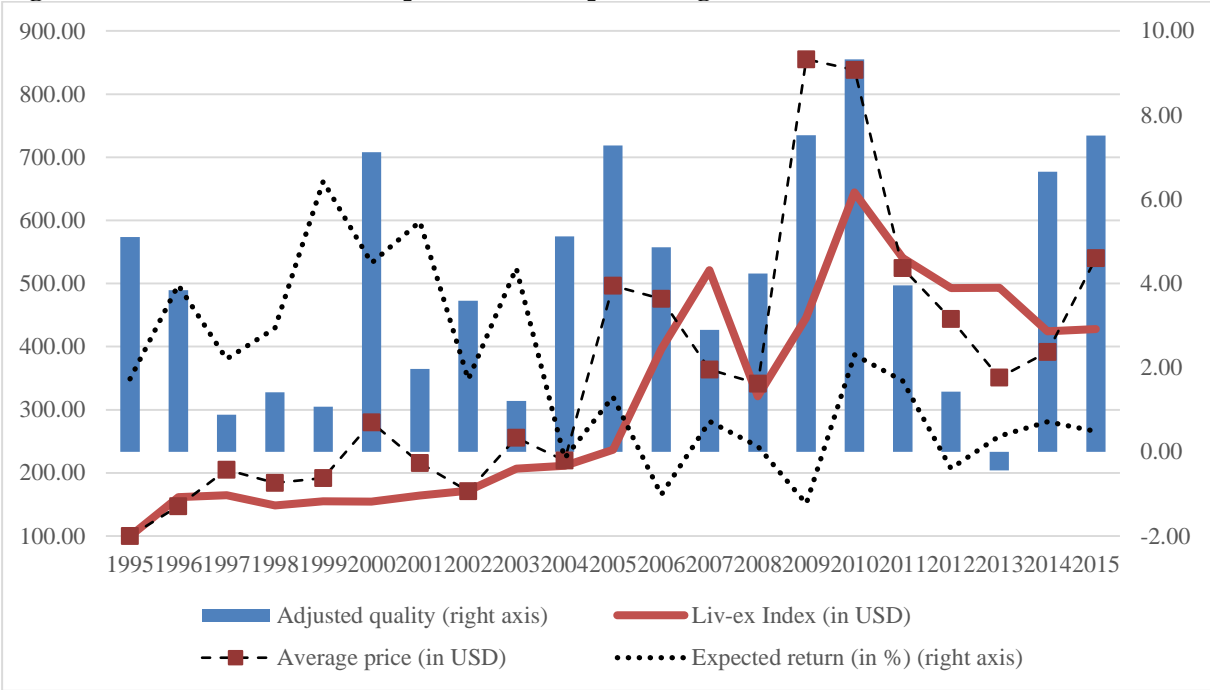**Figure 1: Information and descriptive statistics per vintage**

Table 2: Information and descriptive statistics per wine Château

Château	General information		Reputation		Primary market		Secondary market	
	AOC	Status	96-'05	06-'15	Median score	Median price	Median score	Median price (Q1-2016)
Haut-Brion	Pessac	1GCC	2	1	94 (18)	166.4 (18)	95.5 (18)	331.4 (18)
La Mission-Haut-Brion	Pessac	1GCC	2	2	92.3 (18)	99.5 (18)	93.5 (18)	207.8 (18)
Domaine de Chevalier	Pessac	N.C.	4	5	89 (17)	26.6 (18)	90 (17)	46.4 (18)
Haut Bergey	Pessac	N.C.	5	5	91.5 (14)	16 (16)	90 (16)	30.3 (18)
Haut-Bailly	Pessac	N.C.	5	4	90.5 (18)	29.4 (18)	90 (18)	66.5 (18)
Les Carmes Haut Brion	Pessac	N.C.	5	5	89 (17)	26.3 (18)	89.5 (18)	54.9 (16)
Pape Clément	Pessac	N.C.	4	3	93 (18)	51.4 (18)	94.5 (18)	96.9 (18)
Smith Haut Lafitte	Pessac	N.C.	5	4	92 (18)	30.5 (18)	92 (18)	64.8 (18)
Clarence de Haut-Brion	Pessac	2nd w.	4	4	89 (13)	29.7 (18)	89 (17)	70.5 (18)
Bon Pasteur	Pomerol	N.C.	3	4	90.5 (17)	37 (17)	90 (17)	65.8 (18)
Certan de May	Pomerol	N.C.	2	3	90.8 (16)	54 (11)	89 (17)	73.8 (18)
Clinet	Pomerol	N.C.	2	3	91.3 (16)	48.6 (18)	91 (17)	94 (18)
Clos l'Eglise	Pomerol	N.C.	5	2	93 (15)	17.6 (15)	92.5 (14)	122.6 (18)
Fleur-Pétrus	Pomerol	N.C.	2	2	90.8 (16)	69.3 (13)	90 (17)	135.2 (18)
Gazin	Pomerol	N.C.	5	5	90.5 (16)	38.4 (18)	90 (16)	52.6 (18)
Hosanna	Pomerol	N.C.	5	2	92.5 (12)	90.6 (10)	93.5 (12)	119.1 (18)
La Conseillante	Pomerol	N.C.	2	2	89.3 (16)	65.5 (18)	89 (17)	99.3 (18)
La Fleur de Gay	Pomerol	N.C.	2	3	91.5 (17)	60.7 (18)	90.5 (16)	127.4 (15)
Lafleur	Pomerol	N.C.	1	1	93 (17)	436.6 (10)	93 (17)	424.2 (18)
Latour à Pomerol	Pomerol	N.C.	3	4	89 (16)	34.3 (17)	89 (15)	72.3 (18)
Le Gay	Pomerol	N.C.	5	4	91.3 (16)	62.8 (10)	90 (17)	74.2 (18)
Le Pin	Pomerol	N.C.	1	1	94 (14)	877.3 (9)	93 (16)	1695.1 (18)
L'Eglise-Clinet	Pomerol	N.C.	2	2	93 (17)	103.1 (18)	94 (17)	168.5 (18)
L'Evangile	Pomerol	N.C.	2	2	91.5 (17)	97.8 (18)	92 (17)	128.2 (18)
Petit-Village	Pomerol	N.C.	4	5	88 (15)	31.2 (17)	88 (15)	59.1 (16)
Pétrus	Pomerol	N.C.	1	1	93.5 (17)	764.8 (10)	95 (16)	1817.4 (18)
Trotanoy	Pomerol	N.C.	2	2	91 (17)	81.9 (11)	92 (17)	160.1 (18)
Vieux Certan	Pomerol	N.C.	3	2	92.3 (16)	67 (18)	93 (16)	133 (18)
Angélus	St.-Emilion	1GCC A	2	2	93.3 (18)	87 (18)	93.5 (18)	224 (18)
Ausone	St.-Emilion	1GCC A	2	1	95.5 (18)	265.7 (18)	95.5 (18)	443.2 (18)
Cheval Blanc	St.-Emilion	1GCC A	1	1	93.3 (18)	217.1 (18)	93 (18)	377.4 (18)
Pavie	St.-Emilion	1GCC A	4	2	95 (18)	119.9 (18)	95 (17)	181.6 (18)
Beau-Séjour Bécot	St.-Emilion	1GCC B	4	5	91 (18)	32.3 (18)	91 (18)	53.6 (18)
Beauséjour-Duffau	St.-Emilion	1GCC B	2	3	91.5 (15)	43 (13)	90 (15)	80.9 (18)
Belair	St.-Emilion	1GCC B	5	5	88 (11)	43.5 (12)	87 (12)	45.2 (18)
Canon	St.-Emilion	1GCC B	3	4	89 (17)	40.7 (18)	89 (18)	71.8 (18)
Canon-La-Gaffelière	St.-Emilion	1GCC B	4	4	91.3 (18)	40.7 (18)	92 (18)	69.9 (18)
Clos Fourtet	St.-Emilion	1GCC B	5	4	91.5 (18)	32.8 (18)	91 (18)	55.6 (18)
Figeac	St.-Emilion	1GCC B	3	3	88.5 (11)	50.2 (18)	89 (15)	84.6 (18)
La Gaffelière	St.-Emilion	1GCC B	4	5	89 (17)	32.8 (18)	90.5 (18)	49.9 (18)
La Mondotte	St.-Emilion	1GCC B	2	2	94.5 (17)	165.6 (17)	95 (17)	189.1 (18)
Larcis-Ducasse	St.-Emilion	1GCC B	5	4	91 (17)	21.9 (18)	90 (17)	45.7 (18)
Magdelaine	St.-Emilion	1GCC B	3	5	89.3 (16)	36.5 (15)	90 (17)	54.8 (18)
Pavie-Macquin	St.-Emilion	1GCC B	5	4	93 (17)	39.4 (17)	92 (18)	63.4 (18)
Troplong Mondot	St.-Emilion	1GCC B	2	3	92.5 (18)	38.8 (18)	93 (18)	68.9 (18)
Trottevieille	St.-Emilion	1GCC B	5	5	89.8 (18)	49.3 (11)	89 (17)	57.7 (18)
Valandraud	St.-Emilion	1GCC B	1	2	93 (17)	132.9 (18)	93 (17)	155.4 (18)
Clos de Sarpe	St.-Emilion	GCC	5	4	92.5 (15)	47.4 (14)	94 (15)	69.8 (18)
L'Arrosée	St.-Emilion	GCC	4	5	89 (17)	29.9 (17)	89 (17)	50.5 (17)
Monbousquet	St.-Emilion	GCC	4	4	92 (18)	30.6 (18)	92 (18)	49.2 (18)
Pavie-Decesse	St.-Emilion	GCC	5	3	93 (18)	78.1 (18)	94 (18)	81.9 (18)
Tertre Rôteboeuf	St.-Emilion	N.C.	2	2	90 (9)	101 (12)	90 (11)	117.4 (18)

Table 2 (con't): Information and descriptive statistics per wine Château

Château	General		Reputation		Primary market		Secondary market	
	AOC	Status	96-'05	06-'15	Median score	Median price	Median score	Median price (Q1-2016)
La Lagune	Haut Médoc	3GCC	4	5	91 (15)	23.5 (18)	89.5 (18)	47 (18)
Cantemerle	Haut Médoc	5GCC	4	5	89 (15)	15.6 (18)	88 (17)	33.9 (17)
Margaux	Margaux	1GCC	1	1	93.8 (18)	155 (18)	94 (18)	369.3 (18)
Brane-Cantenac	Margaux	2GCC	5	5	90.3 (16)	25 (18)	90.5 (16)	43.8 (18)
Lascombes	Margaux	2GCC	5	5	91.5 (17)	29.9 (18)	92.5 (16)	53.6 (18)
Rauzan-Ségla	Margaux	2GCC	3	3	90 (15)	37.3 (18)	90 (18)	77.5 (18)
Cantenac Brown	Margaux	3GCC	5	5	88 (15)	20 (18)	87.5 (16)	40.2 (18)
d'Issan	Margaux	3GCC	5	5	89.5 (15)	22.1 (18)	89.5 (18)	56.1 (18)
Giscours	Margaux	3GCC	5	5	89.3 (18)	23.3 (18)	90 (17)	49.8 (18)
Kirwan	Margaux	3GCC	5	5	89.8 (16)	21.9 (18)	90 (18)	50.1 (17)
Malescot Saint-Exupéry	Margaux	3GCC	5	4	92 (17)	24.9 (15)	90.5 (18)	61.6 (18)
Palmer	Margaux	3GCC	2	2	92.5 (17)	91 (18)	94 (18)	162.6 (18)
Prieuré-Lichine	Margaux	4GCC	5	5	88.3 (14)	21.4 (18)	90 (18)	46.3 (18)
du Tertre	Margaux	5GCC	5	5	88 (16)	18 (18)	89 (15)	38.4 (18)
Pavillon Rouge	Margaux	2nd w.	4	3	91 (10)	30 (18)	89 (15)	103.6 (18)
Potensac	Médoc	N.C.	5	5	88 (13)	13.3 (18)	87 (15)	25 (18)
Chasse-Spleen	Moulis	N.C.	4	5	86.5 (9)	15.3 (18)	88 (11)	46 (18)
Poujeaux	Moulis	N.C.	5	5	88.8 (14)	15.5 (18)	89 (16)	33.9 (17)
Lafite Rothschild	Pauillac	1GCC	1	1	93.5 (18)	155 (18)	95.5 (18)	597.5 (18)
Latour	Pauillac	1GCC	1	1	95 (18)	161.3 (17)	95 (18)	438 (18)
Mouton-Rothschild	Pauillac	1GCC	1	1	95 (18)	145.3 (18)	94 (18)	388.4 (18)
Pichon Comtesse de Lalande	Pauillac	2GCC	2	2	93 (18)	57.4 (18)	92.5 (18)	110.5 (18)
Pichon-Baron	Pauillac	2GCC	3	3	91.3 (18)	45.7 (18)	93 (17)	93.1 (18)
Duhart Milon	Pauillac	4GCC	5	4	89 (17)	19.8 (18)	90 (18)	76.9 (18)
Armailhac	Pauillac	5GCC	5	5	89.5 (16)	18.5 (18)	89 (17)	41 (18)
Batailley	Pauillac	5GCC	5	5	88 (14)	22.6 (10)	87.5 (18)	39.3 (16)
Clerc-Milon	Pauillac	5GCC	4	5	90 (17)	24.6 (18)	90 (18)	53.7 (18)
Grand-Puy-Lacoste	Pauillac	5GCC	3	3	90 (16)	29.5 (18)	91 (17)	66.2 (18)
Haut Batailley	Pauillac	5GCC	5	5	88.5 (15)	18.4 (18)	88 (15)	42.7 (18)
Haut-Bages-Libéral	Pauillac	5GCC	5	5	86 (9)	16.6 (18)	89 (13)	48.4 (18)
Lynch-Bages	Pauillac	5GCC	2	3	91 (17)	38.6 (18)	90 (17)	109.5 (18)
Pontet-Canet	Pauillac	5GCC	5	4	92.8 (18)	32.8 (18)	92 (17)	78.2 (18)
Carruades de Lafite	Pauillac	2nd w.	5	2	88.5 (11)	25.7 (18)	90 (15)	199.3 (18)
Le Petit Mouton	Pauillac	2nd w.	5	5	90 (7)	47.5 (14)	89 (11)	107.3 (18)
Les Forts de Latour	Pauillac	2nd w.	3	2	91 (15)	33.4 (17)	91 (17)	160.7 (18)
Cos d'Estournel	St.-Estèphe	2GCC	2	2	92.8 (18)	69.2 (18)	93 (18)	107 (18)
Montrose	St.-Estèphe	2GCC	3	2	93 (17)	46.5 (18)	91 (18)	105.2 (18)
Calon Ségur	St.-Estèphe	3GCC	3	4	91.5 (17)	26.8 (18)	90.5 (18)	68.9 (18)
Lafon-Rochet	St.-Estèphe	4GCC	5	5	89.5 (17)	18.6 (18)	88 (18)	45.8 (18)
Haut-Marbuzet	St.-Estèphe	N.C.	3	5	88 (10)	23.5 (18)	87 (16)	35.4 (14)
Les Ormes-de-Pez	St.-Estèphe	N.C.	5	5	87 (14)	16.3 (18)	86 (15)	38.1 (18)
Phélan Ségur	St.-Estèphe	N.C.	5	5	87.5 (13)	18 (18)	87 (17)	34 (18)
Ducru-Beaucaillou	St.-Julien	2GCC	3	3	93 (18)	62 (18)	93.5 (18)	115.7 (18)
Gruaud-Larose	St.-Julien	2GCC	3	4	89 (15)	32.3 (18)	89 (17)	66.5 (18)
Léoville Las Cases	St.-Julien	2GCC	2	2	94 (18)	94.5 (18)	93 (17)	144.2 (18)
Léoville-Barton	St.-Julien	2GCC	3	3	92.3 (18)	31.6 (18)	92 (18)	76.5 (18)
Léoville-Poyferré	St.-Julien	2GCC	4	3	92 (17)	31.1 (18)	92.5 (18)	76.8 (18)
Lagrange	St.-Julien	3GCC	4	5	90 (17)	23.6 (18)	89.5 (18)	55.3 (17)
Langoa Barton	St.-Julien	3GCC	5	5	88.5 (15)	23.7 (18)	89.5 (18)	43.8 (17)
Beychevelle	St.-Julien	4GCC	3	4	88.5 (17)	24.2 (18)	89 (18)	72.5 (18)
Branaire Ducru	St.-Julien	4GCC	5	4	91 (17)	23.3 (18)	90 (18)	52.7 (18)
Saint-Pierre	St.-Julien	4GCC	5	5	91 (15)	24.5 (18)	91.5 (14)	48.7 (17)
Talbot	St.-Julien	4GCC	3	4	89 (17)	23.4 (18)	89 (18)	48.4 (18)
Clos du Marquis	St.-Julien	2nd w.	5	5	91 (15)	24.3 (18)	90 (16)	41.7 (18)

This table reports information about each château, including its origin (AOC), classification (Status) and Reputation (estimated on the basis of equation [5]), Robert Parker scores and prices are reported as well (median for all vintages 1995 to 2015). The number of observations is reported in brackets.

Table 3: The determinants of wine prices on the primary market (base specifications)

	Base specifications			Alternative specifications						
	1	2	3	No status dummies	No reputation dummies	No AOC dummies	No status and AOC dummies	No Parker scores	No "financial" data	No vintage dummies
R^2	0.7561	0.8424	0.8435	0.8269	0.6884	0.8142	0.7910	0.8405	0.6834	0.8180
Intercept	3.12***	3.17***	3.18***	3.23***	3.25***	3.73***	3.68***	3.14***	2.96***	3.31***
Ln(liv-ex)		0.73***	0.69***	0.69***	0.68***	0.69***	0.69***	0.69**		0.76***
Exp. Return	-12.19***		-1.91***	-1.97***	-2.29***	-2.2***	-2.19***	-1.7***		-1.38***
Good Vintage	0.09***	0.03	0.04*	0.04*	0.05	0.05**	0.05**	0.03	-0.01	
Excellent Vintage	-0.2***	0.02	0.02	0.02	0.01	0.02	0.02	0.02	-0.33***	
Great Vintage	0.48***	0.36***	0.37***	0.37***	0.37***	0.38***	0.38***	0.37***	0.46***	
Scored?	-0.26***	-0.03	-0.05*	-0.06**	-0.1**	-0.1***	-0.1***		-0.22***	-0.07**
Score	0.02***	0.02***	0.02***	0.02***	0.01***	0.02***	0.03***		0.02***	0.02***
$Score^2$	-0.0014*	0.0001	0.0002	0.0012*	-0.001	0.0005	0.0017**		-0.0036***	0.0005
1GCC	0.44***	0.47***	0.47***		1.88***	0.14***		0.49***	0.43***	0.46***
1GCC A	0.39***	0.42***	0.41***		1.27***	0.5***		0.47***	0.4***	0.4***
1GCC B	-0.05	-0.03	-0.03		0.01	0.16***		-0.03	-0.05	-0.04
2GCC	0.42***	0.44***	0.43***		0.73***	0		0.46***	0.45***	0.43***
3GCC	0.27***	0.29***	0.28***		0.34***	-0.12***		0.31***	0.29***	0.28***
4GCC	0.17***	0.18***	0.18***		0.11	-0.17***		0.19***	0.19***	0.18***
5GCC	0.09	0.08*	0.08*		-0.03	-0.23***		0.07	0.12*	0.08
2nd wine	0.41***	0.37***	0.38***		0.43***	0.1**		0.37***	0.42***	0.38***
Saint-Estèphe	0.19***	0.2***	0.2***	0.27***	0.31***			0.22***	0.18***	0.2***
Pauillac	0.3***	0.32***	0.32***	0.41***	0.54***			0.34***	0.3***	0.32***
Saint-Julien	0.22***	0.24***	0.24***	0.44***	0.31***			0.25***	0.21***	0.24***
Margaux	0.21***	0.22***	0.22***	0.42***	0.24***			0.24***	0.2***	0.22***
Pessac-Léognan	0.55***	0.57***	0.57***	0.57***	0.55***			0.61***	0.57***	0.56***
Pomerol	0.83***	0.83***	0.82***	0.63***	1.4***			0.87***	0.88***	0.82***
Saint-Emilion	0.82***	0.83***	0.83***	0.72***	1.05***			0.85***	0.85***	0.83***
Reputation #1	1.85***	1.86***	1.86***	2.11***		2***	2.22***	1.85***	1.88***	1.86***
Reputation #2	0.82***	0.84***	0.84***	1.02***		1.02***	1.13***	0.84***	0.81***	0.84***
Reputation #3	0.36***	0.37***	0.37***	0.46***		0.49***	0.54***	0.37***	0.34***	0.37***
Reputation #4	0.11***	0.13***	0.13***	0.16***		0.19***	0.21***	0.13***	0.1***	0.12***

This table reports the coefficients as well as their significance (***, ** and * denote significance at the 10%, 5% and 1%-level). The Lix-ev Investables Index has been standardized to a value of 1 in year 1996 (this has been achieved by dividing the value of the index at each data by its value in 1996). Reference = non-classified wine from the Médoc region (i.e., Moulis, Haut-Médoc) with a low reputation and a weak to average vintage.

Table 4: Initial mispricing and subsequent returns

	Base specifications		Specifications including a "mispricing" variable			Specifications including "mispricing" and score variables		
	1	2	3a	3b	3c	4a	4b	4c
R^2	0.5198	0.5346	0.5690	0.5755	0.5739	0.5770	0.5826	0.5812
Intercept	0.7184***	0.7059***	0.772***	0.7476***	0.7734***	0.7506***	0.7285***	0.7527***
Mispricing			-0.3356***	-0.5744***	-0.367***	-0.3431***	-0.5682***	-0.3724***
Mispricing +				0.423***			0.3984***	
Mispricing^2					0.1281***			0.1196***
Surprise-in-score (prim.)						0.0136***	0.0117***	0.0124***
Final vs Primeur score						0.0224***	0.0228***	0.0224***
Age	0.0382***							
1GCC	0.2285***	0.2292***	0.2548***	0.2626***	0.2597***	0.2428***	0.2527***	0.2489***
1GCC A	0.2079***	0.2076***	0.2009***	0.2129***	0.204***	0.1621***	0.1766***	0.1672***
1GCC B	0.064***	0.0627***	0.0491***	0.0581***	0.0424***	0.0562***	0.0623***	0.0486***
2GCC	-0.141***	-0.1401***	-0.16***	-0.1629***	-0.1644***	-0.1675***	-0.1688***	-0.1707***
3GCC	0.0089	0.011	-0.0267	-0.0352**	-0.0325*	-0.039**	-0.0451***	-0.0432***
4GCC	-0.0333*	-0.0313*	-0.0701***	-0.062***	-0.07***	-0.0622***	-0.0542***	-0.062***
5GCC	-0.1301***	-0.1292***	-0.1547***	-0.1518***	-0.1557***	-0.1327***	-0.1307***	-0.1343***
2nd wine	0.1448***	0.1441***	0.0986***	0.0859***	0.0901***	0.1147***	0.1014***	0.1059***
Saint-Estèphe	-0.0487**	-0.0483***	-0.0546***	-0.0575***	-0.0566***	-0.0689***	-0.0699***	-0.0696***
Pauillac	0.1085***	0.11***	0.1013***	0.0931***	0.0971***	0.0719***	0.0655***	0.069***
Saint-Julien	-0.0693***	-0.0684***	-0.0541***	-0.061***	-0.0572***	-0.0666***	-0.0723***	-0.0689***
Margaux	-0.1295***	-0.1274***	-0.1269***	-0.1286***	-0.1271***	-0.1417***	-0.1417***	-0.1408***
Pessac-Léognan	-0.2336***	-0.231***	-0.2537***	-0.2727***	-0.265***	-0.2886***	-0.3029***	-0.2968***
Pomerol	-0.1715***	-0.1694***	-0.1694***	-0.194***	-0.1861***	-0.2003***	-0.2192***	-0.2132***
Saint-Emilion	-0.3839***	-0.3805***	-0.3714***	-0.4048***	-0.3858***	-0.3897***	-0.417***	-0.4007***
Reputation #1	0	0.0004	-0.0328**	-0.0527***	-0.0414***	-0.0206	-0.0422***	-0.0304*
Reputation #2	0.0183*	0.0178*	0.0053	-0.0119	-0.0005	0.0093	-0.0079	0.0033
Reputation #3	0.0132	0.0138	0.0049	0.0031	0.0087	0.0113	0.0092	0.0145
Reputation #4	0.0384***	0.0394***	0.0369***	0.0417***	0.0414***	0.0373***	0.0415***	0.0413***

This table reports the coefficients as well as their significance (***, ** and * denote significance at the 10%, 5% and 1%-level). Reference = 1995 vintage.

Figure 2: Mispricing and its evolution on the 2015 en primeur campaign