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VALUATION AND PERFORMANCE OF INVESTMENT GRADE WINES

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Helsinki School of Economics
Abstract
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Purpose of the Study

The aim of the thesis is to evaluate the performance and valuation of investment grade wines. I created two wine indices to track the performance of wines and compared them against other asset classes. In the valuation part I studied the price effect of several factors, including expert opinions, age, production amount, vintage scores, long-term reputation, area, auction house, lot size, year and location of trade. Special emphasis was on the evaluation of points given by Robert Parker on individual wines and the age of wine. I constructed several regression models, which estimate the price of investment grade wines using several qualitative and quantitative factors. The results are compared against previous academic literature and hypotheses, which are based on both academic and general wine literature. As wine investment is relatively new topic from pure investment point of view I discussed the characteristics of wines and the market in some detail.

Data and Methodology

I gathered a very extensive data set for this study. Both the calculation of indices and valuation models are based on the data, which consists of more than 20,000 individual lots traded in five large auction houses around the world during the years 1999-2006. Based on liquidity I selected 34 high quality wines for this study and collected all the observations for their vintages from 1989 to 2001. The data set is more comprehensive than other recent wine studies and enables the building of accurate valuation models and the use of traditional composite, instead of hedonic or repeat sales indices. I constructed two indices, Global 100 and Bordeaux 33, which both are fixed basket composite indices. The valuation model is based on a log-linear hedonic regression, which is the most frequently used tool in the existing literature.

Results

The data was first described in detail to establish the basis for analysis of performance and valuation of wines. The descriptive statistics did not provide dramatic surprises, but tended to emphasize the observations of previous authors. I evaluated the performance of wines both without and with transaction and storage costs. The returns during the observation period were reasonably good at 0.7% monthly level when transaction and holding costs were excluded, but vanish close to zero when the costs were included. The correlations were generally very low with other asset classes. I constructed total of 13 different valuation models to study the effect of different factors. The results were mostly as expected: the effect of Parker points, age and production proved to be the most important factors, while vintage ratings, long-term reputation, and production amount had also quite significant effects. What was surprising was that also the auction house and location of trade affected the price considerably. When the price effect of Parker points and age were studied closer it demonstrated that the effect of Parker points was the strongest between 94 and 100 points, while wines of 7-13 years age experienced much higher appreciation in price than younger and older wines. Finally, the effect of individual vineyards was also estimated and proved to be to the most accurate way to estimate prices.

Helsinki School of Economics
Abstract
Master's Thesis

3. Tammikuuta 2007
Janne Järvinen

ARVOVIINIEN HINNOITTELU JA TUOTTO

TUTKIMUKSEN TAVOITE

Lopputyön tarkoitus on tutkia arvoviinien hinnoittelua sekä niistä saatavia tuottoja. Luon kaksi viini-indeksiä, jotka seuraavat viinien hintakehitystä ja joita vertaan muihin sijoitusinstrumentteihin. Arvonmääritysosassa tutkin useiden eri tekijöiden, kuten asiantuntijalausuntojen, viinin iän, tuotantomäärän, vuosikertapisteiden, maineen, alueen, huutokauppakamarin ja myyntimaan, vaikutusta arvoviinien hintoihin. Erityistä huomiota kiinnitän Robert Parkerin antamien pisteiden sekä viinin iän vaikutukseen. Rakennan useita regressiomalleja, joilla tutkin näiden eri kvantitatiivisten sekä kvalitatiivisten tekijöiden vaikutusta viinien hintoihin. Vertaan tuloksia niin aikaisempaan kirjallisuuteen sekä väittämiin, joita on esitetty eri viinikirjoissa. Koska viinit ovat varsin uusi aihe rahoitusmarkkinoilla, käsittelen viini-investointeihin liittyviä käytännön seikkoja varsin syvällisesti tutkielman alussa.

DATA JA METODOLOGIA

Olen kerännyt erittäin laajan aineiston tätä tutkimusta varten. Sekä viini-indeksit että hinnoittelumallit käyttävät samaa dataa, joka koostuu yli 20 000 viinihuutokauppahavainnosta, jotka on kerätty vuosina 1999-2006 viidestä eri huutokauppakamarista ympäri maailmaa. Erittäin laajasta valikoimasta karsin 34 viiniä tähän tutkimukseen likviditeetin perusteella ja keräsin näiden viinien vuosikerroilta 1989-2001 kaikki havainnot. Tämä aineisto on huomattavasti laajempi kuin viime aikojen viinitutkimuksissa käytetyt aineistot ja mahdollistaa tarkkojen hinnoittelumallien luomisen sekä perinteisten komposiitti-indeksien käytön. Luomieni indeksien nimet ovat Global 100 ja Bordeaux 33. Valuaatiomallit pohjautuvat log-lineaariseen, hedoniseen regressioon, joka on useimmin käytetty hinnoittelumetodi viinikirjallisuudessa.

TULOKSET

Ennen varsinaisia tuloksia kuvailen datan mahdollisimman tarkasti. Deskriptiiviset tulokset datasta eivät ole yllättäviä, vaan vahvistavat lähinnä aikaisempien kirjoittajien tekemiä havaintoja. Viinien tuomia tuottoja tutkin sekä ilman transaktiokustannuksia että niiden kanssa. Jos transaktiokustannukset jätetään huomioimatta, viinit tuottavat varsin tyydyttävän 0.7% kuukausittaisen tuoton, mutta otettaessa transaktiokustannukset huomioon tuotot pienenevät lähes olemattomiin.

Rakennan kaiken kaikkiaan 13 eri hinnoittelumallia, jotka pyrkivät selittämään eri tekijöiden vaikutuksia viinien hintoihin. Suurin osa tuloksista on hypoteesien mukaisia, kuten Parker-pisteiden ja viinin iän voimakas vaikutus hintaan. Myös valmistusmäärä, vuosikertapisteet ja maine vaikuttavat oletetusti viinien hintoihin. Yllättävää sen sijaan on, kuinka voimakas vaikutus huutokauppakamarilla ja huutokaupan sijainnilla on viinien hintoihin. Parker-pisteitä ja viinien ikää tarkemmin tutkittaessa huomataan, että Parker-pisteiden vaikutus on voimakkainta 94 ja 100 pisteen välissä, kun taas 7-13 -vuotiaiden viinien hinnat nousevat huomattavasti voimakkaammin kuin sitä nuorempien tai vanhempien viinien. Lopuksi tutkin myös viinitilan vaikutusta hintaan, ja se paljastuu odotetusti kaikkein merkittävimmäksi viinien hintoihin vaikuttavaksi tekijäksi.

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1. Introduction

In this paper I will study fine wines as an investment class and build models that strive to explain the price of wines in auctions as well as study the price effect of different factors. Special emphasis is put on evaluation of the effect of expert opinions and age. Wines are an exotic investment instruments that have not yet been studied thoroughly and which can be classified either as collectibles, perishable luxury good or both. Even though collectors have traded wines for centuries, the modern wine market where wine can be seen as an investment is still young and far from the traditional perfect market assumptions of e.g. equity and bond markets.

The number of investors looking to invest in wines has increased as alternative asset classes have gained popularity and investors are looking new ways to diversify their portfolios. Wines are often classified as collectibles, like art, antique or baseball cards, which can be also be considered investments. Wines however have natural characteristics, which resemble traditional financial investments unlike most other collectibles. They increase in value and quality as they get older, the value of wines and vintages change in accordance to evaluation of their future potential by experts and there is quite an efficient aftermarket for them. Also, unlike art, which is probably the most common class of investment collectibles, wines are not unique items. There are often several thousands of identical bottles of wine, while a piece of art is usually unique. An investor looking to invest in wines is of course interested in how much he or she will expect to get in return, what is the volatility of the investment, how does it correlate with other asset classes and what are the costs of storage, insurance and trading. Another important issue is the selection of wines for the portfolio from the vast universe of wines. It is however challenging to find comprehensive, objective answers to these questions, as there is only small amount of providers of such data.

In addition, there has been very limited number of studies about wines as an investment class. There are a few papers evaluating the performance of wine investments, but most studies of wines from financial perspective have concentrated in modelling the price of wine in the *en primeur* or other local markets. Many of these studies suffer from limited data sets, which limit

the choice of methods and make the generalization of results challenging. Also, only minority of the studies are made from investors' point of view. Some of the most notable studies include Landon and Smith (1997) work on the effects of quality and reputation indicators on Bordeaux wine, Lecocq and Visser (2003) paper, which compared sensory and objective characteristics on the price of wine, and Burton and Jacobsen's (1999) study on the rate of return on wine investments.

As the market is relatively new and differs greatly from traditional financial markets, the first section of this paper is devoted to introduction of wine market to potential investors. I discuss factors that affect the pricing of wines in auctions and practical matters, like storage and insurance, which are related to wine investments. The main emphasis of this study is based on wines traded at auction houses, but other sources of wines are also discussed. The understanding of the wine market is essential to anyone buying wines in investment purpose and some of the information might be difficult to find from traditional wine literature.

I will contribute to the field by extending the valuation models and by constructing two new investment grade wine indices. Thanks to an extensive data set, which has more than 20,000 observations of wines traded in European and American auction houses between years 1999 and 2006 I will be able to form accurate and extensive indices and price models. The indices are fixed-basket composite indices, which track the performance of a defined wine basket over the period 2000-2006. These differ from the popular hedonic indices, which are used especially in art and real estate market, but also commonly in the wine market. In wine literature hedonic indices, which take into account the changes in quality, are often used because of limited number of price points for wines. The data set in this study however includes monthly observations for a large set of wines, which enables efficient tracking of the price of each wine over the period, and thus makes it possible to use a more traditional method to construct the indices.

The price determinants of wines are estimated with several hedonic regression models. The factors included in the regressions include points given to the wine by Robert Parker, age and region of the wine, vintage rating, production amount, year and location of trade, auction house, lot size and a reputation factor, which is calculated from lagged Parker points, or more precisely

as an average score of ten previous vintages. In addition I will build a model in order to estimate the price effect of the producer of the wine. Special emphasis is placed on the effect of expert opinions and age, which are modelled point-by-point and year-by-year respectively. As mentioned previously, this study is made from investors' point of view and thus I have selected variables, which are available for all market participants. For example I use vintage ratings rather than detailed weather conditions, used by Landon and Smith (1998), to proxy the quality of the vintage and published expert opinions to estimate the quality of individual wines. I also use several variables that are rarely used in existing wine literature, like the produced quantity, auction house and location of trade. Koford and Tschoegl (1997) use the number of coins minted as a proxy for scarcity in their study and find it a significant factor, while Pesando (1993) evaluates among other things the effect of location of trade and auction house on prices of prints.

The rest of the paper is organized as follows: section 2 introduces the reader to the wine market, section 3 is a literature review, sections 4 and 5 are devoted to data and methodology, my hypotheses are presented in section 6, section 7 examines how wine investments have performed, section 8 describes which factors affect the price paid for the wines and the last section is left for conclusions.

2. Wine as an Investment

For any investor investing in any asset it is vital to know what he or she is getting into. For this simple reason I will begin by explaining the main characteristics of investment grade wines (IGW) and their markets. As we all know, there are thousands of different wines offered for consumers throughout the world. However, only a tiny fraction of these can be considered suitable vehicles for investment. A wine can taste delicious, have a good brand name and reputation, but still not qualify as an IGW. The most important characteristic of an investment grade wine is that its price increases as it ages *ceteris paribus*. This implies of course that the wine must develop, not just resist cellaring. For this reason most IGWs are red wines, which age better than white wines. Also, most of the IGWs still come from the France, especially Bordeaux, while wines from other European countries and *New World* (most notably wines from Chile, Australia, New Zealand and South Africa) represent only a minority of the market.

2.1 Introduction to Wine Market

Although wines have been collected for centuries, they have not been regarded as an investment class before the last few decades. Rich people have bought, cellared, enjoyed and sometimes sold fine wines since 17th century when bottling of wine begun. After the Second World War there has been a rapid increase in wine investments, which has resulted in increased price and liquidity of investment grade wines. Wine market, as most other markets, have experienced its ups and downs during the last 50 years. There have been times of extreme optimism and high prices, but also deep recessions when prices and liquidity have suffered. For the reader interested in the development of the wine market, Sokolin (1998) describes the main developments in the wine markets from 1960's to the end of the 20th century.

I was unable to find a reliable source that would verify the total aftermarket size of wines. This is naturally very different from the total global wine market, which covers all consumed table wine in addition to the primary market for investment grade wines. We can get some estimates of the

aftermarket by using the data set gathered for this study. The trades in the data set were worth circa €8,000,000 in 2005, but this excludes almost all wines that are older than 15 years and even the majority of other wines. It actually includes only recent vintages of 33 liquid investment grade wines traded in 5 main auction houses. If all wines from all vintages traded in every auction house and merchant were included, the annual traded volume would increase significantly. A rough estimate of the total size of IGW market made by the author would be around hundred million euros annually. Vast majority of IGW trading still takes place in Europe and North America (split pretty evenly between them) even though especially the Australian high-end wine market has experienced significant growth lately and Asian buyers are also entering the market.

2.2 Factors that affect the price of a wine

Valuing fine wines differs radically from all traditional asset classes. There are no cash flows in form of dividends or interest. Also, unlike companies, the quality of wines cannot be actively managed after they are bottled. The quality of wines however changes over time. Good wines improve for years, even for decades, when stored properly, but may be spoiled if stored in wrong conditions. Fundamentally the price of a wine is linked to its taste. This of course makes it very difficult to value, as tastes differ radically. However, there are sets of characteristics that are widely regarded as "good" or "bad" for a wine. These include the length of taste, the intensity of aromas, the softness of tannins, the level of acids and so on. I will not describe the evaluation of taste in this study as it is not necessary for investors and the subject is already discussed in numerous existing studies and books (*e.g.* Dominé 2004).

The factors that affect wine prices can be classified in many ways. One popular method in research papers (see *e.g.* Lecocq & Visser, 2004) has been to divide them into two different classes, sensory and objective characteristics. Objective characteristics are ones that the buyer can see on the bottle: name of the wine and producer, country of origin, appellation, vintage and condition of the bottle and level of liquid. Sensory characteristics on the other hand reflect the taste of a wine. These are more difficult for the investor to measure. He or she can always buy

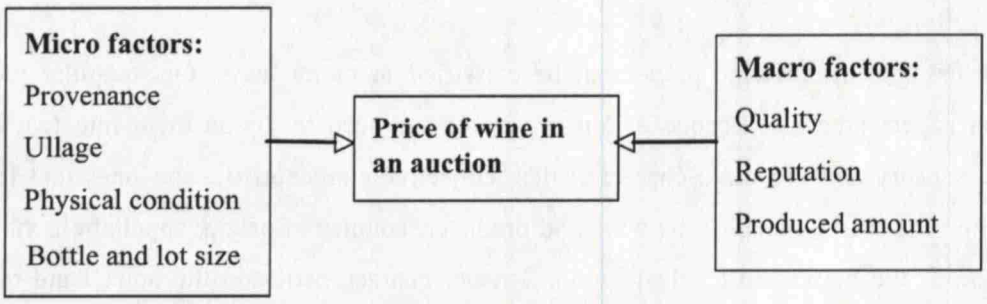
one bottle and taste it, but it is still difficult to measure its value for other buyers. However, investors can use the evaluations made by experts to get a sense of the quality of the wine.

There are dozens of factors that affect the taste, and hence the price, of wines. These are caused by both internal and external factors. Internal factors include the choices made by the producer, like which grapes to use, how long the wines are kept in barrels (and in which barrels) and bottles before selling them, while external factors include most importantly different weather conditions and *terroir*, the characteristics of the land. Again, I will not go into detail regarding the differences between grape varieties, ageing methods or implications of weather and *terroir* on wines, as they are comprehensively explained by *e.g.* Dominé (2004). I will however describe ways to value the most important characteristics of different wines and the kind of proxies that can be used to estimate these factors.

I have divided valuation proxies to macro and micro factors (Figure 1). The first set aims to evaluate the value of certain wine, while the latter concentrates on a single bottle of wine. Here it is very important to distinguish between a wine and a single bottle of wine. The term "wine" as used in this study refers to all bottles of certain vintage of certain wine brand.

Figure 1

The factors affecting the price of a wine in a typical auction are divided into two broad classes: micro and macro. Macro factors are those affecting all the bottles of certain wine, while micro factors affect the price of a single bottle or a lot.



2.2.1 Macro Factors

In this study I assume that there are three broad factors that affect the price of the wine: quality, reputation and scarcity. Earlier studies have used largely similar distinctions; *e.g.* Ali (2003) and Landon and Smith (1997) discuss the effects of quality and reputation on Bordeaux wines. The scarcity effect has been studied for example by Lynn (1989), but has rarely been used in other wine studies. These factors are hard or impossible to measure as such, so I will try to find suitable proxies for them and to justify their usage.

The quality and reputation of a certain wine are difficult to estimate. For an average wine investor it is rather difficult to gather all information that affects the quality of a certain wine, but even more importantly it is almost impossible to evaluate how different factors affect the actual quality of the wine. For example weather conditions in a certain wine region can be accessed with reasonable effort but it will be much more difficult to evaluate how they affect a single wine in that region. Therefore it is better for the investor to use proxies when evaluating the quality of wines. Also the reputation of an estate or a wine is difficult to measure. We have to use a proxy of some kind to evaluate what is the difference in prestige between wine brands.

The most classic of these proxies, which reflects both quality and reputation, is the 1855 classification of Bordeaux chateaus. In 1855 French authorities felt need to classify chateaus to different quality groups, or growths, to make the evaluation of the quality easier for consumers. Thus, the best wineries from the region were placed in five *grand cru classes*, first being the highest and fifth the lowest growth. We must bear in mind that most of the wines (namely all table wines) are excluded from this classification and belong simply to general Bordeaux or some sub-region *appellations*.

Even though the 1855 classification is still valid there are several problems associated with it. Firstly, large majority of wines included are from Medoc, while wines from Pomerol, Graves and St.Emilion are excluded (except for Château Haut Brion, which is from Graves but belongs to 1855 first growth). Because of this, it excludes a large portion of all fine wines even from Bordeaux, and of course from all other corners of France and the rest of the world. Secondly, the

quality of wineries, vines and wines has changed during the last 150 years while the classification has not (except for the promotion of Château Mouton Rothschild from second to first growth in 1973), so it is not completely up to date. However especially the first growth wines are still among the best wines in the world measured by any available scale. So even though the accuracy and coverage of the Bordeaux 1855 rating is limited, it still affects the price of especially Medoc wines as observed by Ali (2003).

Following 1855 classification the excluded Bordeaux regions have created their own similar classification systems. These include for example Graves, St.Emilion and Sauternes. These most often have only two to three growths, instead of the five growths in the Medoc 1855 classification. Only major Bordeaux region not to have a rating system is Pomerol. However, these other regional rating systems have not reached the prestige possessed by the 1855 classification.

Maybe more relevant measures of quality than different regional ratings are the opinions of wine experts. There are several authors who taste and evaluate wines, but one of them is above the rest. Robert Parker can be held as the guru of fine wines and the effect of his opinions on the price of the wines is considerable (Ali *et al*, 2005). His remarks and scores therefore not only give a good approximation of the quality but also of the reputation of all fine wines. A rule of thumb for a wine investor given by Sokolin (1998) is that if Robert Parker has not given the wine over 90 points do not buy it. Other proxies that affect both reputation and quality of wines are the so-called vintage charts. They give an estimate of how good the year was in general for wines in different wine regions of the world. Each region naturally has different weather conditions and thus each region is rated separately and a poor year in Bordeaux might be excellent in California. Vintage charts affect on the general price level of all the wines from the region in a specific year. In a good year all the wines are more expensive and the best wines of these years become cult wines, while during bad years all the wines from the region have an image of poor quality hanging over them. Good examples of great vintages from last two decades for Bordeaux are years 1990 and 2000 while bad years include 1991 and 1992. Even a good score from Parker does not help wines from vintages '91 and '92 – the liquidity and prices remain low. And, on the other hand, the price and liquidity of most of the wines produced in Bordeaux in 1990 and 2000

are good, no matter what the actual quality of the wine is. A good example is provided by Château Léoville Lascases vintages 1989 and 1992. 1989 is one of the best vintages in last two decades with Robert Parker's vintage rating of 90, while 1992 is one of the worst with rating of 79. However, Château Léoville Lascases vintages 1989 and 91 received 89-90 and 91 respectively from Robert Parker, which would indicate them being almost equally good. Yet, the price for a bottle of Léoville Lascases 1989 has been around 100€ per bottle, while the price for a bottle of 1992 is on average less than 35€.

One of the basic factors affecting the price of collectibles is the scarcity of them. In his 1989 study Lynn tested the effect of scarcity to desirability and perceived expensiveness and found negative correlation between these and the produced amount of wine. There are two factors affecting the amount of wine available for investors: the amount produced and the amount consumed. The production varies hugely between different wines; some of the top producers make more than 40,000 cases or 480,000 bottles of a specific wine per year, while the production of some wines only reach some hundreds of cases per year. The amount consumed is almost impossible to measure accurately, but it is directly linked to the age of particular wine. As the amount of bottles cannot increase over time, and at least every now and then some bottles are consumed or destroyed, the total number of bottles is reduced as time passes. Hence I use the production amount as a proxy for scarcity in the valuation models.

Time actually affects the price of a wine in two ways. One is the scarcity effect discussed above and the other is the quality of wine. Fine wines need several years, even decades, to reach their maturity and thus optimal drinking age. Wine, unlike most drinkable or eatable goods gets better with ageing, as the tannins and acids soften. Because of the scarcity and quality effects discussed above, age has positive effect on the price of wine and thus older vines are commonly more expensive than young wines. There is naturally a point after which wines do not increase in quality and eventually the wine turns bad. This point depends on the quality of the wine and vintage. Cheap table wines may only last for a year or two, while a standard investment grade wine develops for at least a decade and can be cellared for 20 to 30 years. Vintage ports and best Bordeaux red wines from may develop for many decades and last more than a century (vintage ports and sherries even many centuries). Often producers and experts give estimates of the

potential of wines: typically they state when the wine is estimated to reach its maturity and how long it can safely be stored in a cellar.

2.2.2 *Micro Factors*

The factors that are discussed above affect the price of the wine in general – or on average. However, in an auction the price of wines vary from lot to lot, not only between different wines and vintages. There are several factors affecting the price differences between different lots of same wine and vintage.

First, and most importantly, the history of wines is vital in auctions. This is called *provenance*, and it tells who has owned the bottles and where they have been stored. William Sokolin gives many examples how provenance has dramatic effects on the price of a wine in his book The Complete Wine Investor (1998). Good and proven storage conditions reduce the risks for buyer and thus increase the price, while wines stored in private cellars or in unknown locations increase the risk and affect negatively on the price. Another important factor is so called *ullage*, which means the level of liquid in the bottle. High ullage indicates proper storage and good cork, while low ullage indicates a risk of *corked* wine. For this reason the level of liquid is usually given in the auction brochure if it is not normal. Also the general condition of bottles, labels and capsules affect the price.

One factor affecting the price per 750ml of wine is the size of the bottle. Different bottle sizes are presented and explained in Table 1. Larger bottles are usually more expensive than smaller ones because wine matures better in larger bottles and there are also fewer large bottles produced (Sokolin, 1998). So there are quality and scarcity effects that make magnums and other large bottle sizes more expensive. Finally, the lot size affects the price of a single bottle. Wines in original full wooden crates are the most valuable, while single bottles are usually sold at discount, according to Sokolin (1998) and Nuikki (2003). This is similar to uncommon lot size in share markets. They are hard to sell and you might have to sell them at discount.

Table 1

Table 1 shows the different bottle sizes, their names and descriptions. Larger bottles are often more expensive as they are manufactured in lesser quantities and wine matures better in them.

Bottle Size	Defined	Description
0.375 Milliliters	Half-bottle	One half of the standard bottle size. Also known as "split", "tenth" or "demi-bouteille".
0.750 Milliliters	Bottle	Standard bottle size, some refer to it as a 'fifth'
1.5 Liters	Magnum	Two standard bottles in one
3.0 Liters	Double Magnum	Equivalent of 4 standard bottles
4.5 - 5 Liters	Jeroboam	Two sizes: or Rheoboam for sparkling wine Jeroboam (3.0 Liters) is equal to 4 standard bottles; Still wine Jeroboam (4.5) equivalent to 6 standard bottles. Sometimes Jeroboam can be 5.0 liter bottle.
6.0 Liters	Imperial	8 standard bottles; traditionally bottled in a Bordeaux-shaped bottle; or, Methusalem for Champagne
6.0 Liters	Methuselah	Used for sparkling wine in Burgundy-shaped bottle; same size as the Imperial
9.0 Liters	Salmanazar	12 standard bottles, 1 case
12.0 Liters	Balthazar	15 bottles of wine; usually for sparkling wines
15.0 Liters	Nebuchadnezzar	20 standard bottles of wine, used mostly for sparkling wine.

2.3 Buying Wines

Investors can buy wine in primary or secondary markets. The sources in the primary markets include wine yards, wine merchants and so-called *en primeur,* or wine futures market. Wine merchants are the most convenient way for many investors to buy young wines, they are easily accessible in most countries, buying is simple and quite safe and the merchant can also offer his/her expertise for the investor. Some vineyards sell part of their production straight to customers, but this is not often the case for IGWs. The *en primeur* market is typical to Bordeaux. They offer buyers the opportunity to buy a kind of wine futures before the wine is even bottled. Secondary trading has traditionally been done through auction houses and it is still the most common method. Other options include buying wines from wine merchants, private investors or Internet exchanges. All of these methods have their advantages and disadvantages. I will now briefly discuss the secondary market channels and their pros and cons.

2.3.1 Auction Houses

Auction houses are the most traditional vehicles in aftermarket wine trading. The most prestigious and most expensive wines are mostly sold through the top auction houses. For example Sotheby's sold Andrew Lloyd Webber's wine collection in 1997 for millions of euros, while Christie's in London conducted a sale of 19,000 bottles from anonymous donor for astonishing $11.3 million. These included $114,614 paid for a jeroboam of Château Mouton-Rothschild 1945, $109,324 for Château Cheval Blanc 1947 and $45,760 for a bottle of Château La Mission-Haut Brion 1945 (Sokolin, 1998).

However, not all the wines auctioned trade in thousands of or even in hundreds of euros. In the data set collected for this study, which includes more than 20,000 auctioned lots of the most liquid investment grade wines, the average price is just above two hundred euros, minimum price was €12 and maximum price was €7,966. The relatively low prices, in comparison with examples mentioned above are mainly explained by the fact that my set includes only wines that are less than 20 years old, most less than 15 years old, while the most expensive wines are old legendary wines from great vintages, which have become rare. The lowest prices can be justified by the fact that not all vintages of all wines can be classified as IGWs, but they are still included in the data.

There are different attractions in auctions for buyers and sellers of wine. For buyers, it is the large supply of different wines that wine merchants are not able to offer. Auction houses also provide security for the buyers as they strive to guarantee that the bottles they sell are not fakes. With some luck and skill buyers can also find bargain deals in auctions. For sellers auctions offer a possibility to get a good return on their wines through an established market channel. The main drawback of auctions for both buyers and sellers is the high level of transaction costs. Most auction houses take their cut from both the buyer and the seller and it often totals 30% of the final price of the wine. Table 2 presents the typical prices charged by auction houses that are included in this study. There are no great differences between different houses, but generally commissions are lower in Europe. Sellers' commissions are variable, but tend to be from 10% to 20% of the hammer price depending on the amount and quality of sold wines. Additionaly the bureaucracy involved in auction trading is rather heavy and time-consuming.

Table 2

Table 2 shows the commissions charged by auction houses as percentage of hammer price.

Commissions	Buyer	Seller *
Sotheby's		
London	15.00%	variable
New York	17.50%	variable
Christie's		
London	10.00%	variable
Amsterdam	17.85%	variable
Geneva	15.00%	variable
USA	17.50%	variable
Morrell's	17.00%	variable
Acker Merral	17.50%	variable
Zachy's	18.00%	variable

* Sellers' comission is variable, but generally 10-20%

2.3.2 Wine Merchants

Wine merchants offer a very convenient way to buy wine. The quality of wines, as well as service, of course varies from shop to shop. In the Nordic countries state-controlled monopolies are the only sources of wines, which limits the supply dramatically. In wine-producing countries merchants tend to offer mostly local wines, which they know best and have direct access to. In non wine-producing countries the supply of wines is often diverse and balanced between the old and New World. The quality of his/her merchant is vital for a wine investor. The best merchants have access to the top wineries and the risks involved in for example *en primeur* purchases are reduced. Sokolin (1998) devotes a whole chapter in his book to promote well-established wine merchants, which is not that surprising as he is merchant himself.

2.3.3 Online Services

Many online services have been launched since the late 1990's. Most of these function as exchanges, or market places, for wines where buyers and sellers are brought together. Others, like LivEx, also provide market reports and market data. The advantages of online services in

comparison with traditional auction houses are lower transaction costs and constant trading. However, online services do not take any responsibility of fake bottles and the buyer protection is weaker. The increased use of Internet has already given the online services an edge and this development is likely to continue in the future. For investors online auction houses or exchanges might prove to be the solution to high transaction costs related to traditional auction houses.

2.3.4 En Primeur Market

En primeur market is effectively futures market for Bordeaux wines. The buyer purchases the wine before it has even been bottled, let alone stored and put to the normal market. The main difference to a traditional financial future is that the wines are actually paid in advance and delivered later. This feature naturally increases the counterparty risk of the buyer and thus increases the importance of the selection of one's merchant. The futures are sold every spring after the wine has been stored in casks for a few months. The wine makers should at this point know quite well the quality of the final product. Before the sale of futures a board of experts is invited to taste the wines and their opinions have a large impact on the prices. Ali *et al.* (2005) studied the effect of expert opinions by using the *en primeur* market and Robert Parker's opinions. They were able to measure his effect on prices, as in 1997 he did not attend the tasting.

En primeur market is attractive for an investor who wants to get hold of the top wines, because they might be very hard to get after they are bottled and sold on the normal market. Most often the investor also gets the wines cheaper by buying futures, but there have been years when the opposite is true (Sokolin, 1998). As, mentioned just as in the futures market the role of the merchant becomes vital. There are countless examples of defaulted, shaky wine merchants who are not able to provide the wine, but disappear with the investors' money.

2.3.5 Private Market

Wine is also traded between wine lovers and investors without any formal market place. The amount of wines traded between individuals is very difficult to estimate, but the market exists, which is not surprising considered the problems with auction houses and other market places. By buying and selling without any third parties both buyers and sellers save considerable amount of time and money. The risks related to private deals are however high, as in any deals between two individuals, and thus the trust between the counterparties is essential. Also, private sales of all alcoholic beverages, including wines, are illegal in some countries.

2.4 Storage of Wines

Storage is a vital part of investing in fine wines. Many valuable bottles have been ruined in poor storage conditions. For the development of wine it is critical to store it in a dark, quite humid place, where temperature is around 12-15 Celsius degrees. Considering these requirements it is no surprise that wine is most often stored in cellars. For investors there are basically two main alternatives when it comes to storing one's wines: either to keep them in one's own cellar or to rent a cellar place. Both of these options have their advantages and disadvantages, but for a wine investor the rent option is often better.

2.4.1 Own Cellar

The most obvious advantages of storing wines in one's own cellar are costs and convenience. After the initial cost of setting up the cellar running it is often cheap. Costs naturally depend on whether the humidity and temperature are naturally suitable for wines or does the cellar require machinery to keep the climate conditions right. Building costs for a cellar might be anything from a few hundred euros to even hundreds of thousands euros. For wine-lovers the fact that wines are readily available is of course very valuable an option. However, the reputation of home-stored wines is usually worse than of those stored in commercial cellars that are proven to be of good

quality. This might have negative impact on the price of wines, if the investor cannot prove that his / her cellar meets all the quality standards.

2.4.2 Outsourced Cellar

There are several different types of cellars where one can store wines. Most of these public cellars are located in large cities for ordinary wine buyers. However, especially in the United Kingdom, there are many tax-free cellars, which are often located in harbour areas. The main advantage of storing wines in a well-established commercial cellar is reputation. A proven quality cellaring has positive effect on the price of wine in auctions. There has been no studies made on the factor, but for example Nuikki (2003) and Sokolin (1998) both estimate that price difference between similar wines with different storage records might be as high as 15%.

The cost of keeping wines in commercial cellars varies greatly. It can be anything from around 5€ to 20€ per case per year. The price usually includes a proper insurance, but practices differ from one place to another and the investors should make sure their wines are insured. For those who also like to drink their wines commercial cellars, especially tax-free cellars, can be inconvenient. When stored in a tax-free cellar, wines cannot be taken from storage without some paper work, time and payment of taxes. In normal cellars the practices differ, but usually it is possible to access them at any time.

2.5 Insurance

It is always good to insure investment grade wines. As mentioned earlier, if the wines stored in tax-free cellars, insurance is often included in the price. If, on the other hand, wines are kept at investor's own house or cellar it is good to make sure they are insured against the usual threats like theft, water and fire damages. In some cases a normal home insurance may cover the wines, but quite often a special insurance is required. For example in Finland practices vary from one insurance company to another, without any clear general industry policy.

2.6 Fake Wines

Fake products are a risk in the wine market, as in most other collectibles markets. Creating a relatively sophisticated fake bottle of wine is not an enormous task. Assume that someone buys cheap, old Bordeaux wine, changes the capsule and label of the bottles to match those of Château Mouton Rothschild from the same vintage. It requires a true expert to spot a fake bottle without removing the capsule and even the cork can be changed and faked. So, the sham may be identified only after tasting the wine – if even then. The risk of fakes is one major reason why provenance is so important. A case with proven history from vineyard to auction house is most probably authentic, while another case with dodgy history may have never seen the chateau it claims to originate from. The top auction houses also try to make sure they do not sell fake bottles by employing industry experts as their reputation, which allows them to charge high fees, is always on the line.

2.7 Wine Market for Investors

The participants in wine market include private collectors, buyers for restaurants, wine merchants and wine investors. In the high-end market most of the buyers are experts and thus the investor should also get accustomed to the market and gain knowledge of both the wines and the market, as information asymmetry might cause big losses for uninformed investors. The current size of the market should allow wealthy individuals and small investment funds to invest into the market without fear of actually pushing up the prices as a result of increased demand. Actually investors are likely to also add supply, as they do not consume the wines they purchase but hold them and sell forward after some years. However, if a fund of considerable size entered the market it probably would push the prices up at least momentarily as result of increased demand for IGWs.

The main points for wine investors are to act rationally according to a predetermined strategy and to establish a way to value wines they buy. Investors should compare the market places and emphasize the reliability and low transaction costs of the seller. The primary market might be the best channel for investors to buy their wines, as the sellers in the primary market do not charge high commission and the unsystematic risk, which is related to the fact that it is often difficult to

evaluate the potential of young wines, can be diversified away by buying several wines from different regions. Rules of thumb given by Nuikki and Sokolin should also be kept in mind: buy only great wines from good vintages, always in full boxes and prefer larger bottles.

3. Literature Review

This section contains a review of the most relevant literature written on wines as an asset class and on the performance of wine investments. I will also introduce some more general studies made on other collectibles, like art and stamps, and collectibles in general. The most important works on hedonic pricing models are introduced in the methodology section.

3.1 Wine Literature

There are of course a great number of books and articles about wines, but only a small fraction of them study the financial side of wines. It is however very useful, if not necessary, for an investor looking to invest in wines to gather basic knowledge of wines in general. One should not invest in shares of a company without knowing anything about the company, industry or general market conditions, and the same goes for wines. Some good references for general wine knowledge are books written by Oz Clarke (2003) or Hugh Johnson (2001). These include the basic facts about different wines, wine regions, winemaking techniques, *terroir*, tasting, storage and so on. There are also a couple of good books written on investing in wines. The Complete Wine Investor by Sokolin and its predecessor Liquid Assets give a good insight into the markets as well as give many practical tips and even buying recommendations. In Vino Veritas by Pekka Nuikki is a Finnish wine investor book, which is a good introductory book for anyone drinking wines or investing in wines. All of these however lack academic view and the reporting of achieved returns tend to concentrate on large gains rather than unbiased total portfolio returns. The rest of this section is devoted to academic literature about wine pricing and wine as an investment class.

3.1.1 Performance of Wine as an Investment

A few studies have evaluated the performance of wines and built different wine indices during the last decades. I was not able to find any indices done after 1990's, but there were several made during 70's and 80's. Burton and Jacobson (1999) have collected several results for different

collectibles in their study to evaluate the performance of collectibles in general. They found six different studies made during the period from 1973 to 1996. In addition Bentzen *et al.* (2002) wrote a discussion paper, which studies Danish auction market and its correlation with several economical indicators. Burton and Jacobson studied mainly the annual returns that the original authors had reported and compared them with equity and debt returns. They conclude that wines generally have produced lower returns than equity but higher returns than debt.

Krasker (1979) constructed the first academic wine index to study the performance of red Bordeaux and California cabernet sauvignon from 1974 to 1977. Krasker was inspired to study the performance of wine as he had read several articles written by wine experts where they insisted that wines produced superior returns compared with traditional asset classes. He found annual nominal rate of return less than 0.5% and a negative annual real rate of return of 7.7%. Krasker concluded that wines did not seem to offer excess returns. However, as Jaeger (1981) points out Krasker's evaluation period included two especially bad years for wines and the estimated costs of storing wine were too high at $1.40 per bottle for a year, which indeed sounds high in 1970's prices. Jaeger used a storage cost of $0.44 per case of wine and included the years 1969-1977 for her model. She concludes that wines outperformed T-bills by a clear marginal (16.6%) during the period.

Ashenfelter *et al.* (1993) presented a wine index related to their study of red Bordeaux wines from vintages 1961 to 1972. In addition to evaluating the effect of weather on wine quality they constructed separate indices for all the vintages for the years 1971-1989. The aggregate results provide negative returns when compared with bonds and shares (Burton & Jacobson, 1999). Ashenfelter *et al.* however made interesting observations about differences between the starting prices for vintages with different quality. They conclude that poor vintages tend to trade at too high prices compared with their price potential. Byron and Ashenfelter (1998) expanded Ashenfelter *et al.*'s (1993) test for Australian premium wine Grange, which is also included in the data set used in this study. They find that the returns offered by a portfolio of Grange from years 1959-1994 were higher than debt and equity on average.

Fase (1996) studied performance of art as an investment and compared it to Bordeaux red wine for the period from 1982 to 1992. He found that wine's performance as an investment was approximately in line with art, lower than equity but higher than debt. Burton and Jacobson (1998) studied several different portfolios, some of them suggested by experts, including Sokolin (1998), over the period from 1986 to 1996. They found that composite indices underperformed equity, but over performed debt slightly during the period. The performance of portfolios selected by experts varied, most of them producing better returns than the composite index. Finally Bentzen, Leth-Sørensen and Smith (2002) compiled a semi-annual premium Bordeaux wine index, which covered vintages 1950-1998 that traded in a Danish auction house during 1988-2002. They compared the performance of the index with several economical indicators, namely consumer confidence, industrial activity, car sales, stock market index, GDP and private consumption. They found different levels of correlation ranging from around zero with industrial production to 0.9 with GDP and private consumption. They also found that the stock market index correlates heavily with the price estimates (0.9), but not so accurately with the actual hammer prices (0.5). The period in the late 1990's saw rapid increase in wines prices because of booming economy. This might also be caused by the entrance of new buyers from east coast of the United States and Eastern Europe (Sokolin, 1998).

The index construction methods differ between these studies. There are basically three different ways to construct wine indices and calculating returns, all of which have their advantages and disadvantages. I will briefly explain these methods, their use and differences. Composite index is the most commonly used method for equity and bond indices. It can be based on either variable or fixed basket of wines. In the first case the composition of the index changes over time, based on selection by the author or on some selection rule (for example liquidity over time). The fixed basket of course remains the same for the whole observation period. The fixed basket method of composite index cannot be used for very long periods, as wines have limited lifetime, but for relatively short period fixed basket provides easily comparable and stable benchmark index. Variable basket enables a longer observation period, but the selection of changes should be done carefully. If the characteristics of underlying wines change, the comparability of the index over time becomes difficult. Composite index has been used for wines by for example Burton and Jacobson (1998).

Other methods include hedonic price indices and repeat sales methodology. Hedonic regression allows the researcher to estimate the pure effect of time, as changes in other variables can be controlled and it also allows changes in the qualities of wines that make up the index. This is especially convenient when a limited number of observations for similar products is available. For example Ashenfelter *et al.* (1993, 1995) used hedonic regression in their studies. The third method of calculating returns is to pool data from repeat sales and run a "repeat sales" regression. This method overcomes some of the problems described in composite indices, as repeat sale regression controls for quality by using the changes in prices for particular wines. Repeat sales method requires the item to be sold at least twice during the observation period, which in case of wines is not a serious problem. However the bottle specific changes must somehow be accounted for to avoid comparing a prime condition magnum with a low-ullage, poorly stored standard bottle.

3.1.2 Valuation of Wine

I will first discuss the history and use of hedonic regression, which is the most often used tool in the wine pricing models. The earliest references to hedonic pricing and regression are the papers by Waugh (1928) and Court (1939). These apply the pricing model to agricultural and automobile prices. However, Ivy Griliches's (1971) article revolutionized the use of hedonic pricing models and showed that it is applicable to far wider use. Also Rosen's (1974) article is a landmark study in use of hedonic regression. Nowadays most housing indices are constructed using the hedonic pricing model. It is also widely used in many collectibles market, like art (Chanel *et al.* 1994, 1996) and wines (Ali & *et al.* 2003).

A large number of studies apply hedonic price analysis to estimate implicit prices for wine quality attributes. They are based on the hypothesis that any product represents a bundle of characteristics that define quality. Their theoretical foundation is provided in the paper by Rosen (1974), which states that goods are valued for their utility-generating attributes. Rosen suggests there are competitive implicit markets that define implicit prices for embodied product attributes, and that consumers evaluate product attributes (e.g. features of a car, indicators of air or water

quality) when making a purchasing decision. The observed market price is the sum of implicit prices paid for each quality attribute. Rosen also recognizes an identification problem for supply and demand functions derived from hedonic price functions, because implicit prices are equilibrium prices jointly determined by supply and demand conditions. Hence, implicit prices may reflect not only consumer preferences but also factors that determine production. In order to solve the identification problem it is necessary to separate supply and demand conditions. Arguea and Hsiao (1993) argue that the identification problem is essentially a data issue that can be avoided by pooling cross-section and time-series data specific to a particular side of the market.

Since the quality of a particular bottle of wine cannot be known until it is de-corked and consumed, buyers' willingness to pay depends on the reputation associated with and the expected quality of that wine. In addition to quality ratings many authors argue that the reputation of the winery, the wine region and the grape variety(-ies) used also affects wine prices. Shapiro (1983) presents a theoretical framework to examine reputation effects on prices. He develops an equilibrium price-quality schedule for high-quality products, assuming competitive markets and imperfect consumer information, to demonstrate that reputation allows high-quality producers to sell their items at a premium that may be interpreted as revenue for producer investments in building reputation. On the demand side of the market, it is costly for consumers to improve their information on product quality too. In such an environment of imperfect information, learning about the reputation of a product or of some of its attributes can be an effective way for consumers to reduce their decision-making costs.

Oczkowski (1994) provides one of the first empirical wine studies to adopt this reputation approach using a hedonic pricing model. He estimates a log-linear function for premium Australian table wine, relating retail prices to six attribute groups: quality, cellaring potential, grape variety, grape region, grape vintage, producer size and various interaction terms. He found all of the variables significant, quality and cellaring potential having a positive price effect, while production amount having negative price effect. Oczkowski found that the differences between vintages, region and grapes were also considerable. In another empirical application to Australian wines, Oczkowski (2001) estimates hedonic price functions for wine assuming attribute measurement errors. He finds significant reputation effects but insignificant quality effects.

Ginsburgh *et al.* (1994) apply the hedonic price method to a sample of 102 Medoc wines. Their data set allows them to disentangle the price effects of weather, reputation (as measured by the 1855 classification), natural endowments (soil, exposure of the vineyards or grapes), and all sorts of production factors. They show that technology and weather conditions explain two thirds of the price variation, and once the reputation variable is added the proportion of explained variance increases to almost 85%. They also show that more recent classifications (such as Parker's classification) do not lead to a better fit of the hedonic price equation than the 1855 classification.

Nerlove (1995) examines the Swedish wine market, which is characterized by the Nordic characteristics of no domestic production, a small share of global consumption, and government control of prices and sales channels. This allows him to presume that prices are exogenous (as opposed to assuming supply is exogenous) and to estimate a reduced form hedonic price function, regressing quantities sold on various quality attributes and prices. Thus, Nerlove assumes that wine consumers in Sweden express their valuation of a particular quality attribute by varying the derived hedonic demand for it.

Golan and Shalit (1993) identify and evaluate quality characteristics for wine grapes produced in Israel relative to California wine. That is, they analyze hedonic grape pricing of the input supply side of the wine market. Their premise is that high-quality wines are produced only when growers are given a price incentive strong enough to supply better grapes. In a two-stage model, they first develop a quality index by evaluating the (relative) contributions of various physical grape attributes to wine quality. Second, they construct a quality-price function relating the price of Californian wine to the quality index developed in the first stage. Analogous to Nerlove, they also assume that prices are exogenous. Ashenfeltet *et al.* (1995) use hedonic regression to estimate the prices of young Bordeaux red wine in their discussion paper. They introduce several weather variables, including average temperature during growing season and harvest, and the amount of rain before the growing season and during the harvest. They show that the quality of mature wines can be predicted by the weather during the growing season.

Landon and Smith (1997) studied the absolute and relative impact of current quality and reputation variables on consumer decisions, using data from the market for Bordeaux wine. They

use suggested retail prices provided by Wine Spectator as the proxy for wine prices, rather than actual prices from merchant or auctions. Their results show that consumers make decisions based on information on reputation (past quality) and collective reputation (average group quality), rather than only current quality. They use points given by Wine Spectator as indication of current quality and Parker's (1985) classification of Bordeaux reputation. The collective quality is measured by the Bordeaux 1855 classification introduced in section II. The results also indicate that reputation has a large impact on consumers' willingness to pay, that long-term reputation is considerably more important than short-term quality movements and that consumers react slowly to changes in product quality. However, the use of suggested retail prices might over-emphasise the effect of long-term reputation, while the actual prices are likely to be affected more by the current quality. Landon and Smith also find that the regional appellations are as important as the reputation of single chateaus.

Combris, Lecocq and Visser (1997) estimate a hedonic price equation and what is referred to as a jury grade equation for Bordeaux wine to explain the variations in price and quality, respectively. Landon and Smith (1997, 1998) also present empirical analyses of Bordeaux wine, focusing on reputation indicators in addition to sensory quality attributes. In both papers, they study the impact of current quality as well as reputation indicators on consumer behaviour using hedonic price functions. Lagged sensory quality ratings define individual product reputation. Regional reputation indicators are government and industry classifications. In addition, their 1997 paper analyzes five individual vintages over the period from 1987 to 1991. Their main conclusions are: reputation indicators have a large impact on consumer willingness to pay; an established reputation is considerably more important than short-term quality improvements; and ignoring reputation indicators will overstate the impact of current quality on consumer behaviour. Their estimated coefficients vary substantially across the five vintages examined.

In an analysis of the U.S. wine market, Schamel (2000) estimates a hedonic pricing model based on sensory quality ratings, individual wine quality and regional reputation indicators for two premium wine varieties: a white (Chardonnay) and a red (Cabernet Sauvignon). The paper examines seven New World regions (Napa and Sonoma Valley, Sonoma County, Oregon, Washington State, Australia, Chile, South Africa) and includes observations from a pool of eight

vintages between 1988 and 1995. However, it does not estimate coefficients for individual vintages. The estimated price elasticity of sensory quality is larger for white wine, indicating that U.S. consumers were willing to pay a higher quality premium for white compared with red wine at that time. However, the results suggest both regional reputation and individual quality indicators seem to be more important to American consumers of red wine. The results also suggest that the marketing of regional origin as a reputation attribute may have a higher payoff for regions primarily growing red wine. In other words, it seems that the public good value of a regional appellation is higher for red wine regions and that individual producers in those regions may benefit more from collective marketing efforts.

Schamel and Anderson (2001) estimate hedonic price functions for premium wine from Australia and New Zealand, differentiating implicit prices for sensory quality ratings, wine varieties, and regional as well as winery brand reputations over the vintages from 1992 to 2000. They use quality and reputation scores provided by an Australian wine critic James Halliday and other quality ratings from *Winestate* wine magazine. The prices are Australian retail prices. For Australia, the results suggest regional reputations in general are becoming increasingly significant through time, indicating an intensifying regional quality differentiation. In addition, some specific cool-climate regions are becoming increasingly preferred over other regions. Price premiums based on brand reputation also are shown to be significant. For New Zealand, regional quality differentiation is considerably less significant than in Australia. In each country, price premium associated with both Halliday's and Winestate magazine's sensory quality ratings, and with Halliday's winery ratings and classis wine designations, are highly significant.

Jones and Storchmann (2001) use wine auction prices for 21 prestigious Bordeaux wines to assess the respective effects of the year of vintage, the grape composition (acid and sugar levels), and quality (as measured by Parker points). They estimate the price effects of each variable for each wine and find quite large variations in the price effects. For example the price increase induced by a one-point increase in the Parker rating is 7% on average, ranging from less than 1% to more than 10%, while the effect of one extra year of cellaring varied from 1.2% to 9.7%. As basically all of the Bordeaux red wines are blends of cabernet sauvignon and merlot, they estimate acid and sugar levels related to weather conditions each year. They find that merlot

dominated wines are more sensitive to climate conditions and they profit more from ageing. Other interesting findings include the fact that wines from small wineries and cabernet sauvignon dominated wines are more sensitive to Parker points than others.

Lecocq and Visser (2003) study the effect of objective and sensory variables using hedonic technique to wines. They include objective characteristics appearing on the label, as well as sensory characteristics and quality, as measured by expert tasters in the price equation. Authors use three almost identically structured data sets (two on Bordeaux wines, and one on Burgundy wines), which enable them to make comparisons between wine regions and comparisons over time. Their results indicate that characteristics that are directly revealed to the consumer upon inspection of the bottle and its label (ranking, vintage and appellation) explain the major part of price differences, while sensory variables do not appear to play an important role. Wine prices are also hardly affected by the grades assigned by professional wine tasters. Although jury grades have a significant effect, their impact on prices is very small compared with the impact of ranking and vintage. Lecocq and Visser also find that the jury grade, unlike the price, is primarily determined by sensory characteristics. Only one out of five of the variables that have a significant influence in the jury grade equations is an objective variable.

Hadj, Ali and Nauges (2004) exploit a panel data set covering 132 Bordeaux châteaux over sixteen vintages (1982-1983, 1985-1998) to estimate the influence of current quality (as measured by Parker grades and by an overall vintage score given by Wine Spectator) and reputation (as measured by the ranking of the wine and by the average of the scores Parker gave to previous vintages) on the pricing of en primeur wines. They find that prices mainly depend on the reputation of the châteaux through their ranking. They also find that the marginal impact of Parker grades on en primeur prices is significant but small: a one-point increase in the grade leads to a price increase of 1.01%.

Dubois and Nauges (2005) use a subsample of the Hadj, Ali and Nauges (2004) data set, including 108 châteaux over the 1994-1998 vintages. They argue that true quality, which is known by the producer but unobserved by the consumer and the econometrician, will not only influence the pricing of en primeur wines but also the Parker-rating, implying an endogeneity

issue which may lead to biased estimates. Controlling for unobserved quality allows them to disentangle the effect of quality from the effect of Parker grades on prices. They find evidence that Parker grades significantly affect the price of en primeur wines: a one-point increase in the grade increases the price by 1.38%. They also show that the impact of Parker's judgment is clearly over-estimated when unobserved quality is not accounted for since in this case it equals 3.95%, which is much larger than the effect found by Hadj Ali and Nauges (2004) using the whole data set.

Costanigro, McCluskey and Mittelhammer (2006) study different categories of the wine market by using hedonic regression. They find evidence that consumers value the same wine attributes differently across wines, depending on the price range under consideration. Differences across the lower-priced segments are mostly relatively small, while the fine wines segment has a radically different hedonic function. Number of cases produced, expert rating scores, and aging have a stronger impact on price in the fine wine price categories than in the lower-priced categories. Regional appellations, along with other information reported on the label, have a positive effect on price only for the inexpensive and mid-low price segments, and are non-significant or negative for the higher ones.

3.2 Other collectibles

I will briefly present selected studies concerning collectibles other than wines to get perspective on both the performance and valuation of wines in comparison with other similar assets. I will begin by presenting some evidence of the scarcity effect related to collectibles, followed by general literature about collectibles and finally I will present some specific works on other collectibles that resemble this study.

The role and meaning of scarcity have been recurring themes in economics. Some papers have been written already in 19th and early 20th century, including Rae (1907; 1834) who provides one of the first discussions of fashion and conspicuous consumption as a motive for acquisition. Veblen (1973; 1899) based his work on Rae's paper but emphasises the importance of social status brought by rare objects. Other authors have continued to analyse and classify consumption

of rare objects, early work include for example Marshall (1920) and Leibenstein (1950). Hirsch (1976) and Scitovsky (1987) discuss scare goods that signal social status. Hirsch describes items, which do not have additional supply (items created by dead artists, feudal castles, etc.), while Scitovsky studies goods, whose supply is less limited (items by living artists, exotic holidays, etc.). Wines belong to the latter part and can be considered as rare goods, which can boost social status of the owner. Frank (1985) argues that people select their occupations and workplaces partly by their perceived rarity. He shows that people are willing to accept lower wage for high-status, rare position. However, some authors have theorized that the price premium of rare objects might be due to other reasons than their rarity per se. For example Klein and Leffler (1981) argue that that people use price as an indicator of quality. Then people value the scarce object, not for its scarcity, but rather because of its anticipated higher quality.

Koford and Tschoegl (1997) estimate the market value of rarity using two American coins. They find that the price of coins correlates with rarity. The price elasticity of original mintage was in range of 0.28-0.84. Coins differ from wines in respect that they do not increase in quality over time, but on the other hand they are not consumed, even though some coins are probably lost, over the years. Lynn (1989) did two separate studies to measure the desirability of scarce items. Both tests were conducted by questionnaires where indication of rarity was given in the material. In the first test, using two prints – rare and available – he found that the rare print is thought to be more expensive than the widely available. The second test involving a white whine showed that people are more willing to buy the rare rather than widely available wine, whether they had the price information or not. These tests would indicate that people indeed are more interested and more willing to buy rare items rather than readily available items other things being equal.

Burton and Jacobsen (1999) collect the results from several studies of different collectibles to measure the returns of different collectibles. For wines, the results are presented in section 4.1. However, they cover also studies on prints, antique furniture, ceramics, coins, visual arts, stamps and other collectibles like Beanie Babies and Stradivarius violins. They conclude that in general collectibles do not provide returns in excess of equities or bonds, when transaction and holding costs are included. There are some exceptions, but they are limited to some time periods and sub-samples of some collectibles. I will present a few studies for different types of collectibles to

evaluate the differences between them and wines. The most studied type of collectible is art, especially paintings. This is probably because the market has existed for several centuries and for example Reitlinger (1961, 1970) provides a widely used data set, which includes observations from 1650 onwards. Empirical studies have usually analysed certain sector of art, such as the market for modern art or the market for Impressionists, and draw conclusions for these. The returns from paintings are often divided to financial returns and consumption services (including decorative value and prestige to owner).

For example Anderson (1974), whose work is considered to have opened the field of art related financial papers, investigates the Old Master paintings markets, English 18th and 19th century art, Impressionists and 20th century painters for the period from 1780 to 1970 using the Reitlinger data set. He assumes decorative returns to depend primarily on size, condition, and subject matter, while aesthetic and prestige services depend on attribution (signed or not signed), artistic reputation of the work and provenance; finally, financial services are assumed to be determined by expected rate of return and risk. These data sets do not contain all the information to account for the whole list of influential factors. Thus Anderson regresses realised prices (in logs) on year in which the work was sold, size of the work, year in which the work was painted, age of painter when the work was painted, whether the artist was alive when the work was sold, and place of sale. He uses average prices for each artist as a proxy for aesthetic-prestige services. The only significant variables he finds are the year in which the work was sold, its size and reputation.

Baumol (1986) argues that the art market does not have an equilibrium level of price and investigates the returns from art to strengthen his remarks. He uses the same data as Anderson (1974), but excludes all speculative resales that could bias the results. He finds that the return on art was only 0.55% annually during the period 1652-1961 even when transaction and holding costs were excluded. He concludes that this difference may be attributed to the return provided by aesthetic pleasure, aesthetic pleasure being equal to the spread of art investment return to bonds. Buelens and Ginsburgh (1993) respond to Baumol's (1986) paper and show that some sub-segments of the art market actually over performed the market during the period. Frey and Pommerehne (1989) compare the returns of art to the returns of other assets. They use the same

Reitlinger data in their analyses but they extend it to cover the period of 1961-1987. They report an annual return of 1.4% over the period of 1635-1949 and 1.7% for the period of 1950-1987 compared with financial asset returns of 3.3% and 2.4% correspondingly, which is lower than traditional asset classes during the same period.

Goetzmann (1993) identifies separate periods in history with differing returns for art, as well as analyses the correlation to other assets. Goetzmann also uses the Reitlinger data extending it with other auction data set for years 1971-1987. He estimates an annual price index using the Repeated Sales Regression (RSR) model that has been commonly used in estimating art price indices. He notes that the return on art is below the total return to stocks or bonds if the whole period is considered, but argues that when the time frame is restricted only to the period after 1850 the art returns exceed the financial market returns: 6.2% and 2.6 % respectively. Goetzmann identifies three bull markets and three bear markets between 1650 and 1987. Even though he identifies a period of stronger returns in art than traditional financial market assets, he strongly doubts that art would be an instrument superior to traditional financial instruments, due to the high volatility of returns on investment in art and the strong correlation to other assets, notably to stocks.

Buelens and Ginsburgh (1993) conduct their study in two parts. In the first part of their study they run the same equations for the resales as Baumol (1986). In the second part of their study they adopt a different methodology and use hedonic regression, an alternative technique to derive a price index reconsidering the Baumol's approach of a repeated sales estimator. Buelens and Ginsburgh claim that RSR method is biased as it includes only a small subset of the sales and hence follow Channel, Gérard Varet and Ginsburgh (1990) by using all occurred entries in the data. They construct an art price index using the hedonic regression technique and all the 5,900 sales mentioned in the Reitlinger Compendium (1961). Buelens and Ginsburgh describe paintings by three variables: the year of sale, school, the country of origin of the painter and a dummy variable taking the value 1 if the painter was still alive when the sale occurred. They conclude that by using the hedonic approach the results tend to concur with the results of Baumol (1986). The difference in some of the return estimates are, according to Buelens and Ginsburgh due to the fact that the original estimates calculated with RSR method are based on a very small number of

observed resales. They also argue that the pessimistic conclusions on art returns of Baumol are largely due to English paintings that wore out of fashion and were over-presented in the sample. Buelens and Ginsburgh do not compare art to other assets directly and state that it was not the initial purpose of their study as they rather were inquiring whether the rates of return obtained in the art market in 1980's were compatible or not with what had happened in the art markets over the past centuries as described by Baumol (1986).

Pesando (1993) contributes to the field by two means: by enlarging the field of art related financial studies to use the price data of modern prints to and by introducing the "masterpiece portfolio". His method differs from most other researchers, but results prove to be similar. What is interesting is that he finds that the location of trade and auction house have significant price effect on prints. Czujack (1997) focuses the most part of her work in the calculation of the different factors that influence prices of a single artist, Pablo Picasso. She obtains a relatively large sample of observations for her study as Pablo Picasso's work of art are of high quality and well documented, and during the period from 1963 to 1994 about 800 different Picassos have been sold by the major auction houses around the world. The study utilizes the available information on 921 sales; 126 works have been sold more than once. Restricting herself in the works of a well known and widely collected artist like Picasso, Czujack gets to work with an extremely well documented dataset of relatively homogenous work which allows her to define a large number of characteristics for each Picasso work. Similar study with wines would be possible by studying only one wine across different vintages. However, the limited number of documented vintages would restrict the use of statistical methods.

Locatelli-Biey and Zanola (2002) studied the performance of sculptures as an investment. Sculptures are relatively small part of all collectibles, representing 3-5% of all collectibles sold in auctions. They used a data set of 27,000 auctioned sculptures over the period the of 1987-1995 and run a hedonic regression to estimate the returns. They divided the data in three portfolios and find that the expensive portfolio behaves unlike the two other portfolios. The expensive portfolio experienced a strong boom in early 90's but otherwise the performance was quite poor. The two other portfolios were more stable, but did not perform any better. Taylor (1983) studies the performance of stamps and report similar findings. The returns after transaction costs are lower

than for traditional financial investments and investors should only buy stamps if they place a considerable value on the ownership of rare stamps.

4. Data

As mentioned already in the introduction, I have been able to gather an extensive data set for this study. The data is focused on the investment grade wines, but thanks to large number of observations, it is still well diversified in many aspects: there are wines from different countries and regions, auctions have taken place in different auction houses and cities during the period of around seven years. The set contains vintages 1989-2002 for 34 different wines and, for a couple of wines, also vintages 1986 to 1988, as these wines are sold to the market later and thus vintages from 1998 to 2002 were not available. All vintages for the selected wines are included in the data, which means that not all the wines can be considered as IGWs, as generally only wines from good vintages have potential to increase in value significantly. These non-IGW observations however provide a valuable benchmark and are important for calculation of Parker point and age premiums.

The selection of wines is based on liquidity in the aftermarket. I used experts' (Nuikki 2001, Sokolin 1998) lists and regional appellations to screen potential IGWs. After the initial selection I checked how many observation of recent vintages there were for each wine and selected the most liquid ones for the data set. As I wanted to select wines for which the price setting process is fairly accurate I only selected wines, which have more than 200 observations during the period. However, the final number of observations is lower for some wines as I removed outliers and unsold lots from the data set. Outliers included non-sold lots, very high and low prices, which were caused by for example poor condition of bottles or provenance (low prices) and charity auctions (high prices). The removed amount accounted for less than 3% of total observations, but especially the unsold lots were concentrated for certain wines and vintages. Wines with low number of observations suffered more from the effect of unsold lots and poor wines from poor vintages were much more common to remain unsold than good and excellent vintages.

The final data set includes 20,392 observations of completed trades in global wine auctions from January 1999 to February 2006[1]. One auction observation includes the following information: price per 750ml, name, region and vintage of the wine and in addition the lot number, number of bottles sold in that particular lot, location of trade, date of trade and name of the auction house. I have added the score given for the wine by Robert Parker, or in the case he has not evaluated the wine, the score given by Wine Spectator. Parker has tasted most of the wines, there was not a single wine brand in my sample that he had not graded, but there were some vintages of certain wines that were missing. These account for roughly 5% of total number of vintages included in the data but only less than 2% of the total data set. I believe this method can be justified, as investors are likely use the same method: Parker is the first choice for obtaining expert opinion, but in the case that is not available Wine Spectator provides a backup source for it. I will use the term "Parker point" for this variable in the following chapters, even though sometimes the source is Wine Spectator.

The produced amount per vintage is difficult to obtain for every wine. The production may differ from one year to another quite significantly, but the producers do not always release the information. Usually exceptional amounts are announced, while during normal-output vintages the information is not specifically pointed out. For this reason I have mostly used the average production for all the wines, obtained from Wine Spectator, Robert Parker, Vino Veritas or from producer websites. For vintages for which different level of output was released and recorded by Wine Spectator or Robert Parker I have used the exact amount. This may cause some inaccuracies, but not affect the final results significantly as most large variations are take into account.

Vintage ratings reveal information about the general quality of all wines produced in the specific region influenced especially by weather conditions. These were obtained primarily from Wine Spectator and secondarily from Robert Parker in a similar manner as individual wine ratings. That is, Parker's vintage charts were used only if Wine Spectator did not have ranking for the specific vintage for the specific year (this is the case for very poor vintages, like Bordeaux 1991

[1] The auctions held by Sotheby's, Christie's, Acker Merral, Morrel's and Zacchy's in London, New York, Los Angeles, Paris, Geneva and Amsterdam are included.

and 1992). Wine spectator was used as the primary source to avoid excess correlation between vintage and wine ratings. Wine Spectator gives broader vintage scores for regions, e.g. Bordeaux is divided only into left and right bank, while Parker divides the areas to smaller entities, e.g. Bordeaux is divided into 7 sub-regions. Parker's vintage ratings are thus more likely to be affected by factors that are also included in the individual wine ratings, like the timing of harvest and grape selection. They are also more likely to be averages of the individual wine ratings of the region than the broader Wine Spectator scores.

The information on Bordeaux regional classifications, which were discussed earlier, was added to existing information. However, because of limited number of wines used in the data, only Medoc 1st and 2nd growths were used as such, while rest of the Medoc growths were summed up to "Medoc other classifications" variable. From Graves and St.Emilion only first growth wines were selected to the data set. Pomerol does not have official classification, but Nuikki (1998) presented an unofficial classification. Again, all wines from Pomerol in the data were from the first growth of this unofficial classification.

Finally, I have calculated a "reputation factor" for all the wines to evaluate how long-term performance influences the price of a wine, following Landon and Smith (1997). For example some wines consistently receive Parker points in excess of 95 points, while others only receive such scores in great vintages. Reputation score is calculated as an average of individual wine ratings from Robert Parker (or Wine Spectator if Parker had not evaluated the vintage) over the ten previous vintages. After that the best average rating for each vintage was given the index number 100 and all the others were compared with this rating to get the standardized scores. This way annual fluctuations, caused by change in vintage quality, were eliminated and I was able to calculate the relative reputation of the specific wine against other IGWs for each year. As this factor is more complex, all tests are done with and without it and results are reported separately.

4.1 Descriptive Statistics

Table 3 shows the different wines that are included in the data. As can be observed France, especially Bordeaux, is the dominating source of investment grade wines. Total of 26 wines come

from France, 20 from Bordeaux, 3 from Burgundy and 3 from Rhone. In my data set there is only one Australian wine, while there are two Italian wines as well as four from the United States. I have only used Bordeaux classifications in the test, but the classifications for Italian wines are also presented in Table 3. In Bordeaux, all five Medoc 1855 first growth classified wines are included in the data set. From second growth four wines are included in addition to one wine from both third and fifth classification. Other Bordeaux wines include one Suaternes sweet white wine, two wines from Pomerol, two from St. Emilion and one from Graves. Actually there are two wines from Graves, as Château Haut Brion, which is included in the Medoc first growth is also in the Graves classification. Table 4 shows the same statistics for regions, rather than single wines.

The average production column in Table 3 shows the average annual production (in cases of 12's) for all the wines. These figures give some hints about characteristics of different wines and regions. Medoc and most of Bordeaux chateaus produce quite large amounts annually, while Burgundy's domains might produce only a few hundred cases of a single wine. In Bordeaux chateaus traditionally produce only a few wines (second wines are inferior to the main wine), but batches are quite large. The two chateaus from Pomerol make an exception to this rule, as they produce only a very limited amount of their wines. In Burgundy wine makers are organized differently: they own a small share of vines from many sub-regions and thus produce several small batches of different wines. One domain might well produce 10 different high quality wines, while total manufacturing still remains under 15,000 cases. Italian manufacturers are often quite large, while US estates are divided into two groups: large producers and cult wine wineries. The cult wineries together with Bordeaux *garage* winemakers are the newest trend in wine making. They produce only a very small amount of exceptionally good wines (and aim to produce excellent wines every year regardless of the vintage quality) and often only sell them directly to people who are on their waiting lists. In recent years both the US cult wineries and Bordeaux *garage* chateaus have received constantly excellent grades from both Robert Parker and Wine Spectator. These chateaus could be characterized as hedge funds of the wine business, as they often produce small amounts of wines somewhat untypical for their region and sell only to limited amount of buyers.

Table 3

Table 3 shows the wines that are included in the data set. First column shows the name of the wine and producer, while second and third columns tell where the wine is from. Classification refers to the *appellation* of the wine showing both the region and order of growth class. Medoc I means that the wine is from Medoc first growth classification. Average production implies the average annual production of the wine in cases of 12 bottles. Numbers of observations tells how many lots of the wine have been included in the data set and average price is calculated from all observations including every included vintage in the data set. Bordeaux is clearly the dominating area in number of wines and in number of observations. The variations in average production, number of observations and average prices are considerable between different wines.

Wine / Producer	Country	Region	Classification	Average production	Number of observations	Average price
Grange / Penfolds	Australia	Barossa Valley	NR	8,000	272	190.53 €
Château Mouton Rothschild	France	Bordeaux	Medoc I	25,000	2,004	134.16 €
Château Lafite Rothschild	France	Bordeaux	Medoc I	18,000	1,550	177.58 €
Château Latour	France	Bordeaux	Medoc I	10,000	1,486	199.64 €
Château Margaux	France	Bordeaux	Medoc I	12,500	1,358	235.23 €
Château Haut Brion	France	Bordeaux	Medoc I**	11,000	1,321	239.30 €
Château Pichon-Longueville Comtesse de Lalande	France	Bordeaux	Medoc II	20,000	991	81.38 €
Château Léoville Lascases	France	Bordeaux	Medoc II	45,000	947	98.15 €
Château Lynch Bages	France	Bordeaux	Medoc V	35,000	916	84.58 €
Chateau Petrus	France	Bordeaux	Pomerol I*	2,500	847	887.92 €
Château Cos d'Estournel	France	Bordeaux	Medoc II	24,000	745	65.57 €
Château Cheval Blanc	France	Bordeaux	St. Emilion I	10,000	735	241.44 €
Château Ducru Beaucaillou	France	Bordeaux	Medoc II	19,000	706	63.95 €
Château La Mission Haut Brion	France	Bordeaux	Graves I	6,000	608	150.01 €
Château Palmer	France	Bordeaux	Medoc III	13,000	551	80.53 €
Château d'Yquem	France	Bordeaux	Sauternes I	9,000	406	220.99 €
Château Lafleur	France	Bordeaux	Pomerol I*	1,000	229	231.62 €
Château Ausone	France	Bordeaux	St. Emilion I	2,000	134	165.95 €
La Tâche / Domaine de la Romanée-Conti	France	Burgundy	NR	1,600	430	570.87 €
Flagey-Echézeaux / Domaine de la Romanée-Conti	France	Burgundy	NR	1,150	225	2,370.17 €
Richebourg / Domaine de la Romanée-Conti	France	Burgundy	NR	1,000	219	372.44 €
Hermitage / Paul Jaboulet-Ainé	France	Rhône	NR	7,500	626	88.83 €
Châteauneuf du Pape / Domaine Beaucastel	France	Rhône	NR	15,000	443	62.16 €
La Turque / Maison Guigal	France	Rhône	NR	400	234	243.59 €
Châteauneuf du Pape / Rayas	France	Rhône	NR	1,500	224	310.38 €
La Landonne / Maison Guigal	France	Rhône	NR	800	213	239.67 €
Hermitage / Domaine Jean-Louis Chave	France	Rhône	NR	2,000	186	142.33 €
Sassicaia / Tenuta San Guido	Italy	Tuscany	DOC	13,000	379	125.30 €
Tignanello / Marchesi Antinori Srl	Italy	Tuscany	IGT	25,000	221	76.72 €
Cab. Sauv. Reserve / Robert Mondavi Winery	USA	Napa Valley	NR	15,000	316	69.19 €
Special Selection Cab. Sauv. / Caymus Vineyards	USA	Napa Valley	NR	2,000	311	143.06 €
Insignia / Joseph Phelps Vineyards	USA	Napa Valley	NR	15,000	281	93.26 €
Eisele / Araujo Estate	USA	Napa Valley	NR	2,000	279	201.50 €

* Pomerol rating in the unofficial rating presented by Nuikki (2003)

** Château Haut-Brion belongs to Medoc first growth and Graves first growth

The number of observations column shows how many trades is included in the data set of certain wine. This figure includes all the vintages, but is cleaned out of outliers and unsold lots. Typically less than 3% of observations were removed. One observation does not mean one bottle, but one lot, which is most often one case or 12 bottles of wine. As we can see the classic Bordeaux wines have most observations and are thus the most liquid wines in the market. Smaller and less known wines have smaller amount of observations, which means lower liquidity for investors. The wines that are included here are at least moderately liquid and most can be considered as IGWs. There are wines that have more observations, but which cannot be considered as IGWs because their value do not tend to increase over time (in excess of holding costs) and there are IGWs which do not have enough liquidity to be included here. The first group include many Bordeaux wines, especially those from second and third growths of Medoc 1855 classifications, while the second mostly consists of small Burgundy, U.S. cult and Bordeaux garage wines.

The last column shows the average price from the whole period for the wines. The price is for 750ml of wine, or one standard bottle. Again, this includes all the vintages from 1989 to 2002, except for Château D'Yquem and Grange vintages 1986 to 1998. The first growth wines from Medoc are among the most expensive, which of course is not a surprise. However the most expensive wines come from Burgundy and Pomerol. The lower ranked Medoc, Rhone and New World wines are generally less expensive.

Table 4 shows the average production, number of observations and average prices for regions, instead of single wines. It gives clear indication that the average annual production is positively correlated with the number of observations and negatively correlated with the average price on a general level. Both of these observations are intuitive if we consider other collectibles markets: large amount of items enables liquid aftermarket but makes them less of a rarity and thus decrease prices as Koford and Tschoegl (1997) clearly observed in their study.

Table 4

Table 4 describes the data in terms of regions and classifications. Average production is the weighted average number of all wines and vintages of the region. Number of observations is sum of all observations from the regions and average price is the weighted average price of all wines and vintages.

Region	Average production	Number of observations	Average price
Bordeaux, of which	15,471	15,534	197.53 €
Medoc	22,150	11,254	122.08 €
Pomerol	1,750	1,076	559.77 €
Graves	8,500	1,929	194.66 €
St. Emilion	6,000	869	203.69 €
Sauternes	9,000	406	220.99 €
Burgundy	1,250	874	1,104.50 €
Rhône	4,533	1,926	181.16 €
Rest of the World	11,429	2,059	128.51 €
Total	**64,612**	**20,393**	**4,197,242 €**
Weighted average	**15,190**	**-**	**205.82 €**

Tables 5 and 6 describe the data set in terms of included variables. Table 5 shows the mean, standard deviation, minimum and maximum for quantitative variables, while table 6 shows the proportions of qualitative factors.

Table 5

Table 5 presents the number of observations, minimum, maximum values, means and standard deviations for quantitative variables for the data set. Vintage score and reputation are not modelled however as quantitative, but as qualitative in the model.

Quantitative	N	Minimum	Maximum	Mean	Std. Deviation
ln(Price)	20384	2.48	8.98	4.9	0.8
Price	20384	12	7,966	219.0	332.4
Age	20384	2	20	9.4	3.6
Parker	20384	74	100	93.7	4.1
Production	20384	300	45,000	15,943.9	10,772.8
Vintage score	20384	58	99	92.3	6.1
Reputation	20384	90.5	100	95.4	1.7

Table 5 above presents main characteristics of quantitative variables for the data set. The first row is natural logarithm of prices, which is used in the regression model. Age is the age of the wines in full years at the time of trade, Parker refers to points given to the wine by Robert Parker

(or by Wine Spectator if Parker has not rated the specific vintage), production is the number of cases produced, vintage score is the score given by Wine Spectator (or by Robert Parker if Wine Spectator has not ranked the region for that vintage) for a specific region in a specific year, while reputation is the relative reputation of the wines in a specific year based on past scores given by Robert Parker (or Wine Spectator) as described above.

As can be observed the variations in the price and production amounts are considerable, while age, Parker and vintage scores and reputation are more stable. The huge variation in prices is not a great surprise as the characteristics differ considerable and as for any collectibles there are always the top of the range, very rare and expensive items. Large variations in the production volumes signal the differences in winemaking cultures around the world and different strategies adopted by wine makers. Age of the wines in this data set is limited by selection. In general all the wines are less than 15 years old at the time of trade, only exceptions for this rule are wines that are released to the market later than the standard two to three years after the harvest. On the other hand the futures contracts are not included in the data, so the youngest wines to trade are usually 3 to 4 years old, but in a few cases only 2 years old. These two factors limit the age generally between 2 and 15 years and in some cases between 5 and 20 years. The average age of the wine is around 10 years when it is traded, which is much closer to the general upper limit of 15 than the lower limit of 2 years.

The scores given by Robert Parker and Wine Spectator for wines and vintages also have natural restrictions. The range given by Robert Parker and Wine Spectator for wines and vintages is between 50 and 100 points. As can be seen both are on average well over 90 points, which would imply that both the wines and vintages tend to be excellent for the traded wines. For comparison the average vintage score that Robert Parker assessed for French vintages from 1990 to 2005 is less than 87[2] and the average of all ratings given for single wines is 88.2 (www.erobertParker.com). This observation is in line with comments by for example Sokolin

[2] Calculated by simply averaging all scores given by Robert Parker to different French regions in year 1990 to 2005. Parker has more detailed vintage score tables than Wine Spectator, which is the reason Parker scores are used here. Both tend to be very close to each other each year. Vintage ratings are pretty objective as they are related to the quality of grapes overall in the region.

(1998) and Nuikki (2003) who recommend buying only great wines from good vintages when investing in wines, as the liquidity for poor vintages and less than excellent wines is limited. Finally the reputation factor that I calculated for all wines and vintages does not offer any great surprises. The maximum here is again 100 points, as for every vintage the wine with best reputation is given the score of 100 and the others are compared against this wine. Because of the very strict selection of wines for this study, there are not great differences, average being over 95 points and even the minimum is over 90 points.

Table 6

Table 6 presents dummy, or qualitative, variables used in the study. These are divided into 7 groups: region, year of trade, lot size, auction house, location of trade, Parker points and age of wine. The proportion tells how many variables in the whole data set belong to specific variable. The sum of proportions for each group of variables adds up to 100%, as each observation is associated with one variable inside each group.

Variable	Proportion	Variable	Proportion
Burgundy	4.3%	Parker 100	9.7%
Rhone	9.4%	Parker 99	5.3%
Medoc 1st growth	39.9%	Parker 98	5.0%
Medoc 2nd growth	16.6%	Parker 97	2.8%
Medoc other	7.2%	Parker 96	11.2%
Graves	3.0%	Parker 95	11.8%
St.Emilion	4.3%	Parker 94	7.7%
Pomerol	5.3%	Parker 93	7.0%
Rest of the World	10.1%	Parker 92	8.4%
Trade 2006	1.0%	Parker 91	6.6%
Trade 2005	22.3%	Parker 90	9.3%
Trade 2004	22.8%	Parker 89	6.4%
Trade 2003	21.2%	Parker 88	3.4%
Trade 2002	15.0%	Parker 87	2.8%
Trade 2001	6.5%	Parker < 87	2.5%
Trade 2000	6.5%	Age 2-3	1.8%
Trade 1999	4.8%	Age 4	6.8%
Case of 12	71.8%	Age 5	8.0%
Case of 6	11.8%	Age 6	8.9%
Odd lots	16.4%	Age 7	10.2%
Sotheby's	40.2%	Age 8	9.0%
Acker Merral	11.2%	Age 9	9.7%
Christie's	41.7%	Age 10	8.6%
Zachy's	0.8%	Age 11	5.6%
Morrell's	6.1%	Age 12	6.9%
Location: Europe	50.7%	Age 13	7.7%
Location: USA	49.3%	Age 14	6.6%
		Age 15	6.2%
		Age 16-20	4.0%

Table 6 presents the dummy variables that are used in this study to measure qualitative factors. These are divided into groups and the proportion of each variable inside the group is presented in second and fourth column. First and the most obvious group is the region / appellation category, which tells from which region the wine is from. Second group controls the year of trade, third presents the lot size, fourth the auction house in which the lot was traded and fifth the location of trade. Sixth and seventh variable groups present the Parker points and age of wine as dummy variables.

In the first group, which indicates the origin of wine, Bordeaux is by far the most common region. The first growth of Medoc (which consists of only 5 wines) represents nearly 40% of the over 20,000 observations. Medoc second growth counts for 16.6%, while three Bordeaux regions cover around 13% of total observations. Other areas include Burgundy with 4.3%, Rhone valley with 9.4% and rest of the world with 10.1%. The distribution shows well how dominating the Bordeaux region still is in the investment grade wine segment, even though New World wines have captured much larger portion of cheaper segments of the wine market in recent years.

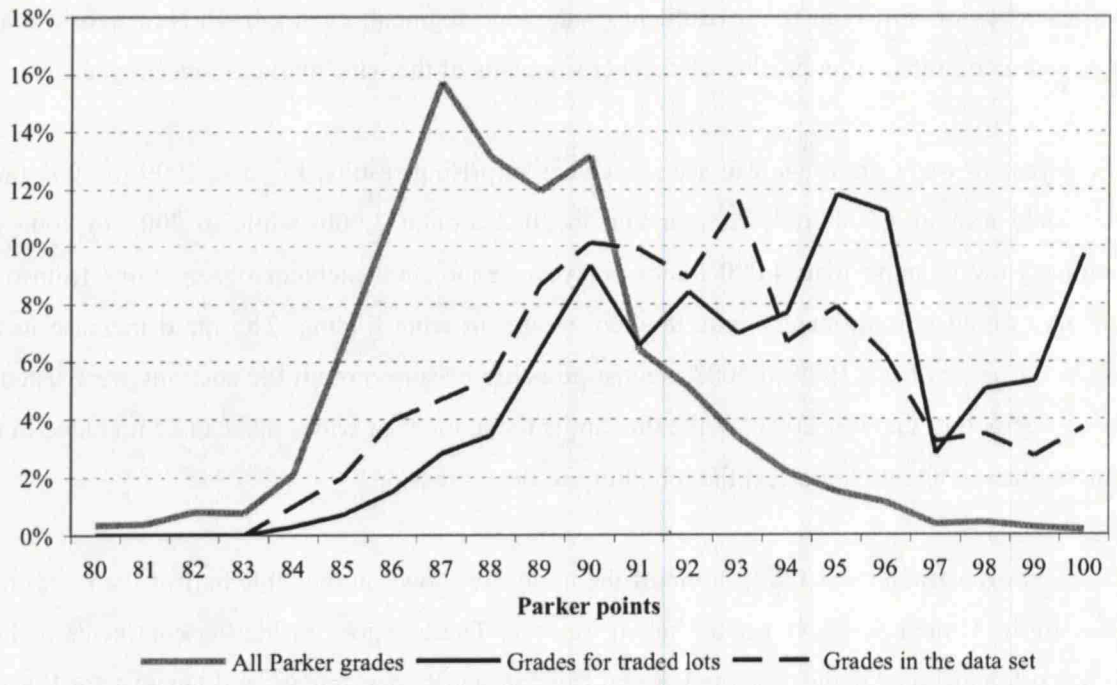
In the year of trade group we can see somewhat surprising results. In years 1999 to 2001 there were only around 1,000 trades a year and in 2002 around 3,000, while in 2003 to 2005 the number grew to more than 4,000 trades per year. Year 2006 includes observations from only January, which is traditionally quite a silent month in wine trading. The rapid increase in the number of trades from 1999 to 2003 is most probably because not all the auctions were listed to the source before the year 2003. While this limits the number of wines that can be included to the wine indices, it should not affect the reliability of the regression.

Next dummy variable was the location of the trade. As shown in the table half of the trades take place in the United States and other half in Europe. The locations inside the continents include New York and Los Angeles for the US and London, Paris, Amsterdam and Geneva for Europe. Of these New York and London are the two dominating cities of wine trade, both with around 45% of market share. In the next group we can see similar polarization of trades to two main auction houses: Christie's and Sotheby's. In my data set both account for more than 40% of the

total trades while the three other auction houses account for far smaller share of trades. This indicates that the trading of the top end investment grade wines tend to happen in the most famous auction houses. The next group shows the lot size of the observation. The vast majority of nearly 72% of all lots are full cases of 12 bottles. Another 11% are half cases and only 16.4% of total included trades are other lot sizes. This underlines one of the rules set by Sokolin and Nuikki: always buy and sell full cases when investing in wines. It seems that the liquidity for cases is far better than for so called odd lots.

Figure 2

Figure 2 shows the percentage distributions of Parker points for all rated wines (grey line), for wines included in my data set (dotted black line) and for traded lots in my data set (solid black). The traded lots line thus describes the liquidity-weighted Parker scores for the dotted line. The picture clearly shows that my data set includes higher than average rated wines and inside the data set the higher-rated wines are traded more than those with Parker points less than 90.



The last two groups present the Parker points and age of wine at the time of trade, which are both measured as quantitative and qualitative. The qualitative analysis makes it possible analyze whether the relation between price and Parker points / age of wine is linear or follows some other

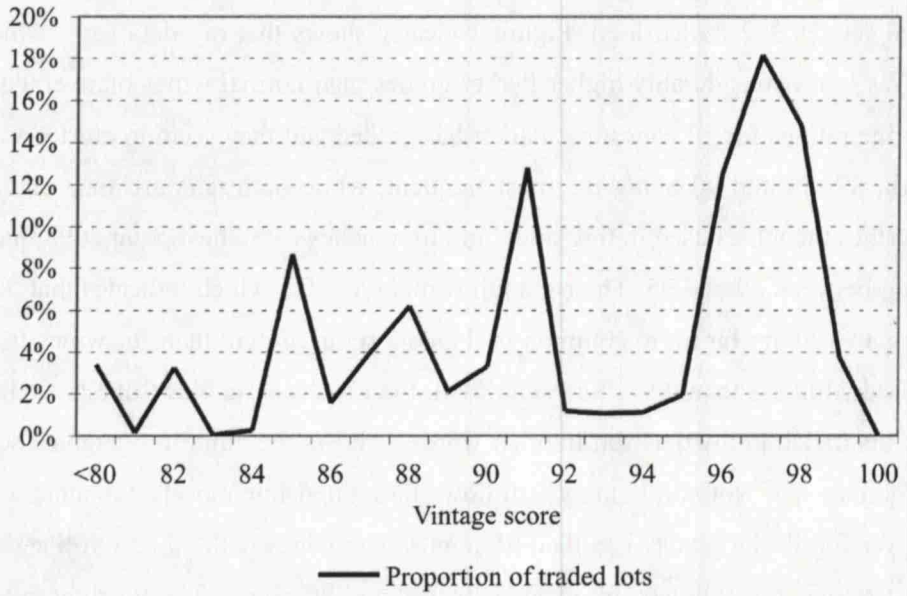
pattern. The most common Parker points in the data set are 100, 96, 95 and 90, which all account for more than 9%. Also other scores between 89 and 94 are well presented, while scores below 89 (anything between 50 and 88) account for less than 9% in total. The relatively low proportion of wines with score of 97 is somewhat surprising, as observations on both sides are far more common. The age of traded wines seems to be fairly constant from 4 to 15 years, even though the proportions for ages 5 to 10 are higher than other ages. Not surprisingly the youngest and oldest wines are rare in my data set, as it excludes almost all over 15 years old wines, while wines less than 4-year old are seldom traded.

I collected the aggregate data of Parker's individual wine scores to compare how it differs from my data set and to better explain the pattern observed for Parker points in the data. Figure 2 presents the distributions of Parker points for all rated wines (includes nearly 55,000 wines), the wines in my data set (total of 405 vintages for 32 wines) and also the liquidity-weighted scores for my data set (20,392 traded lots). Figure 2 clearly shows that my data set – which includes mainly IGWs – has considerably higher Parker grades than normal wines on average. The black line shows the ratings for all wines that Parker has graded and they seem to cluster around the 87 points mark, 87, 88 and 90 being the most frequent, while both tails are flat. The dotted line, which describes the wines used in this study, in turn reaches its highest point at 93, most frequent scores being between 89 and 95. The right tail is relatively fat, which indicates that the very high scores of 98 to 100 are far more common in the data set used here than for wines in general (ca 3% compared with less than 0.5% for each three). Finally the solid black line presents the scores for all the lots traded in my data set. In other words it shows the liquidity-weighted scores for the wines in the data set. Not surprisingly it follows the dotted line closely for most grades, being slightly lower for all the grades less than 95 points. The wines with 95 and 96 Parker points are traded most frequently, followed by wines with 100 and 90 points. The fat right tail emphasises the fact that the best wines have far more liquidity than good and normal wines. For example the most common grade for all wines, 87, accounts for almost 16% of all grades given by Robert Parker, while only 2.8% of wines traded in my data set have received the score. On the other hand almost 10% of trading has been done with wines that have the full 100 points from Parker, who has given that score to mere 0.16% of all wines.

It is very interesting to see how much does the vintage quality affects the liquidity of wines. In Figure 3 the data is presented according to vintage score. Although the variation between different vintage scores is surprisingly large, the scores between 95 and 99 are the most frequent in the data set (they account for 50% of total observations) as expected. For some reason the vintage score of 91 is also very common. Figure 3 seems to back up the comments made by for example Sokolin (1998) that investors should mostly buy wines from excellent vintages. At least the liquidity for these wines seems to be much better on average than for wines with worse vintage ratings.

Figure 3

Figure 3 shows the distribution of vintage scores for all the observations in my data set. The variations are surprisingly large, but the fact that the majority of observations have vintage score higher than 95 was expected.

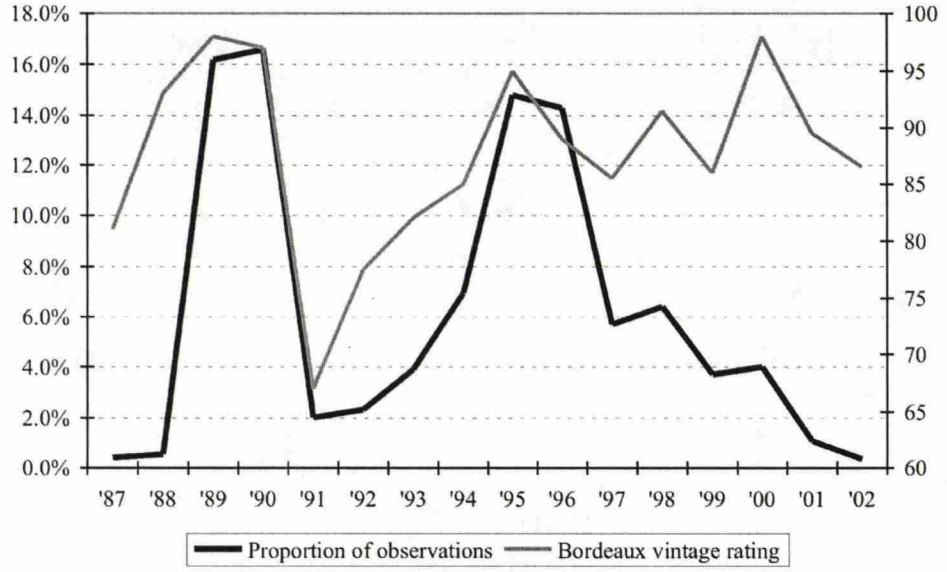


The effect of vintage quality on liquidity can also be observed from Figure 4, which shows the distribution of observations across different vintages and the Bordeaux vintage rating. The Bordeaux vintage rating is the average of ratings for both banks from Wine Spectator (and in case of 1987, 1991 and 1992 the average over all red wine regions from Robert Parker's vintage charts). The black line represents the vintage's share of total observations, while the thinner grey line shows the Bordeaux vintage rating. The proportion of vintages correlates heavily with the

Bordeaux vintage ratings, as Bordeaux is the by far the largest supplier of wines for the data set. The first two vintages 1987 and 1988 have only a few observations because only observations of a couple of wines are included in the data set. 1989 and 1990, which were excellent in Bordeaux, are also the most common in the data set. 1991 and 1992, the disastrous Bordeaux vintages, in turn represent for less than 5% of total observations together. Years 1993 and 1994 were mediocre with quite a low proportion of total trades, while both 1995 and 1996 were good vintages with high proportion of trades in the data set. After 1996 the proportion of trades begins to decline, even though there are excellent years in Bordeaux. This is because the trading with more recent vintages started later in the observation period and thus the proportions are relatively low.

Figure 4

Figure 4 shows the distribution of observations across different vintages and the Bordeaux vintage rating. The Bordeaux vintage rating is the average of ratings for both banks from Wine Spectator (and in case of 1987, 1991 and 1992 the average over all red wine regions from Robert Parker's vintage charts). The black line represents the vintage's share of total observations shown on the left axis, while the thinner grey line shows the Bordeaux vintage ratings displayed on the right axis. The proportion of vintages correlates heavily with the Bordeaux vintage ratings, as Bordeaux is by far the largest supplier of wines for the data set.



The prices of wines in the data set are far from normally distributed. Figure 5 shows the distribution of prices and as can be observed the distribution has a fat right tail. This is natural as

prices of investment grade wines are often are above 1,000 euros per bottle, while the average is only around 200 euros. As the natural minimum for the price of wine is zero, the distribution is skewed to right. All the observations above 1,000 euros are included in the last data point. Partly because of this I have used the natural logarithm of price in the regressions. The ln(Price) distribution is presented in Figure 6. As can be seen, the natural logarithm of price has a distribution quite close to normal distribution.

Figure 5

Figure 5 presents the frequency distribution of the price of wines included in the data set. All the observations, which have the price in excess of 1,000 euros, are included in the last data point. As can be observed the distribution has a long and fat right tail and is far from normal.

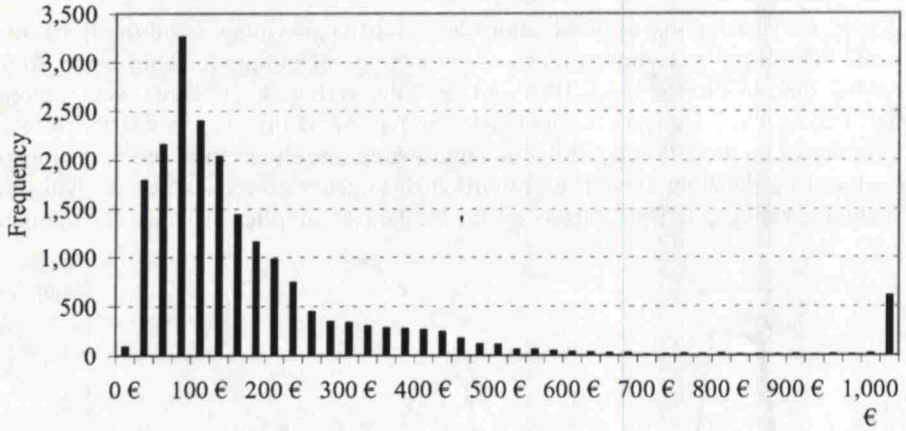
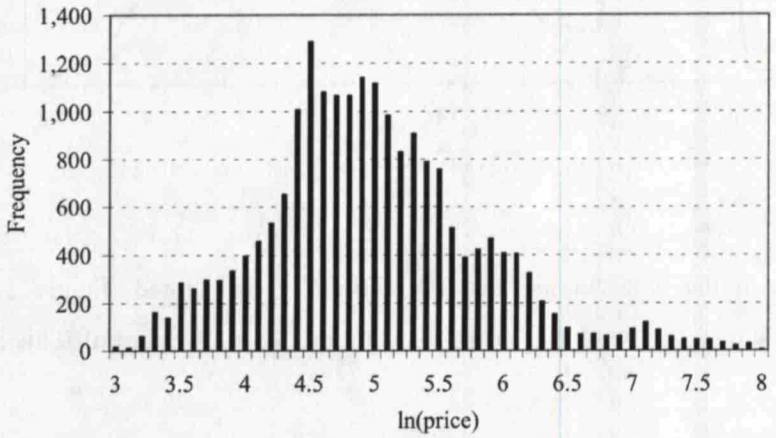


Figure 6

Figure 6 presents the frequency distribution of the natural logarithm of price of wines in the data set. Even though not normal, this distribution resembles it considerable more than the price distribution without the logarithmic transformation.



4.2 Correlation of Variables

In this section I will discuss correlations of different variables. Table 7 presents the correlations for quantitative variables, together with significance levels. Table 8 shows the correlation between quantitative and qualitative variables.

Table 7

Table 7 is a correlation matrix for the quantitative variables. It shows the Pearson's correlation for all pairs of quantitative variables used in this study: Price, Parker points, age of wine, vintage score, reputation factor and production amount (presented in thousands of cases). The significance level of correlations is marked after each coefficient (*** = 1%, ** = 5% significance level). Correlations in excess of 0.20 are bolded.

Variable	Price	Age	Parker	Vintage	Reputation	Production
Price	1.000	**0.23** ***	**0.52** ***	**0.31** ***	**0.42** ***	**-0.43** ***
Age		1.000	-0.01 **	**0.25** ***	0.15 ***	-0.02 ***
Parker points			1.000	**0.39** ***	**0.32** ***	-0.12 ***
Vintage score				1.000	-0.03 ***	0.10 ***
Reputation					1.000	**-0.23** ***
Production						1.000

Table 7 shows that price has a positive correlation with age, Parker points, vintage scores and reputation, but negative correlation with production quantity. This is in line with existing literature and does not provide any surprises. Both the current quality, measured by Parker points, and lagged quality, measured by the reputation factor, are highly significant with 0.52 and 0.42 correlations with price. Age does not correlate with Parker points or production amount, but surprisingly has 0.15 correlation with reputation and 0.25 correlation with vintage scores. The latter figure can be explained by the fact that years 1989 and 1990 are the most common one in the data set and they are both one of the oldest and best vintages in the data set. The fact that correlation also seems to have a positive correlation with age is harder to explain. It might be that Parker is more cautious in scoring very young wines and this would cause young wines to have lower lagged scores than older wines, which have been re-rated.

Parker points are also positively correlated with both vintage and reputation as expected, but slightly negatively correlated with production amount. The fact that Parker points are positively correlated with vintage is inevitable and the number is actually lower than expected. The quite

strong positive relation between Parker points and reputation indicates that the good vineyards are able to produce good wines from year to year, in other words the performance of wine makers seems to be persistent. The negative correlation with production quantity indicates that larger vineyards are able to produce better wines. Vintage scores do not correlate with reputation as expected. This is because the reputation scores are standardized for every year to neutralize the effect of vintage quality. The slight negative correlation with production quantity is surprising and hard to explain. Finally, reputation and production quantity are negatively correlated, which indicates that larger producers are better able to maintain their quality over time.

Table 8 presents the correlation between quantitative and qualitative variables. As the amount of qualitative variables, and thus the number of correlation, is considerable I have bolded the correlations in excess of 0.20 to make it easier to spot the highest correlations easier. For each qualitative variable the correlation with the price and age of wine, Parker and vintage scores, reputation factor and production quantity is shown. The qualitative variables are presented as groups to make the comparison easier.

The most important numbers for the first group of variables, the origin of the wine, are the correlations with price, Parker points, reputation and production quantity. Burgundy, Pomerol and Medoc first growth vineyards produce most often expensive IGWs, while lower Medoc growths are usually cheaper. The Medoc first growths and Pomerol wines, together with wines from Rhône, also tend to get higher points from Robert Parker but this seems not to be the case for Burgundy. The reputation of Medoc first growths and Pomerol wines is significantly higher than those of other regions. Especially other growths of Medoc and St. Emilion tend to have low long-term reputation. The correlation between growing regions and production quantity are expected, as they were clearly observable already in Table 3. The Medoc vineyards produce large quantities of wines, while most other regions produce less wine per vintage, or in case of especially Burgundy produce several small batches of different wines. The correlations between area with age and vintage scores are low as expected. Most of these wines age well for the first 15 years, but there are some observable differences. The wines from Bordeaux tend to age longer, than those from Burgundy and the New World. Also it seems that Burgundy has received significantly lower vintage scores on average, which is caused by worse climate conditions for

wine growing. The differences of correlation between vintage scores and different Medoc regions are probably due to the fact that first growth wines are almost always great, while some of the other growth vineyards probably produce IGWs only in good vintages.

Table 8

Table 8 presents the correlations between quantitative and qualitative variables. Each qualitative variable group is presented separately. Price is the price of a single bottle of wine in euros, age is the age of wine in years, Parker indicates the points given by Robert Parker, vintage is the vintage score given by Wine Spectator, reputation indicates the lagged Parker score and production is the production quantity in thousands of cases. The significance level of correlations is marked after each coefficient (*** = 1%, ** = 5% significance level). Correlations in excess of 0.20 are bolded.

Variable	Price	Age	Parker	Vintage	Reputation	Production
Area						
Burgundy	**0.39** ***	-0.05 ***	-0.05 ***	**-0.15** ***	0.02 **	**-0.29** ***
Rhone	-0.13 ***	0.01	0.09 ***	-0.07 ***	-0.01	**-0.26** ***
Medoc 1st growth	**0.17** ***	0.05 ***	**0.13** ***	0.00	**0.43** ***	0.10 ***
Medoc 2nd growth	**-0.35** ***	-0.05 ***	-0.13 ***	0.08 ***	**-0.22** ***	**0.49** ***
Medoc other	**-0.22** ***	0.05 ***	-0.11 ***	0.06 ***	**-0.40** ***	**0.28** ***
Graves	-0.05 ***	-0.01	0.01	0.02 ***	-0.08 ***	**-0.16** ***
St.Emilion	0.07 ***	0.00	-0.09 ***	0.04 ***	**-0.15** ***	-0.14 ***
Pomerol	**0.38** ***	0.03 ***	0.13 ***	-0.02 **	**0.20** ***	**-0.29** ***
Rest of the World	-0.09 ***	-0.05 ***	-0.06 ***	0.01	-0.09 ***	-0.15 ***
Year of trade						
2006	0.00	0.04 ***	-0.01 **	-0.02 ***	0.05 ***	-0.02 **
2005	-0.01	0.12 ***	0.01	-0.02 ***	0.21 ***	-0.01
2004	-0.05 ***	0.05 ***	0.01	0.00	0.03 ***	-0.01
2003	-0.03 ***	0.01	0.02 **	0.00	0.04 ***	-0.04 ***
2002	0.09 ***	0.00	0.01	0.00	0.01	0.00
2001	0.01	-0.06 ***	-0.06 ***	0.00	-0.09 ***	0.05 ***
2000	0.00	**-0.18** ***	0.00	0.03 ***	**-0.24** ***	0.05 ***
1999	0.00	-0.12 ***	-0.02 **	0.02 ***	**-0.18** ***	0.02 ***
Location of trade						
Europe	-0.20 ***	-0.08 ***	**-0.16** ***	-0.17 ***	-0.11 ***	0.12 ***
U.S.	0.20 ***	0.08 ***	**0.16** ***	0.17 ***	0.11 ***	-0.12 ***
Auction house						
Sotheby's	0.03 ***	**-0.16** ***	0.00	0.01	**-0.16** ***	0.05 ***
Acker Merral	0.10 ***	0.01	0.11 ***	0.08 ***	0.11 ***	-0.08 ***
Chistie's	-0.10 ***	**0.15** ***	-0.10 ***	-0.09 ***	0.09 ***	0.00
Zachy's	0.03 ***	0.07 ***	0.00	0.03 ***	0.00	-0.01
Morrell's	0.00	-0.01	0.04 ***	0.04 ***	0.01	0.02 **
Lot size						
Case of 12	**-0.22** ***	-0.05 ***	-0.07 ***	0.01	-0.10 ***	**0.23** ***
Case of 6	**0.13** ***	-0.02 ***	0.04 ***	-0.01	0.08 ***	**-0.15** ***
Odd lots	**0.16** ***	0.07 ***	0.06 ***	0.00	0.05 ***	**-0.14** ***

The next group of qualitative variables present the correlations between different years of trade and quantitative variables. Not surprisingly the price of wines do not correlate heavily with the year of trade. The wines however tend to be older in recent years of trade, which is natural as included vintages remain the same during the whole observation period. Both Parker and vintage scores are also practically zero-correlated with year of trade, but the reputation factor is amazingly highly correlated with the years 1999, 2000 (negatively) and 2005 (positively). This is most likely because the wines traded in 1999 and 2000 are younger on average than those traded in 2005. As mentioned age and reputation have are positively correlated. Finally the production quantities have a very low correlation with the year of trade, as expected.

Both of the location of trade dummies are presented, but they are of course opposite to each other, as they are compared against each other. The wines traded in the U.S. are positively correlated with price, which indicates that either the wines traded in the U.S. are of better quality, or that they are simply more expensive. The next column shows that wines sold in the U.S. are also older, which explain at least some of the price premium. The wines traded in the U.S. are also positively correlated with Parker points, vintage ratings and reputation, but negatively correlated with production quantity. All of these factors were observed to be correlated similarly with prices, and thus the price difference shown in the price column might be due to difference is wine quality rather than only prices.

The correlations between auction house dummies and quantitative factors are relatively low, but there are also clear differences. For example the wines traded in Christie's tend to be cheaper than wines in other auction houses, while still older. They however were from weaker vintages and received lower Parker points on average, but surprisingly had higher reputation. The other large auction house, Sotheby's, sells younger wines, with lower reputation and higher production, which would indicate that it sells more New World wines. There are also some differences between the smaller auction houses, but nothing really astonishing.

Finally the lot size dummies provide some evidence of which wines are traded in full cases and which sometimes in small cases and odd lots. The wines sold in full cases have negative correlation of 0.22 with price, while half cases and odd lots are positively correlated, 0.13 and

0.16 respectively. Thus it seems that the wines sold in odd lots are more expensive than those in full cases. This is somewhat unexpected as for example Sokolin (1998) recommends selling only in full cases to get the best price. It might however be the case that the sellers only sell more expensive wines in odd lots, and the auction houses might even decline to sell cheap wines in odd lots. Also, odd lots are usually older and have better Parker points and reputation than those of half cases and especially full cases. Also, full cases correlate positively (0.23) with production quantity, while half cases and odd lots have negative correlations of 0.15 and 0.14 respectively. Thus it seems that rare wines, which might enjoy scarcity premium, are more often sold in half cases and in odd lots. So, it seems that wines sold in half cases or odd lots are often expensive, rare wines, while most of the normal IGWs are sold in cases of 12 bottles.

5. Methodology

In this section I will go through the main methodologies used in the paper. I will begin with the methods used to compile wine indices and after that explain the methodology that is used to analyze the different factors affecting the price of wine in an auction. The theory has mosty been discussed in the literature review, so in this section the emphasis is on the selection and implementation of methodology. I will first present the index construction methods and after that the valuation models for auctioned wines.

5.1 Index Construction Methods

I have constructed two indices to analyze wines as an investment class and to make them comparable with other asset classes. The relatively short time span and limited number of observations constrain the statistical significance of the comparison, but it will anyway give potential investors some idea how wine prices have behaved during the last 6 years. The idea has been to construct indices based purely on liquidity, which is observable by all market participants. Both indices are composite indices with fixed basket of underlying wines during the whole period, which eliminated the need for any changes and thus eliminated any "wine-picking" that is observable in some commercial wine indices.

The fact that the same wines remain in the index for the whole period also means that the indices can be considered as total return indices, rather than pure price indices, which are often calculated using hedonic regression. This means that the increase in value of wines, natural process of wines getting mature, is included in the indices. The advantage of using total return indices is the straight comparability with total return bond and commodity indices. Total return indices also provide the investors with the information how much profit the wines have generated during the period, rather than just look at the prices. Hedonic indices are at their best when analysing collectibles, which are unique or for which quality changes from one lot to another. Repeat sales

regression, which is often used for art is even more aimed towards pieces of collectibles, which cannot be compared against each other. A traditional composite index however is more suitable for wines in this case as I have a large amount of observations for similar products over the observation period. There are two kinds of composite indices, variable and fixed basket. The variable basket means that the underlying portfolio changes over time according to some criteria, while the fixed basket index has the same constituents for the whole period. The variable basket indices are more suitable for longer observation periods, as the quality and liquidity of wines change over time and very few wines can be used in the index for more than 15 years. However the change in the underlying portfolio may skew the performance of the index, and for relatively short period of time a fixed basket offers the most accurate index construction method.

Thus, both of the indices are composite indices with fixed basket of wines. This means that fixed baskets of wines are selected for both indices and the performance of each wine is then tracked over the whole period. Also the weights of the wines in the indices remain fixed for the whole observation period. In practice this means that I have calculated the average price for all the wines for each month and quarter and calculated weighted average index values based on these values. If there was not a single trade done on some wine during a month or a quarter I have used the average price of previous month or quarter.

The wines in the indices are all from quite recent vintages so that they would be systematic with the objectives of this paper. That is, to approach the subject from investor's, rather than wine collector's point of view. As mentioned above, buying older wines requires a lot more expertise and contains more risk than investment in rather recent vintages, as the bottle specific factors become more important when wines grow older. Both of the indices have the same time period, from beginning of year 2000 to the end of January 2006. The first index, named Global 100, is quarterly based, global wine index, which includes 100 most liquid vintages for 31 wines from vintages 1989 – 2000. The other, named Bordeaux 33, is monthly based, Bordeaux red wine index that includes 33 most liquid vintages of 14 wines from vintages 1989 – 1996. It is vital for accurate price formulation that there are several observations. This is because the different bottle and lot specific factors affect the final price significantly, but when the average of several trades is used these differences should average out. I also selected liquidity for the factor affecting the

weightings of wines in the index. This is because liquidity seems to be the single most important factor, which indicates the investment potential of investment grade wines, based on previous literature and descriptive statistics from this data set.

To illustrate the scale of holding and transaction costs I also calculate the Bordeaux 33 index including costs. These are of course quite rough estimates of the real costs, as accurate information is not available on sellers' commissions and the holding costs of wine differ from investor to investor. For the "costs included" index I assume an investment horizon of 6 years and 1 month, which is the same as the observation period for the index. I assume that the total transaction costs are 30%, which includes both the buyer's and seller's commissions. The holding costs are estimated to be 15 euros per case per year, which is about 0.6% of the cost of an average case of investment grade wines (12 bottles of wine that costs 200 euros). Both the costs are transformed to monthly figures and summed up. The total monthly cost is thus estimated to be 0.46% of the value of the investment.

5.1.1 Global 100 Wine Index

The Global 100 wine index includes 100 most liquid wines during the 7-year period from 1999 to 2006 from vintages 1989 to 2000. Calculation of the index starts in the beginning of year 2000, as there were several wines that did not have enough observations in 1999. The weightings of the wines are based on relative liquidity of the selected wines during the period. This means that wines that are traded more often have more impact on the index than those with relatively few trades. In the beginning of year 2000 the index was given the value of 100 and other observations are compared with this value. Because the liquidity of especially New World wines and some of the very small Burgundy wineries is relatively weak, only quarterly average prices are used. Otherwise the risk of bottle specific factors affecting the index would be considerable. Over 50 trades were made on all of the wines selected for this index during the whole period.

5.1.2 Bordeaux 33 Wine Index

For most parts the Bordeaux 33 wine index is similar to the Global 100 wine index. The Bordeaux 33 wine index however includes only 33 most liquid vintages for 14 different wines during the 7-year period from 1999 to 2006 from vintages 1989 to 1996. The calculation of Bordeaux index also begins from the beginning of 2000. The weightings of the wines are based on relative liquidity during the period. In the beginning of year 2000 the index has value of 100 and other observations are compared with this value. This index contains the "blue chip" wines of Bordeaux, which are the most famous and traded of all wines. All the wines are red wines, most from Medoc. Over 150 trades were made on all of the wines selected for this index during the period.

All the comparisons with other asset classes are done using the Bordeaux 33 wine index to maximize the number of observations. For Bordeaux wine index there are total of 73 observations and it enables statistical analysis against other indices. The global wine index that has only 24 observations does not qualify for statistical analysis. However, as the most important constituents are the same for both of the indices they have very high correlation.

5.2 Hedonic price model

As mentioned in the literature review the theory and practice of the hedonic price functions were developed largely to the use of agricultural economics: see for example Waugh (1928), Fettig (1963), Rosen (1974), Coelli *et al.* (1991) and Williams *et al.* (1993). Nowadays hedonic regressions are also widely used studies of art, other collectibles and real estate markets. A hedonic price function relates the price of a product to its various attributes or characteristics. Essentially any variable which influences investors' utilities or producers' costs is a candidate for inclusion in the function. In other words the function is not limited to pure quality factors. If the attribute is continuously measurable (quantitative) then the respective partial derivative of the function represents the implicit marginal attribute price. If the attribute is qualitative, in other words not continuously measurable, the displacement of the consumption or production possibility frontier occurs, and a clear theoretical interpretation for the function remains, see

Edmonds (1984). In this latter case partial derivatives are not defined but estimates measure the impact of the presence of the attribute represented by the variable. Most hedonic functions use a combination of both qualitative and quantitative variables (Coelli *et al.* (1991) and Williams *et al.* (1993)).

The standard Rosen (1974) theoretical framework assumes that consumers' or investors' bid functions are always tangential to producers' offer functions at the equilibrium hedonic price gradient. Given the competitive market structure assumption, the hedonic price function is a function of product attributes alone; it is not a function of individual investor and producer traits. This raises the question of the suitability of Rosen's pure competition equilibrium framework for the investment grade wine market. Three specific issues need to be addressed: the flow of information, the relative sizes of individual producers and investors, and transaction cost.

The information flow on which investors base their decisions appears to be adequate. Price history of different wines can be obtained from several sources, as well as quality ratings of the wines. The size of both buyers and sellers in the secondary market is usually rather small and thus price setting is not biased or affected by large buyers or sellers. The transaction cost issue is somewhat similar to real estate markets, but even more severe. As mentioned earlier, transaction costs of a single trade can be more than 30%, which effectively limits the liquidity and affect the behaviour of buyers and sellers in the market. Slight (or even moderate) pricing errors might occur without market taking corrective actions as transaction costs more than negate the possible gains made by exploitation of these errors. Especially because of the high transaction costs the possibility of auction prices not reflecting the equilibrium cannot be absolutely ruled out.

I have built several models to test for different variables, divided into three distinct sets. Following the methodology used in Ali *et al.* (2003) I selected to use the log-linear model, where the natural logarithms of price are used instead of linear to normalize the target variable. By using the log-linear model the regression estimates the relative rather than absolute effect of variables in price. The log-linear model proved to offer the best fit and to behave more stable than other models. I also ran the regressions using normal linear regression and several transformations (including $price^{0.5}$, $price^{-0.5}$, $price^{1.5}$ and $price^{-1}$ following Costanigro *et al.* (2006)).

The first set of models could be described as the main set, as its variables are the most traditional. The second set is identical to first set, expect that it includes the reputation factor in each model. The third set includes only one model, which measures the reputation of each vineyard individually. That is, in the last model most of the variables used in the first two sets of models are excluded and replaced with vineyard variables. All the quantitative variables: age, Parker points, vintage ratings, reputation factors and production quantity are normal continuous variables, while each qualitative variables have their own dummy variables, which receives value zero or one. The qualitative variables are divided into several variables groups: region / appellation, year of trade, auction house, location of trade and lot size. Each variable group has a base case, against which other alternatives are compared.

Table 9 shows the first set of models, while Equations 1-13 show the functional form of the models 1-13 respectively. As can be seen the first model is a normal regression without any qualitative factors. The natural logarithm of price is estimated using the Parker points, age, production amount and vintage score of each wine. The second model includes qualitative variables for the region and appellation of the wines, while the third model introduces the year of trade variable to the equation. The year of trade functions as a control variable to show the general trends in the price level. The location of trade, auction house and lot size are introduced to fourth model to see whether any of these variables has significant effect on the price. In the fifth model the Parker scores are presented as dummy variables instead of a quantitative variable. This way we can study more accurately how the movement in Parker points affects the value of wine. In the final model of the first set the age variable is also transformed into dummy variables to estimate the effect of age in more detail. The functional forms for model 1-6 are presented in Equations 1-6 respectively.

Table 9

Table 9 presents all the regression models used in the study. The variables and variable groups are displayed under each model. Parker points, age, production, vintage score and reputation are quantitative variables and the rest are qualitative variable groups. Each group of qualitative factors consist of several dummy variables, while the base case assumption (BC) is displayed after each of these. The main difference between previous models is indicated by bolding the new variable(s) / variable group(s). For the second set of models (7-12) the comparison is done against the first set of models (1-6) respectively. Models 1-6 and 7-12 are identical expect for the reputation factor, which is included for each of the latter group. 13th model strives to explain the difference between vineyards included in the data set by using a vineyard dummy instead of reputation and region dummies.

Model 1	**Model 2**	**Model 3**	**Model 4**
Constant	Constant	Constant	Constant
Parker points	Parker points	Parker points	Parker points
Age	Age	Age	Age
Production ('000's of cases)	Production ('000's of cases)	Production ('000's of cases)	Production ('000's of cases)
Vintage score	Vintage score	Vintage score	Vintage score
	Area - BC: Medoc 1st growth	Area - BC: Medoc 1st growth	Area - BC: Medoc 1st growth
		Year of trade - BC: 2003	Year of trade - BC: 2003
			Lot size - BC: Case of 12
			Auction house - BC: Christies
			Location of trade - BC: USA

Model 5	**Model 6**	**Model 7**	**Model 8**
Constant	Constant	Constant	Constant
Age	Production ('000's of cases)	Parker points	Parker points
Production ('000's of cases)	Vintage score	Age	Age
Vintage score	Area - BC: Medoc 1st growth	Production ('000's of cases)	Production ('000's of cases)
Area - BC: Medoc 1st growth	Year of trade - BC: 2003	Vintage score	Vintage score
Year of trade - BC: 2003	Lot size - BC: Case of 12	**Reputation**	**Reputation**
Lot size - BC: Case of 12	Auction house - BC: Christies		Area - BC: Medoc 1st growth
Auction house - BC: Christies	Location of trade - BC: USA		
Location of trade - BC: USA	Parker dummies - BC: 94		
Parker dummies - BC: 94	**Age dummies - BC: 8**		

Model 9	**Model 10**	**Model 11**	**Model 12**
Constant	Constant	Constant	Constant
Parker points	Parker points	Age	Production ('000's of cases)
Age	Age	Production ('000's of cases)	Vintage score
Production ('000's of cases)	Production ('000's of cases)	Vintage score	**Reputation**
Vintage score	Vintage score	**Reputation**	Area - BC: Medoc 1st growth
Reputation	**Reputation**	Area - BC: Medoc 1st growth	Year of trade - BC: 2003
Area - BC: Medoc 1st growth	Area - BC: Medoc 1st growth	Year of trade - BC: 2003	Lot size - BC: Case of 12
Year of trade - BC: 2003	Year of trade - BC: 2003	Lot size - BC: Case of 12	Auction house - BC: Christies
	Lot size - BC: Case of 12	Auction house - BC: Christies	Location of trade - BC: USA
	Auction house - BC: Christies	Location of trade - BC: USA	Parker dummies - BC: 94
	Location of trade - BC: USA	Parker dummies - BC: 94	Age dummies - BC: 8

Model 13
Constant
Parker points
Age
Production ('000's of cases)
Vintage score
Year of trade - BC: 2003
Lot size - BC: Case of 12
Auction house - BC: Christies
Location of trade - BC: USA
Vineyard - BC: Château Mouton Rothschild

$$\ln(price) = c + \beta_1(Parker) + \beta_2(age) + \beta_3(production) + \beta_4(vintage\,score) + \varepsilon \quad (1)$$

$$\ln(price) = c + \beta_1(Parker) + \beta_2(age) + \beta_3(production) + \beta_4(vintage\,score) + \sum_{i=1}^{8}\beta_{4+i}(region_i) + \varepsilon \quad (2)$$

$$\ln(price) = c + \beta_1(Parker) + \beta_2(age) + \beta_3(production) + \beta_4(vintage\,score) + \sum_{i=1}^{8}\beta_{4+i}(region_i) + \sum_{i=1}^{7}\beta_{12+i}(year\,of\,trade_i) + \varepsilon \quad (3)$$

$$\ln(price) = c + \beta_1(Parker) + \beta_2(age) + \beta_3(production) + \beta_4(vintage\,score) + \sum_{i=1}^{8}\beta_{4+i}(region_i) + \sum_{i=1}^{7}\beta_{12+i}(year\,of\,trade_i) + \beta_{20}(Europe) + \sum_{i=1}^{4}\beta_{20+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{24+i}(lot\,size_i) + \varepsilon \quad (4)$$

$$\ln(price) = c + \beta_1(age) + \beta_2(production) + \beta_3(vintage\,score) + \sum_{i=1}^{8}\beta_{3+i}(region_i) + \sum_{i=1}^{7}\beta_{11+i}(year\,of\,trade_i) + \beta_{19}(Europe) + \sum_{i=1}^{4}\beta_{19+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{23+i}(lot\,size_i) + \sum_{i=1}^{14}\beta_{25+i}(Parker\,dummy_i) + \varepsilon \quad (5)$$

$$\ln(price) = c + \beta_1(production) + \beta_2(vintage\,score) + \sum_{i=1}^{8}\beta_{2+i}(region_i) + \sum_{i=1}^{7}\beta_{10+i}(year\,of\,trade_i) + \beta_{18}(Europe) + \sum_{i=1}^{4}\beta_{18+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{22+i}(lot\,size_i) + \sum_{i=1}^{14}\beta_{24+i}(Parker\,dummy_i) + \sum_{i=1}^{13}\beta_{38+i}(age\,dummy_i) + \varepsilon \quad (6)$$

As mentioned the second set of variables is similar to the first set, except for the reputation factor, which is included in all the regressions. The final model, number 13, however differs from

the earlier models in several ways. The vineyard variable is introduced to the model, while the region and reputation factors are excluded. All the vineyards, not wines, are given a dummy variable to see much the actual name of the producer, which is stated on the bottle, affects the final price. This also enables the comparison of earlier models, which strive to be more general, to a very detailed model. The results from this last regression of course cannot be generalized to account for any wines other, than those included in the regression. Equation 7 shows the functional form of model 10, from which the functional forms of models 7-9 can be derived by removing relevant variables. Equations 8 and 9 present the functional forms of models 11-12 respectively and Equation 10 shows the functional form of the 13th model.

$$\ln(price) = c + \beta_1(Parker) + \beta_2(age) + \beta_3(production) + \beta_4(vintage\,score) + \beta_5(reputation) + \sum_{i=1}^{8}\beta_{5+i}(region_i) + \sum_{i=1}^{7}\beta_{13+i}(year\,of\,trade_i) + \beta_{21}(Europe) + \sum_{i=1}^{4}\beta_{21+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{25+i}(lot\,size_i) + \varepsilon \quad (7)$$

$$\ln(price) = c + \beta_1(age) + \beta_2(production) + \beta_3(vintage\,score) + \beta_4(reputation) + \sum_{i=1}^{8}\beta_{4+i}(region_i) + \sum_{i=1}^{7}\beta_{10+i}(year\,of\,trade_i) + \beta_{20}(Europe) + \sum_{i=1}^{4}\beta_{20+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{24+i}(lot\,size_i) + \sum_{i=1}^{14}\beta_{26+i}(Parker\,dummy_i) + \varepsilon \quad (8)$$

$$\ln(price) = c + \beta_1(production) + \beta_2(vintage\,score) + \beta_3(reputation) + \sum_{i=1}^{8}\beta_{2+i}(region_i) + \sum_{i=1}^{7}\beta_{10+i}(year\,of\,trade_i) + \beta_{18}(Europe) + \sum_{i=1}^{4}\beta_{18+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{22+i}(lot\,size_i) + \sum_{i=1}^{14}\beta_{24+i}(Parker\,dummy_i) + \sum_{i=1}^{13}\beta_{38+i}(age\,dummy_i) + \varepsilon \quad (9)$$

$$\ln(price) = c + \beta_1(Parker) + \beta_2(age) + \beta_3(production) + \beta_4(vintage\,score) + \sum_{i=1}^{7}\beta_{4+i}(year\,of\,trade_i) + \beta_{11}(Europe) + \sum_{i=1}^{4}\beta_{11+i}(auction\,house_i) + \sum_{i=1}^{2}\beta_{15+i}(lot\,size_i) + \sum_{i=1}^{32}\beta_{27+i}(vineyard_i) + \varepsilon \quad (10)$$

6. Hypotheses

In this section I will state and explain hypotheses on the performance and price formulation of wines. These are mostly formed on the basis of existing literature and market observations of several authors. Most of the hypotheses are related to price formulation, as the relatively short period of time makes the accurate evaluation of performance of wine investments challenging.

The first two hypotheses are related to the performance of wines:

I. Wines do not provide better returns than equities and bonds after considering the transaction and holding costs.
II. The returns from wines correlate positively with equities, but not with corporate bonds and commodities.

The first hypothesis is based on Burton and Jacobsen (1999) paper, where they compiled results from several studies that evaluated the performance of different collectibles. They conclude that collectibles do not provide better returns than equities or T-bills in general. I base the second hypothesis on the discussion paper by Bentzen *et al.* (2002), where they found that wines correlated highly with equity index. As I was not able to find studies comparing the returns from wines with corporate bonds and commodities, I assume that they do not correlate.

The following hypotheses are related to the price formulation of wines.

III. Age, Parker's score, vintage score and reputation factor have positive effect on the price of wine, while production amount has negative effect.
IV. Wines coming from Bordeaux and Burgundy are valued higher than other wines.
V. The 1855 Medoc classification has a significant effect on the price. The better the classification the higher the price.
VI. The location of auction and the auctioneer do not have significant effect on the price.
VII. The wines sold in lots of 12 are more expensive than other lot sizes.

As mentioned in the literature review many studies have showed that age of wines, vintage quality, experts' opinions and lagged quality or reputation have positive effect on the price of wine. However, the relative strength of different variables, especially current versus lagged quality has been controversial. Different authors have presented contradicting results, depending on the data set and selection of variables. The inverse relation between price and production amount origins from the general collectible literature – the scarcity of items should affect the price of it. Hypotheses IV and V are based on the reputation theory: traditional regions have established themselves better to the market and the classifications further enhance this effect. For example Schamel (2001) observed that regional reputation affect the prices significantly for Australian and New Zealand wines.

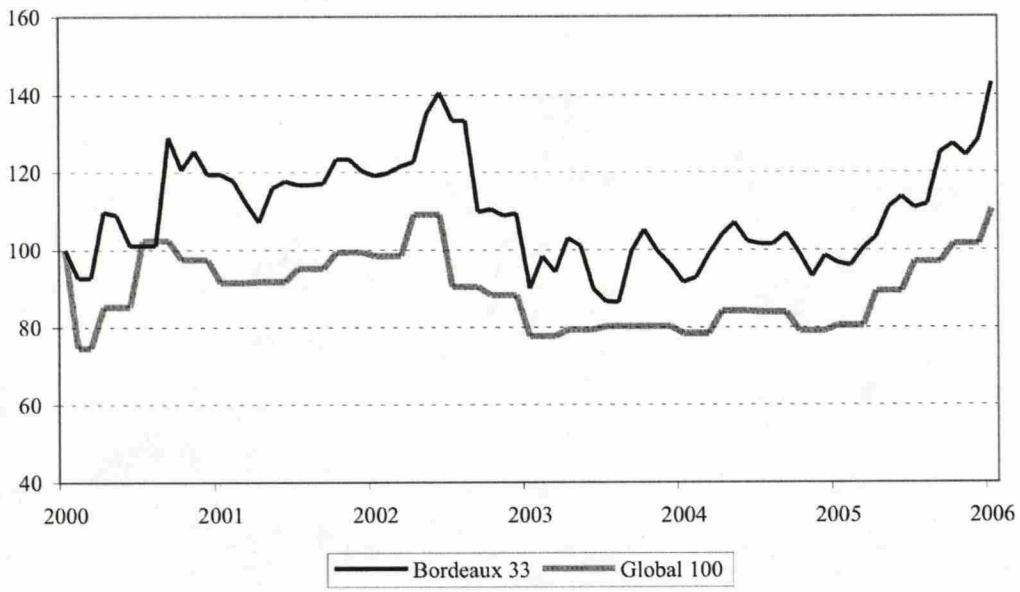
Hypothesis VI is based on the classical efficient market hypothesis. The same wine should be similarly priced no matter where and by whom it is sold. All of the auction houses in the sample are regarded as first-tier houses, so they should have similar quality of service and reputation. The effects of location and auction house have not been tested before with wines. However Pesando (1993) found that the price of prints varied from one city and auction house to another. Hypothesis VII in turn is contrary to efficient market theory. Again, in an efficient market the lot size should not affect the price, nevertheless, many writers, like Nuikki (2003) and Sokolin (1998) have observed that full boxes are valued higher than single bottles or odd lots. The data available enables the testing of this long-lasting impression in the markets.

7. Performance of Wine Investments

In this section I will evaluate the performance of the two wine indices as such and against other asset classes. I will begin by describing the performance of Global 100 and Bordeaux 33 wine indices during the period from 2000 to 2006. After that, I will compare the Bordeaux 33 index with S&P500 equity index, FTSE total return corporate bond index and Reuters/Jefferies CRB total return commodity index.

Figure 7

Figure 6 presents the performance of Global 100 (grey line) and Bordeaux 33 (black line) wine indices. The start value for both in the beginning of year 2000 is 100. The indices correlate highly, which is not a surprise as they include many of the same wines.

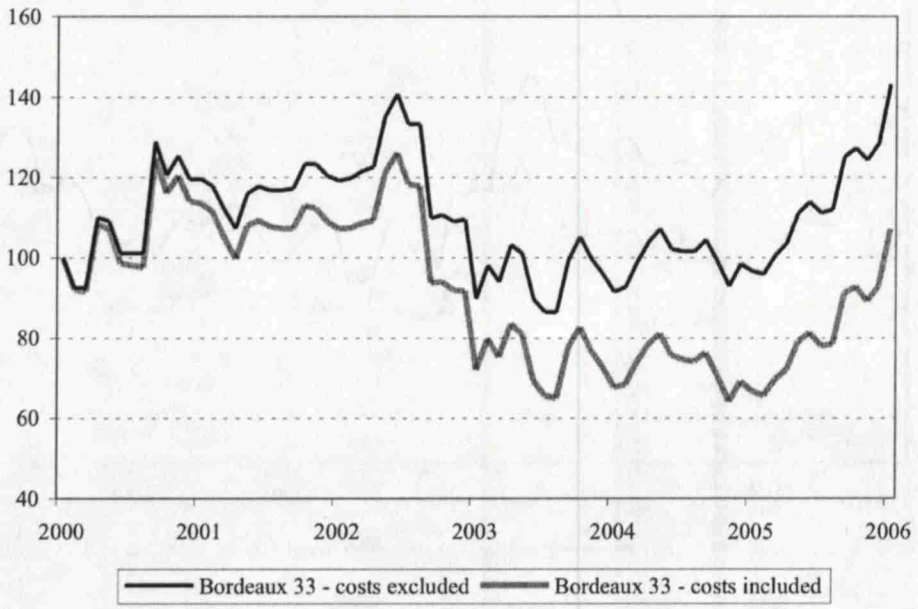


The performance of both indices, the Bordeaux 33 and Global 100, is presented in Figure 7. They track each other very close, which is not surprising as they have partially the same constituents. The average monthly returns were 0.7% for the Bordeaux 33 and 0.3% for Global 100 during the whole period, while monthly volatilities were 7.0% and 5.7% respectively. It is important to note

that the Global 100 index is calculated quarterly, which makes it look less volatile than the Bordeaux 33 index. The indices have performed quite well during the period from year 2000 to 2006. Years 2000 and 2005 were both great for investors, while there was a large drop in prices in late 2002 and early 2003. It is interesting that both 2000 and 2005 are considered to be excellent vintages, so there might be a relationship between early expectations about the vintage and general price level. Also the en primeur prices in 2000 and 2005 both were / are very high compared with normal years.

Figure 8

Figure 8 presents the Bordeaux 33 wine index with and without transaction and holding costs. The holding costs are very small portion of total costs. They were estimated to be annually 15€ per case of wine, which is 0.63% of total value of the wines or 0.05% monthly. The transaction costs were estimated to be 30% for the holding period of 6 years, which is the calculation period of the index. This translates into 0.42% monthly cost.



For wines, the average monthly return of 0.7% can be considered quite good, but we must bear in mind that it does not include transaction costs. When trading costs are included (approximately 30%) the total return during the period vanishes close to zero. The effect of transaction costs and holding costs is presented in Figure 7, which shows the Bordeaux 33 index excluding and

including the costs. The holding costs were estimated to be 15€ per case and the transaction costs 30% of total value of the trade. The holding costs were transformed into a percentage of an average investment grade wine case (2,400€) and prove to be insignificant during the holding period. The graph assumes that the costs are amortized over the holding period, which is assumed to be the calculation period of the index. The problem of high transaction costs is the single most important hurdle in investing in wines through the first tier auction houses. For investing purposes the emergence of online market places for wines is very promising.

Figure 9

This graph shows the performance of the Bordeaux 33 wine index (with and without transaction and holding costs) during the period 2000-2006 against S&P 500 equity index, FTSE corporate bond total return index and Reuters CRB total return commodity index.

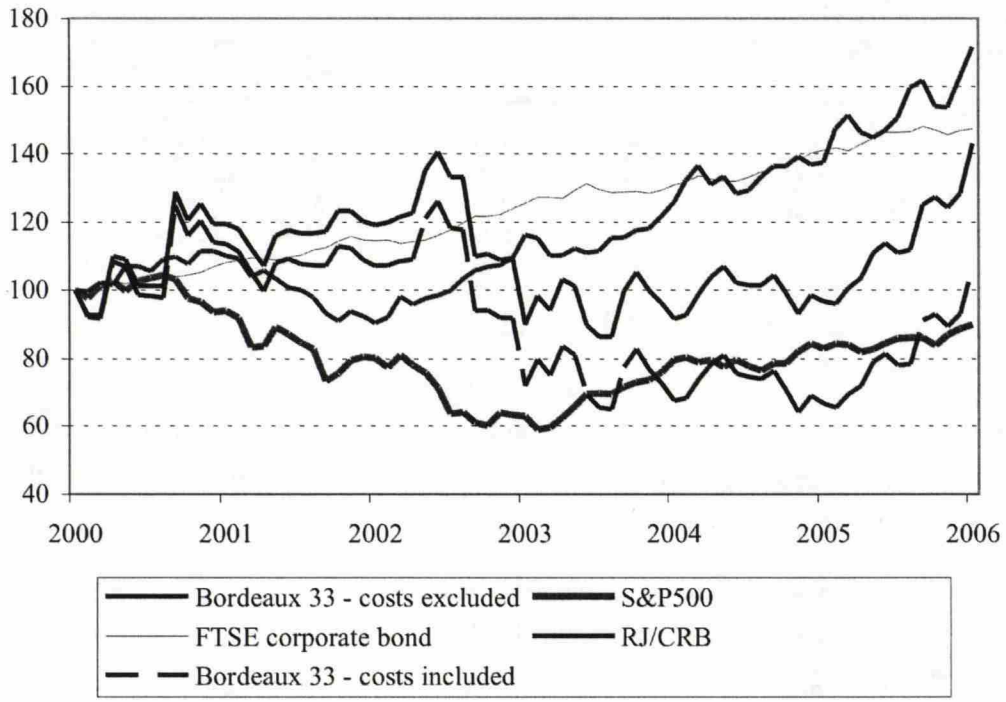


Figure 9 presents the standardized equity, fixed income, commodities and wine indices, while Tables 10 and 11 show the descriptive statistics and correlations for these indices. As can be seen, wine has performed quite well when compared with other asset classes. However, the short

observation period makes the generalization of the results difficult. FTSE corporate bond index seems to be the most stable, while the changes in other indices are considerable larger during the observation period. Especially equities performed badly during the first half of the period, from 2000 to 2003, after the IT bubble burst in late 2000. Also commodities experienced a downturn in the 2001, but otherwise they have increased steadily over the time. The rising oil prices and soaring demand for several commodities in China have played major role in pushing up the returns from commodities. The Bordeaux 33 wine index is clearly the most volatile of the indices, especially the sharp drop in the middle of the period and large increases in early 2000, 2002 and the whole 2005 show how large the monthly changes can be.

Table 10

Table 10 shows descriptive statistics for the compared indices. First column gives the name of the index, second the number of observations, third and fourth present the minimum and maximum values during the period, while fifth column shows the average value of the index and the final column the standard deviation.

	Monthly		Annual			
Index	**Average return**	**Volatility**	**Average return**	**Volatility**	**Maximum**	**Minimum**
Bordeaux 33, excluding costs	0.73%	7.0%	8.8%	83.5%	143.03	86.40
Bordeaux 33, including costs	0.42%	8.2%	5.0%	98.0%	126.16	63.99
Global 100 wine index	0.31%	5.7%	3.7%	68.3%	110.56	74.67
S&P 500 equity index	-0.1%	3.7%	-1.0%	44.3%	104.31	58.82
FTSE corporate bond index	0.5%	0.8%	6.5%	9.2%	148.16	100.00
Reuters / CJB commodity index	0.79%	2.9%	9.5%	34.7%	171.59	90.32

The average returns and volatilities of the compared indices are shown in Table 10. The table shows both monthly and annual performance and volatility of the different indices. In addition the maximum and minimum values are presented in the last two columns. As already indicated by the graph, wines have performed quite well compared with other asset classes when it comes to pure returns and trading costs are excluded. The average monthly return of 0.73% is higher than that of equities and bond and only slightly lower than commodities. The picture however changes when the costs are included, average return being only 0.42% monthly. Only equities, which had a terrible bear run in the first half of the observation period provided investors with lower returns. However, wines have been very volatile during the observation period, even more volatile than commodities and equities. This is not that surprising, as the wine market is much smaller than equities, bond and commodities and, as for collectibles in general, the price setting

process is less accurate. The minimum values reveal the deep recession of equities and the more stable nature of bonds, compared with other asset classes presented here. Both Figure 9 and Table 10 show clearly that wines do not produce better returns than bonds, however they are able to beat the S&P 500 equity index. This is partly against hypothesis I, but the more relevant comparison during the observation period is the corporate bond index.

Table 11

Table 11 shows the (Pearson's) correlations of all the compared indices and their significance levels. The significance level of correlations is marked after each coefficient (*** = 1%, ** = 5% significance level).

Correlations	Bordeaux 33 Excluding costs	Bordeaux 33 Including costs	S&P 500 Equity index	FTSE Corp. bond index	RJC/RB Comm. index
Bordeaux 33 - Excluding costs	1	0.991	0.066	-0.179	0.356
Significance level		0.000 ***	0.585	0.133	0.002 ***
Bordeaux 33 - Including costs		1	0.044	-0.163	0.341
Significance level			0.711	0.171	0.003 ***
S&P 500 Equity index			1	-0.097	0.178
Significance level				0.418	0.134
FTSE Corporate bond index				1	-0.188
Significance level					0.113
RJC/RB Commodity index					1
Significance level					

Many investors try to diversify their investment and thus the correlation of wines with other asset classes is probably more relevant than pure returns. What is encouraging is the low or negative correlation with both equities and bonds, and relatively low correlation with commodities, shown in Table 11. This would indicate that wine could be an effective diversification tool for many portfolios. However, especially the low correlation with equity index is somewhat surprising and against hypothesis II, as Bentzen *et al.* (2006) found high correlation in their study using Danish data from 1990's.

In general it seems that wines as an asset class are not very interesting for financial investors. The returns after considering transaction and holding costs are low, especially considering the high volatility in prices. If transactions costs decreased wines could become an interesting diversification tool for investors as the correlation with both bonds and equities are very low. Also, the high volatility and nature of the market could allow some investors to gain large

returns. It is clear that the information asymmetry in the wine market is relatively large and the information flows are imperfect. In the next section I will take a closer look at the factors affecting the price of wines in auctions and this could provide investors with more information how to profit from wines.

8. Price Formulation in Wine Auctions

This section is devoted to the analysis of pricing of wine in auctions. I will present how much different factors affect the price of wine and discuss their implications. I will also compare my results with my hypotheses and other authors' earlier studies. I will begin by presenting the base case for each model in Table 12. The base case shows the specification for qualitative models against which the qualitative variables are compared. I tried to select the most common alternative for each variable group as a base case to make the models robust. If the base case would be far from the median case the accuracy of the model could suffer. Also, by selecting a frequent variable as the base case I avoid the risk that all the other variables are compared against a base case, which is inaccurate because of low number of observations.

Table 12

Table 12 presents the base case assumptions for each models and variable groups. The variable groups are presented in columns and models in rows. Only the qualitative variables have base cases. The selection of base case variables is based on frequency and distribution, so that the base case variables would be one of the most frequent inside the variable group and middle of the distribution (for example Case of 12 is by far the most common lot size, while Parker score of 94 and age of 8 are in the middle of the variables groups).

Regression	Area	Year of trade	Lot size	Auction house	Location of trade	Parker dummy	Age dummy	Château dummy
Model 1								
Model 2	Medoc 1st growth							
Model 3	Medoc 1st growth	2003						
Model 4	Medoc 1st growth	2003	Case of 12	Christie's	USA			
Model 5	Medoc 1st growth	2003	Case of 12	Christie's	USA	94		
Model 6	Medoc 1st growth	2003	Case of 12	Christie's	USA	94	8	
Model 7								
Model 8	Medoc 1st growth							
Model 9	Medoc 1st growth	2003						
Model 10	Medoc 1st growth	2003	Case of 12	Christie's	USA			
Model 11	Medoc 1st growth	2003	Case of 12	Christie's	USA	94		
Model 12	Medoc 1st growth	2003	Case of 12	Christie's	USA	94	8	
Model 13		2003	Case of 12	Christie's	USA			Mouton Rothschild

The base case assumptions are similar for first two set of models, as the only difference between them is the quantitative reputation factor, which is added to each of the models 7-12. Models 1

and 7 have only quantitative variables, while all other models have at least one qualitative variable group. Medoc 1st growth was selected as the base case for region variable group as it is the most frequent in the data set and the average price of Medoc 1st growth is relatively close to the average of the whole data set[3]. The year of trade base case 2003 also is one the most frequent and lay in the middle of the observation period. For the lot size "case of 12" was selected as a dummy variable as it was by far the most common one (76% of all observations). The base case for auction house is Christie's, which along Sotheby's was the most common auction house in the data set. For location of trade both alternatives were approximately as frequent. I ended up selecting the United States as the location of trade base case. For both the Parker and age dummies I selected values, which lay in the middle of the distributions, 94 and 8 respectively. Finally, Château Mouton Rothschild, which was the most frequent wine in the data set, was selected as the vineyard base case for model 13.

The percentage change for qualitative variables is only reliable for values inside observation range. For example the effect of Parker points can be used in the range around 85 to 100 points, while production amount effect is reliable for wineries that produce less than 50,000 cases. I have calculated a price of an example bottle for models 1-12 using each model to test the robustness of the models and to spot differences between the models. The example bottle is an 8-year old, Medoc 1st growth wine from vineyard that produces 15,000 cases of wine and from a vintage that received 94 points, while the wine got 94 points from Robert Parker, has reputation of 97 points and traded in year 2003 at Christie's in the U.S. as a lot of 12. Of course not all models test for all of the attributes, for example for model number 1 the example bottle in an 8-year old wine which received 94 points for both vintage and Parker score and was produced 15,000 cases.

Table 13 presents the results for models 1-6. Models 1-3 are presented on the first page and 4-6 on the second page. Each model is on its own column and coefficients are displayed for all the variables that are included in the model. The model statistics, r-squared, F-value, standard errors of the estimates and price of an example bottle are presented below each model. The r-squared values are very close to adjusted r-squared values (difference less than 0.01) for each of the 13

[3] The average values for different variables are presented in Table 3: average age is 9.7, average Parker points 93.7, average production amount almost 16,000 cases and average vintage score 92.3.

models and are therefore not presented separately. As mentioned the first set of models is the basis for this study and the other models are compared with it. The first model uses only the quantitative variables: age, Parker points, production amount and vintage score. It thus omits the effect of regions, year and location of trade, auction house and lot size. However, it indicates the effect of all the quantitative variables and results from other models are compared against this to highlight differences and discuss reasons. In general the results from the regression are as expected and prove to support hypothesis I, which predicted that Parker points, age and vintage score have positive effect on price, while production amount has negative effect.

8.1 The Price Effect of Quantitative Variables

The high influence (9.3%) of Parker points is not surprising, as other authors have reported similar results. As mentioned before Parker points signal not only the quality, but also reputation of the wine and thus are probably the single most important quantitative factor that investors and buyers evaluate. Age also seems to affect the price of wine significantly, one extra year of cellaring increases the price of wine 4.7% on average. This can be interpreted as the annual yield for wine investors. Again, this was predictable and follows earlier studies and Hypothesis III. Age affects basically all three components of wine valuation: reputation, quality and scarcity. The wine gains some reputation when it grows older, it improves in quality as it gets more mature and the number of bottles decreases as a function of time and thus the price goes up. Both the effect of Parker points and age are studied in more detail in models 5 and 6. The relatively small effect of vintage score (1.8%) is somewhat surprising but this is probably due to the fact that Parker points tend to be significantly higher for good vintages and thus the pure effect of vintage score is relatively low. The last coefficient in the model is the produced amount of wine, which in this case is measured in thousands of cases. As was predicted in hypothesis III the production amount has negative correlation with the price of wine. This can be linked to the scarcity effect, as more wines means larger supply and thus the collectible item is not as rare as its comparable, less-produced, competitor. However, the negative price effect of an extra 1,000 case of wine is only around three percent, so from wine makers point of view it is probably not worth restraining production only for scarcity's sake. Of course, less production often leads to better quality, which has led many chateaus especially in Bordeaux to cut production during the past 15 years.

The r-squared value for the first model is relatively low at 0.474, F-value being almost 4,600 and standard error of the estimate 0.614. These indicate that the model is highly significant, but only explains around 50% of total price of wines, while the standard error is relatively large. The price of the example bottle using this model is 144.34€, which is relatively low compared with the average price of 219€ in the data set, even though all the attributes of the example bottle are quite close to the averages of quantitative variables (see Table 3).

Table 13

Table 13 presents the first set of models that aim to explain the price formulation of wines in an auction. The variables are in the first column, quantitative variables first and then the dummy variable categories, all separated by horizontal lines. The base case (BC) of all the qualitative variables is shown next to the name of variable group. The first three models are on the first page and the models 4-6 are on the second page. For each model the betas for each variables are presented first, with significance level (*** = 1%, ** = 5% and * = 10% significance level). The next column shows the actual price effect of the coefficient calculated as following: Price effect = e^{beta}-1. For quantitative variables price effect is the amount of change in the price if the coefficient increases by one unit, while for qualitative variables the price effect tells the difference between the coefficient and base case alternatives.

	Model 1		Model 2		Model 3	
Variable	**Beta**	**Price effect**	**Beta**	**Price effect**	**Beta**	**Price effect**
Constant	-4.999 ***		-5.155 ***		-5.339 ***	
Parker points	0.089 ***	9.3%	0.078 ***	8.1%	0.081 ***	8.4%
Age	0.046 ***	4.7%	0.043 ***	4.4%	0.049 ***	5.0%
Production ('000's of cases)	-0.031 ***	-3.0%	-0.010 ***	-1.0%	-0.010 ***	-1.0%
Vintage score	0.018 ***	1.8%	0.029 ***	2.9%	0.027 ***	2.7%
Area - BC: Medoc 1st growth						
Burgundy			1.509 ***	352.4%	1.536 ***	364.7%
Rhone			-0.611 ***	-45.7%	-0.581 ***	-44.1%
Medoc 2nd growth			-0.615 ***	-45.9%	-0.605 ***	-45.4%
Medoc other			-0.633 ***	-46.9%	-0.620 ***	-46.2%
Graves			-0.480 ***	-38.1%	-0.483 ***	-38.3%
St.Emilion			0.164 ***	17.8%	0.160 ***	17.4%
Pomerol			0.913 ***	149.2%	0.923 ***	151.7%
Rest of the World			-0.334 ***	-28.4%	-0.298 ***	-25.8%
Year of trade - BC: 2003						
2006					0.092 ***	9.6%
2005					0.004	0.4%
2004					-0.048 ***	-4.7%
2002					0.206 ***	22.8%
2001					0.270 ***	31.0%
2000					0.222 ***	24.8%
1999					0.192 ***	21.2%
Dependent variable	ln(price)		ln(price)		ln(price)	
R^2	0.474		0.770		0.786	
F-value	4,589.97		5,669.02		3,944.88	
Standard error of the estimate	0.614		0.407		0.392	
Price of example bottle	144.34		164.75		151.45	

Variable	Model 4 Beta	Model 4 Price effect	Model 5 Beta	Model 5 Price effect	Model 6 Beta	Model 6 Price effect
Constant	-4.965 ***		2.378 ***		2.875 ***	
Parker points	0.078 ***	8.1%				
Age	0.048 ***	5.0%	0.040 ***	4.1%		
Production ('000's of cases)	-0.009 ***	-0.9%	-0.007 ***	-0.7%	-0.007 ***	-0.7%
Vintage score	0.026 ***	2.6%	0.026 ***	2.6%	0.024 ***	2.4%
Area - BC: Medoc 1st growth						
Burgundy	1.453 ***	327.7%	1.500 ***	348.2%	1.481 ***	339.5%
Rhone	-0.601 ***	-45.2%	-0.567 ***	-43.3%	-0.570 ***	-43.5%
Medoc 2nd growth	-0.606 ***	-45.5%	-0.623 ***	-46.4%	-0.625 ***	-46.5%
Medoc other	-0.618 ***	-46.1%	-0.600 ***	-45.1%	-0.615 ***	-46.0%
Graves	-0.486 ***	-38.5%	-0.448 ***	-36.1%	-0.447 ***	-36.1%
St.Emilion	0.162 ***	17.6%	0.144 ***	15.5%	0.142 ***	15.3%
Pomerol	0.891 ***	143.9%	0.902 ***	146.6%	0.903 ***	146.6%
Rest of the World	-0.369 ***	-30.9%	-0.319 ***	-27.3%	-0.306 ***	-26.4%
Year of trade - BC: 2003						
2006	0.105 ***	11.1%	0.130 ***	13.9%	0.174 ***	19.0%
2005	0.000	0.0%	0.017 **	1.7%	0.039 ***	3.9%
2004	-0.051 ***	-5.0%	-0.043 ***	-4.2%	-0.033 ***	-3.3%
2002	0.233 ***	26.2%	0.222 ***	24.9%	0.209 ***	23.3%
2001	0.245 ***	27.7%	0.236 ***	26.6%	0.225 ***	25.3%
2000	0.207 ***	23.0%	0.211 ***	23.5%	0.196 ***	21.7%
1999	0.166 ***	18.0%	0.143 ***	15.4%	0.158 ***	17.1%
Lot size - BC: Case of 12						
Case of 6	0.117 ***	12.4%	0.114 ***	12.0%	0.109 ***	11.5%
Odd lot	0.082 ***	8.5%	0.069 ***	7.1%	0.062 ***	6.4%
Auction house - BC: Christies						
Sothebys	0.064 ***	6.6%	0.058 ***	6.0%	0.067 ***	6.9%
Acker Merral	0.080 ***	8.3%	0.063 ***	6.5%	0.060 ***	6.1%
Zachys	0.134 ***	14.4%	0.126 ***	13.4%	0.105 ***	11.1%
Morrells	-0.079 ***	-7.6%	-0.080 ***	-7.7%	-0.064 ***	-6.2%
Location of trade - BC: USA						
Europe	-0.098 ***	-9.4%	-0.099 ***	-9.4%	-0.100 ***	-9.6%
Parker dummies - BC: 94						
Parker 100			0.638 ***	89.2%	0.595 ***	81.2%
Parker 99			0.440 ***	55.2%	0.419 ***	52.1%
Parker 98			0.483 ***	62.0%	0.464 ***	59.0%
Parker 97			0.338 ***	40.2%	0.302 ***	35.3%
Parker 96			0.143 ***	15.3%	0.129 ***	13.8%
Parker 95			-0.065 ***	-6.3%	-0.093 ***	-8.9%
Parker 93			-0.279 ***	-24.3%	-0.300 ***	-26.0%
Parker 92			-0.168 ***	-15.5%	-0.195 ***	-17.7%
Parker 91			-0.317 ***	-27.2%	-0.334 ***	-28.4%
Parker 90			-0.328 ***	-27.9%	-0.348 ***	-29.4%
Parker 89			-0.408 ***	-33.5%	-0.448 ***	-36.1%
Parker 88			-0.427 ***	-34.8%	-0.464 ***	-37.2%
Parker 87			-0.458 ***	-36.8%	-0.492 ***	-38.9%
Parker 86			-0.406 ***	-33.4%	-0.443 ***	-35.8%
Age dummies - BC: 8						
Age 2-3					0.015	1.5%
Age 4					-0.015	-1.4%
Age 5					-0.017	-1.7%
Age 6					-0.058 ***	-5.6%
Age 7					-0.030 **	-3.0%
Age 9					0.030 ***	3.1%
Age 10					0.079 ***	8.2%
Age 11					0.156 ***	16.9%
Age 12					0.294 ***	34.2%
Age 13					0.339 ***	40.3%
Age 14					0.361 ***	43.5%
Age 15					0.405 ***	49.9%
Age 16-20					0.349 ***	41.8%
Dependent variable	ln(price)		ln(price)		ln(price)	
R^2	0.795		0.816		0.821	
F-value	3,030.76		2,305.71		1,825.39	
Standard error of the estimate	0.364		0.364		0.359	
Price of example bottle	152.21		151.59		144.60	

8.2 Effect of Region / Appellation

The second model introduces the region / appellation variable group to the regression. The regions and classification seems to play a vital role in pricing of investment grade wines. The differences between regions are enormous: while wines from Burgundy are on average more than three times more expensive than Medoc first growth, Medoc lower growths (3-5) wines are on average around 46% cheaper than the first growth. Rest of the regions lie between these two extremes. Pomerol turns out to be the most expensive area of Bordeaux, which was somewhat surprising as Medoc 1st growth is generally considered the most famous area inside Bordeaux. This can be attributed largely to the strong role of Château Petrus, which is both highly liquid and very expensive wine. The region also includes Château Lafleur, which is also from the expensive end of the spectrum. Wines from St. Emilion are also more expensive than Medoc 1st growth, which is surprising. In this case the fact that Château Cheval Blanc, which is one the most expensive wines in the market, has unnaturally high weight in St. Emilion coefficient seems to cause the surprising results. If a larger sample of St. Emilion wines was included the coefficient would most probably be significantly lower. Wines from Graves and Medoc 2nd growth classifications are price lower than the benchmark as expected.

The next two regions are Burgundy and Rhone, the other two main red wine producing regions of France. The first is probably best known from its prestigious pinot noirs, while the Rhone's Chateauneuf du Papes are also widely known. Burgundy produces the most expensive wines in my data set. Wines from Rhone in turn trade at around 45% discount compared with Medoc first growth. Rest of the world coefficient includes wines from Italy, Australia and the United States. Even though there are some wines that are very expensive, they are generally more than 30% cheaper than the benchmark. We can conclude that hypotheses IV can be accepted, as Medoc second growth and other growths are less expensive than the first growth. It is impossible to compare classifications from other Bordeaux regions against these. Hypothesis V is partially accepted: wines from Burgundy most definitely are more expensive than other wines, but Bordeaux includes appellations which are cheaper than wines from other regions.

The changes in quantitative variables, when compared with model one are relatively low. The effect of Parker points reduced by one percentage point, while the effect of vintage scores increased by one percentage point. The price effect of age remained approximately the same, but the effect of production amount decreased quite dramatically from 3% to 1%. These changes were likely when area variables were introduced. First of all, production amount is often linked to the winegrowing area as explained earlier. In this case the negative effect price declined especially because almost all of the low production – expensive wines are from Burgundy and thus the region variable explains large share of the price premium. The effect of vintage ratings increased, which is natural as vintage ratings are regional and thus the model is able to take full advantage of the vintage ratings, as regions are included. The effect of Parker points probably decreased because of increased accuracy of vintage ratings. The effect of age remained approximately the same, which is logical, as the wines from different regions should increase in value at the same rate.

The r-squared value, which measures how well the model predicts the price increased significantly from the first model: 0.77 against 0.47. Also the F-value increased to almost 5,670, while standard error decreased to 0.41. Thus, it seems that area / appellation has a large effect on the price of wine and the accuracy of the model increase significantly when the variable group is included in the regression. The price of the example bottle increased to 164.75€, as the region of the bottle (Medoc 1st growth) was included in the estimate and it is more expensive than regions in average.

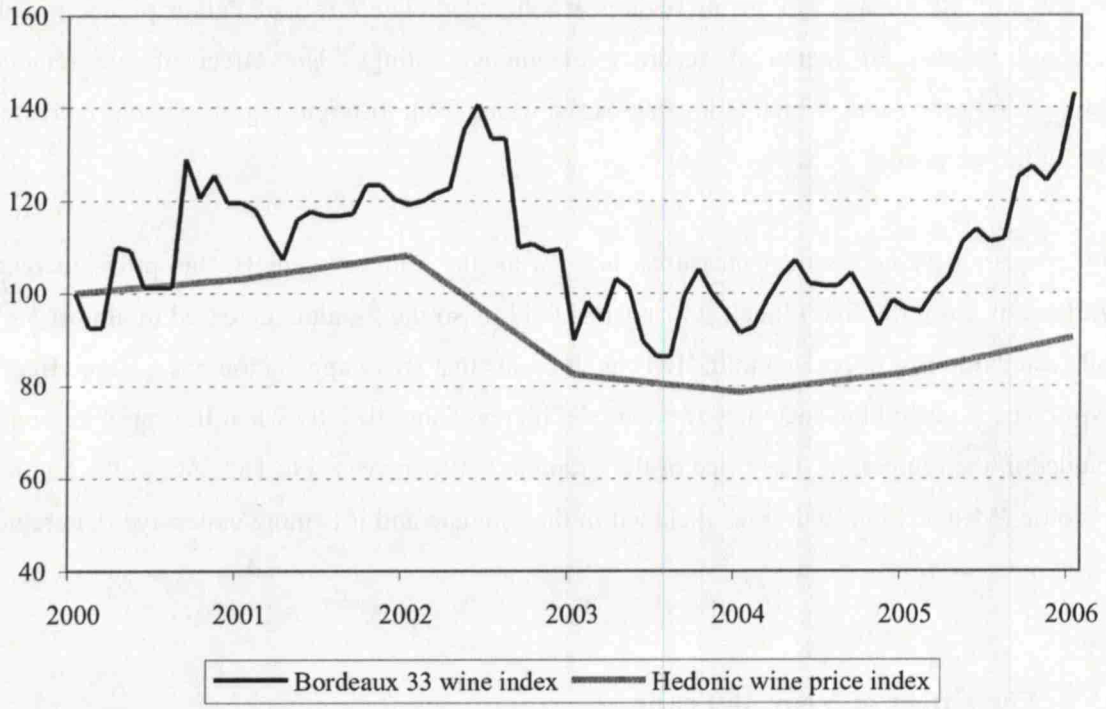
8.3 The Effect of Year of Trade

The year of trade variable is introduced into the 3rd model. It aims to neutralize the general change in prices of wines, which is caused by change in the overall market. At the same time it functions as another, hedonic, wine index and as mentioned earlier hedonic indices are used in several wine studies. The logic behind the hedonic index is that the regression controls for the change in quality and the year of trade dummies thus include only macro price information related to specific years. Thus it is a price index that only follows the prices, not returns, of wines. The hedonic index is presented in Figure 10 with the Bordeaux 33 composite wine index.

The general patterns of indices are quite similar, but the fact that hedonic index is annual, compared with the monthly Bordeaux index, causes some differences and the hedonic indices seem less volatile. Also, the hedonic index, which does not include the natural appreciation in prices of wines, is naturally below the Bordeaux 33 index.

Figure 10

This graph shows the Bordeaux 33 wine index and hedonic wine price index. The hedonic wine index is obtained from the hedonic regression and is effectively calculated from the "year of trade" dummies and is thus annual, while Bordeaux 33 is a monthly index. This causes the hedonic index seem less volatile.



The changes in other variables are very small, which makes sense, as the attributes of the wines over time should be relatively stable. The r-squared value increases slightly to 0.79 from 0.77 in the previous model, which indicates that the regression becomes more accurate when the general trend is controlled with the year of trade variable. Also the standard error decreases to 0.39 from 0.41. The F-value however declines significantly, as a number of variables increases from 14 to 22. The price of the example bottle declines to 151€, as the base case year, which is used for the example bottle, is below average.

8.4 Effect of Location, Auction House and Lot Size on Price

The fourth model introduces three new variables to the regression, all related to the auctions. First, the price differences between auction houses are tested, next the effect of location is estimated and finally the price effect of lot size is calculated. In an efficient market the location of trade, the auction house and lot size should not have any effect on prices. However, the results from the regression indicate surprisingly high differences in all of these.

Probably the most surprising result came from the lot size variable, which against hypothesis VII shows that half cases and odd lots trade at premium against full cases. This is in contrast with observations and advices given by Sokolin and Nuikki. However, I believe there is a good explanation for this surprising observation. As both Sokolin and Nuikki write, large bottles like magnums trade at premium as they tend to mature better and they are fewer in number. These large bottles more often trade in odd lots, which could explain the difference. The scarcity or very high prices of some wines might also lead them to trade in half cases and odd lots.

In addition the large price differences between auction houses and locations of trade are surprising. Because the large and significant differences, we have to reject the hypothesis VI. One reason why the prices in the US might be higher than in Europe is the fact that I have used premium prices, which include the buyers' premium. This premium is much higher in the US than in Europe as Table 3 shows. It might be that buyers compare the hammer prices and place their bids according to those and thus end up paying higher prices in the United States. Fluctuations in exchange rates may also have caused some differences. The observation that wines traded at Zachy's are around 20% more expensive than those traded Morrel's is very surprising. The hedonic regression should eliminate differences between the quality difference in offerings and time of trade, so the differences should emerge from differences in service level or buyers. Even the difference between the two largest and best-known auction houses, Christie's and Sotheby's, is almost 7%. This is even more surprising, as the offering of these two should be very close to each other. The differences between auction houses are difficult to explain properly without examining the offering and services of the houses in more detail. Pesando (1993) found

similar results for art prints and these findings show that the prices of collectibles vary from one auction house and location to another.

The changes in other variables compared with previous models are relatively small. The largest changes occur in the region / appellation coefficients, where the price effect of the Burgundy and Pomerol coefficients decrease from 364% to 328% and from 152% to 144% respectively, while the discount for New World wines increase from 26% to 31%. This observation seems to confirm that the price premium of odd lots and small cases is due to the fact that they are generally more expensive wines, most of which come from Burgundy and Pomerol. The r-squared value of the fourth model increased slightly compared with previous one (0.80 vs. 0.79), while standard error (0.36 vs. 0.39) and F-value (3030 vs. 3950) decreased. The price of the example bottle remained stable at 151€. It thus seems that while the introduction of these new variables increase the accuracy of the regression, they do not cause any dramatic changes.

8.5 A Closer Look at Parker Points

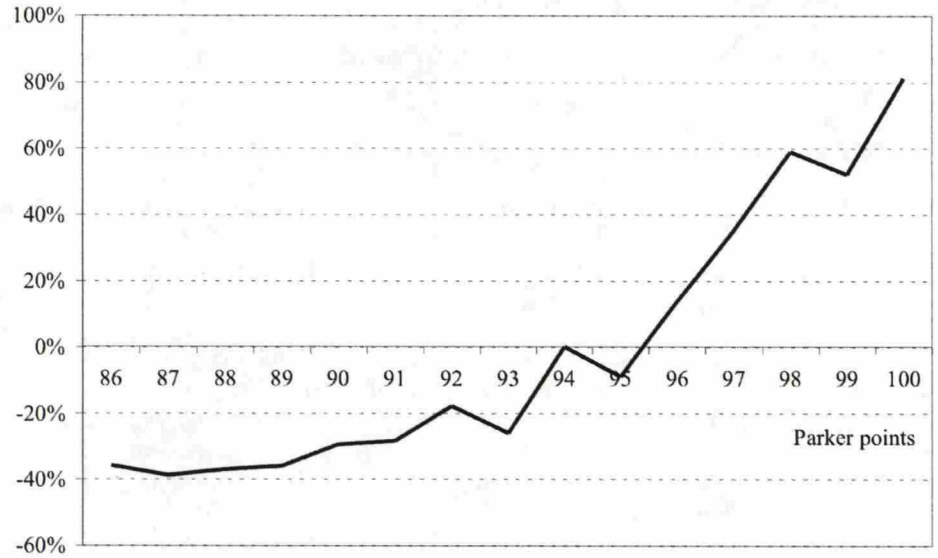
The model number 5 takes a closer look at the price effect of Parker points. Model number 5 excludes the quantitative Parker variable and replaces it with a set of dummy variables, one for each Parker point from 86 to 100, where 86 includes all Parker points below 87. This way I can take a closer look how the price of wine changes with Parker points, for example what is the difference between one point increase from 89 to 90 compared with an increase from 99 to 100. The results provide more insight to investment grade wines and emphasise some points mentioned earlier. The results are shown in Table 12 (second page, model 5) and Figure 11 presents the effect of Parker points graphically.

The results from model 5 support the results from earlier regressions, which show strong positive relationship with price and Parker points of wines. However, as can be seen from Figure 5 the relationship is not linear throughout the scale. The price effect of Parker points is relatively low for wines which have received less than 90 points, whereas the effect is very strong for wines that received more than 95 points. There are three points (93, 95 and 98) which show small negative change from previous points. For the 98-point observation the reason might be the low number of

observations with 98 points, but for the two other out-of-line observations there are no logical explanations.

Figure 11

Figure 11 graphically presents the price effects of different Parker points on wine. 94 Parker points is the base case against which the price effects of other variables are compared. The difference is shown as percentages on the vertical axis. There is a clear positive relationship with Parker points and price, even though there are a few out-of-line observations. The price effect seems to be especially strong after the 95-point threshold, while the difference for points under 90 points is considerable lower.



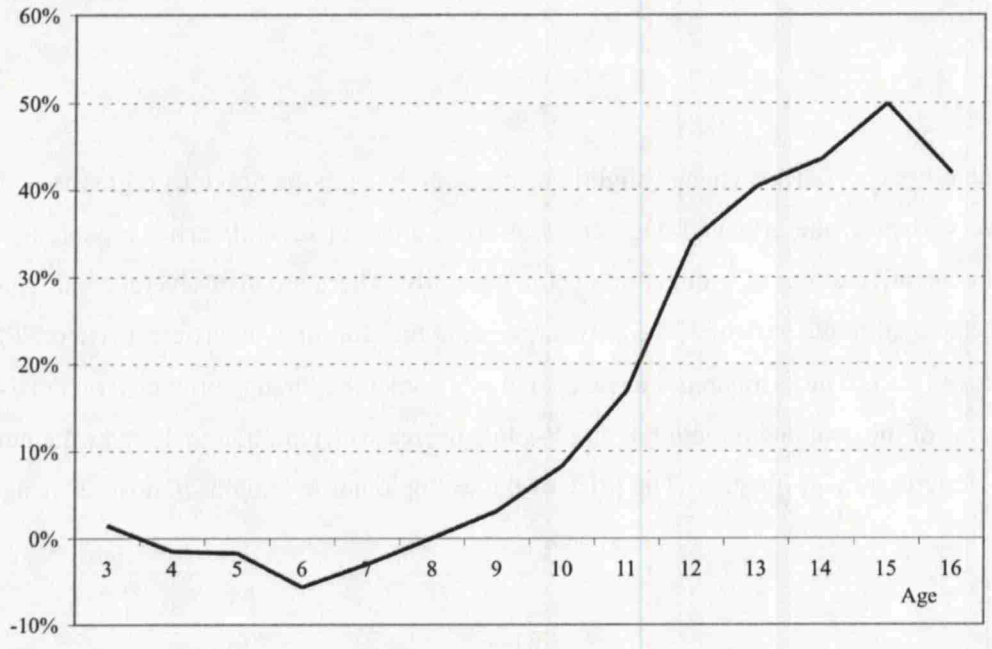
Some of the other coefficients change slightly or moderately from the previous regressions. From quantitative variables, the effect of age decreases from 5.0% in several earlier models to 4.1% and also the negative effect of production declines slightly. There are also several small changes in many of the qualitative variables, the only large being the Burgundy coefficient (from 328% in model 4 to 348%). The r-squared increase to 0.82 from 0.80 in the previous model, while standard error of the estimate remain flat and F-value decreases from 3030 to 2306 as the number of variables increases significantly. The price of the example bottle remains almost unchanged at 151.59€.

8.6 A Closer Look at the Ageing Effect

The last model of the first set, number 6, strives to explain the effect of age more accurately in a similar manner as the previous model did for Parker points. The results for the whole model are presented in Table 12 and the effect of age is described graphically in Figure 12. The results are extremely interesting and somewhat surprising. The price of wines actually decreases during the first six years, after which the value begins to increase until they reach 15 years of age, the price again declining thereafter. Wines experience the most intense increase in their price from years 9 to 13, during which the price of wines increase almost 40% on average. There is a relatively low number of observations for wines with age of 16 to 20, so they are grouped under a single variable. It seems that the price of wines on average starts to decline during the period from 15 to 20 years.

Figure 12

Figure 12 shows the effect of ageing for wines. The first point includes observations for both 2 and 3 year old wines and the last point includes all observations for wines that are from 16 to 20 years old. The shape of the curve is surprising. It shows that wines tend to decrease in value before the age of 6, after which they increase in value, especially strong for a period from 9 to 13 years. The wines begin to decline in value during the last point (16-20 years old), which is sooner than expected.



This result was unexpected as wines are often considered to increase in value for much longer time. The best and most prestigious wines probably do increase in value for a longer period, as their quality improves after 20 years. The liquidity for most wines however decreases with time as more bottles are consumed, which leads to more inefficient price setting and higher liquidity premium, which could explain the deterioration of prices of older wines. Also, this provides valuable information for investors, as there is clearly a period when wines increase in value substantially. A winning strategy seems to be to buy wines when they are 9 or 10 years old and sell them at the age of 15 years: the value of wines on average increases more than 40% during this 6-7 year period.

8.7 The Reputation Factor

The models 7-12 are identical to models 1-6 respectively, except that the reputation factor introduced in section 5.2 is added to each model. The results are presented in Table 14, models 7-9 in the first page and 10-12 on the second page. The format is quite similar to Table 13. The variables are presented in the first column, followed by the coefficients for the models, but on the third column of each model the difference in price effect compared with a similar model without the reputation factor is presented. The model statistics (r-squared, F-value, standard error and the price of example bottle) are presented below each model. To ease the comparison between the two sets of models the model statistics of a similar model without the reputation factor and the difference between the two are also presented. On general level the quantitative variables change slightly when reputation factor is introduced, regional and year of trade dummies change moderately and other qualitative variables are quite stable. The model statistics, especially the r-squared statistics, improve slightly.

The reputation factor in the first model of the set, which includes only quantitative variables, is surprisingly large, price effect being more than 11%, while the price effect of Parker points and age decrease by 1.7% and 1.0% to 7.4% and 3.6% respectively. This would indicate that the long-term reputation is actually more important than the Parker points given for the specific vintage.

As mentioned earlier, reputation factor is calculated as an average of the Parker points of the past ten years. For example Ali et al. (2003) found similar results in their study. In the seventh model the reputation effect is considerably lower, at 4.3%. On the other hand other quantitative variables are much closer to the second model, and different from the sixth regression. The changes in the region / appellation dummies are generally moderate, but the price effect of lower ranked Medoc (Medoc other) variable is almost 26% larger than in model number 2. The change in the St.Emilion dummy (28% vs. 20%) is also quite large. It thus seems that the reputations of wines are consistently different across different regions.

Table 14

Table 14 presents the regression models 7-12, which are similar to models 1-6 respectively, but the reputation factor, described in section 5.2, is added to each model. Models 7-9 are on the first page and 10-12 on the second page. The variables are presented in the first column, followed by the betas, price effects (price effects are calculated as follows: Price effect = e^{beta}-1) and the differences in price effect compared with models 1-6 for each of the models 7-12 respectively. The quantitative variables are presented first followed by qualitative variables, which are divided into variables groups indicated by horizontal lines. For qualitative variables the base case alternative (BC), against which other variables are tested is shown in the first line of the variable group after the name of the group. The significance levels for the coefficients are shown after the beta-values (*** = 1%, ** = 5%, * = 10% significance level). The model statistics are presented below the betas of each model. These include the r-squared, F-value, standard error of the estimate and the price of an example bottle. Again to ease comparison between the first set of models the same statistics for models 1-6 and the difference between the two are presented next to the model statistics.

		Model 7			Model 8			Model 9	
Variable	**Beta**	**Price effect**	**Difference**	**Beta**	**Price effect**	**Difference**	**Beta**	**Price effect**	**Difference**
Constant	-13.973 ***			-8.937 ***			-12.557 ***		
Parker points	0.072 ***	7.4%	-1.7%	0.074 ***	7.6%	-0.5%	0.073 ***	7.6%	-0.8%
Age	0.035 ***	3.6%	-1.0%	0.039 ***	4.0%	-0.4%	0.046 ***	4.7%	-0.3%
Production ('000's of cases)	-0.028 ***	-2.7%	0.3%	-0.009 ***	-0.9%	0.1%	-0.009 ***	-0.9%	0.1%
Vintage score	0.025 ***	2.5%	0.7%	0.030 ***	3.1%	0.2%	0.029 ***	2.9%	0.2%
Reputation	0.105 ***	11.1%	11.1%	0.042 ***	4.3%	4.2%	0.080 ***	8.4%	8.4%
Area - BC: Medoc 1st growth									
Burgundy				1.549 ***	370.5%	4.0%	1.619 ***	405.0%	8.7%
Rhone				-0.560 ***	-42.9%	5.2%	-0.475 ***	-37.8%	11.2%
Medoc 2nd growth				-0.558 ***	-42.8%	5.8%	-0.490 ***	-38.7%	12.2%
Medoc other				-0.405 ***	-33.3%	25.6%	-0.368 ***	-30.8%	28.7%
Graves				-0.504 ***	-39.6%	-2.4%	-0.348 ***	-29.4%	14.4%
St.Emilion				0.247 ***	28.1%	8.7%	0.322 ***	38.0%	17.5%
Pomerol				0.908 ***	147.9%	-0.5%	0.916 ***	150.0%	-0.7%
Rest of the World				-0.281 ***	-24.5%	5.4%	-0.185 ***	-16.9%	11.9%
Year of trade - BC: 2003									
2006							0.037	3.8%	-5.3%
2005							-0.033 ***	-3.3%	-3.7%
2004							-0.038 ***	-3.7%	1.0%
2002							0.221 ***	24.8%	1.6%
2001							0.319 ***	37.5%	5.0%
2000							0.354 ***	42.5%	14.1%
1999							0.314 ***	37.0%	13.0%
Reputation factor	**Included**	**Excluded**	**Difference**	**Included**	**Excluded**	**Difference**	**Included**	**Excluded**	**Difference**
Dependent variable	ln(price)	ln(price)		ln(price)	ln(price)		ln(price)	ln(price)	
R^2	0.511	0.474	0.037	0.774	0.770	0.004	0.798	0.786	0.012
F-value	4,259.53	4,589.97	-330.44	5,357.01	5,669.02	-312.01	4,031.76	3,944.88	86.88
Standard error of the estimate	0.592	0.614	-0.02	0.403	0.407	0.00	0.380	0.392	-0.01
Price of example bottle	172.96	144.34	28.62	170.74	164.75	5.99	158.09	151.45	6.65

Variable	Model 10 Beta	Price effect	Difference	Model 11 Beta	Price effect	Difference	Model 12 Beta	Price effect	Difference
Constant	-11.696 ***			-4.747 ***			-4.380 ***		
Parker points	0.071 ***	7.4%	-0.7%						
Age	0.046 ***	4.7%	-0.3%	0.038 ***	3.8%	-0.3%			
Production ('000's of cases)	-0.009 ***	-0.8%	0.1%	-0.006 ***	-0.6%	0.1%	-0.006 ***	-0.6%	0.1%
Vintage score	0.028 ***	2.8%	0.2%	0.028 ***	2.8%	0.2%	0.025 ***	2.6%	0.2%
Reputation	0.075 ***	7.7%	7.7%	0.072 ***	7.5%	7.5%	0.073 ***	7.6%	7.6%
Area - BC: Medoc 1st growth									
Burgundy	1.540 ***	366.6%	9.1%	1.586 ***	388.2%	8.9%	1.567 ***	379.4%	9.1%
Rhone	-0.500 ***	-39.4%	10.6%	-0.469 ***	-37.5%	10.3%	-0.471 ***	-37.6%	10.4%
Medoc 2nd growth	-0.499 ***	-39.3%	11.3%	-0.518 ***	-40.5%	11.1%	-0.519 ***	-40.5%	11.2%
Medoc other	-0.385 ***	-31.9%	26.2%	-0.377 ***	-31.4%	25.1%	-0.389 ***	-32.3%	25.3%
Graves	-0.361 ***	-30.3%	13.3%	-0.331 ***	-28.2%	12.4%	-0.329 ***	-28.0%	12.6%
St.Emilion	0.311 ***	36.5%	16.1%	0.301 ***	35.1%	16.9%	0.301 ***	35.2%	17.3%
Pomerol	0.888 ***	143.1%	-0.3%	0.893 ***	144.4%	-0.9%	0.894 ***	144.5%	-0.8%
Rest of the World	-0.256 ***	-22.6%	12.0%	-0.208 ***	-18.8%	11.7%	-0.193 ***	-17.5%	12.0%
Year of trade - BC: 2003									
2006	0.054 *	5.6%	-5.0%	0.082 ***	8.5%	-4.7%	0.126 ***	13.4%	-4.7%
2005	-0.034 ***	-3.3%	-3.3%	-0.014 **	-1.4%	-3.1%	0.009	0.9%	-2.9%
2004	-0.042 ***	-4.1%	0.9%	-0.033 ***	-3.3%	1.0%	-0.023 ***	-2.3%	1.1%
2002	0.244 ***	27.6%	1.1%	0.234 ***	26.4%	1.2%	0.225 ***	25.2%	1.6%
2001	0.290 ***	33.7%	4.7%	0.280 ***	32.3%	4.5%	0.276 ***	31.8%	5.2%
2000	0.329 ***	38.9%	12.9%	0.327 ***	38.7%	12.3%	0.317 ***	37.3%	12.9%
1999	0.280 ***	32.3%	12.1%	0.253 ***	28.7%	11.5%	0.272 ***	31.3%	12.1%
Lot size - BC: Case of 12									
Case of 6	0.101 ***	10.7%	-1.5%	0.101 ***	10.6%	-1.2%	0.096 ***	10.1%	-1.3%
Odd lot	0.073 ***	7.6%	-0.8%	0.062 ***	6.4%	-0.7%	0.054 ***	5.6%	-0.7%
Auction house - BC: Christies									
Sothebys	0.060 ***	6.2%	-0.3%	0.056 ***	5.7%	-0.2%	0.065 ***	6.7%	-0.2%
Acker Merral	0.071 ***	7.3%	-0.9%	0.056 ***	5.7%	-0.7%	0.052 ***	5.3%	-0.8%
Zachys	0.149 ***	16.1%	1.5%	0.142 ***	15.3%	1.6%	0.119 ***	12.6%	1.4%
Morrells	-0.064 ***	-6.2%	1.5%	-0.065 ***	-6.3%	1.6%	-0.048 ***	-4.7%	1.6%
Location of trade - BC: USA									
Europe	-0.086 ***	-8.2%	1.3%	-0.086 ***	-8.3%	1.2%	-0.088 ***	-8.4%	1.2%
Parker dummies - BC: Parker 94									
Parker 100				0.625 ***	86.9%	-1.2%	0.581 ***	78.7%	-1.4%
Parker 99				0.387 ***	47.3%	-5.1%	0.365 ***	44.0%	-5.3%
Parker 98				0.417 ***	51.7%	-6.4%	0.396 ***	48.6%	-6.6%
Parker 97				0.327 ***	38.6%	-1.1%	0.290 ***	33.6%	-1.3%
Parker 96				0.157 ***	17.0%	1.4%	0.144 ***	15.4%	1.4%
Parker 95				-0.032 ***	-3.2%	3.3%	-0.061 ***	-5.9%	3.3%
Parker 93				-0.252 ***	-22.3%	2.7%	-0.274 ***	-24.0%	2.7%
Parker 92				-0.159 ***	-14.7%	1.0%	-0.185 ***	-16.9%	1.0%
Parker 91				-0.306 ***	-26.4%	1.1%	-0.324 ***	-27.7%	1.0%
Parker 90				-0.289 ***	-25.1%	3.9%	-0.309 ***	-26.6%	3.9%
Parker 89				-0.367 ***	-30.7%	4.3%	-0.407 ***	-33.5%	4.1%
Parker 88				-0.368 ***	-30.8%	6.1%	-0.405 ***	-33.3%	6.2%
Parker 87				-0.393 ***	-32.5%	6.8%	-0.427 ***	-34.7%	6.7%
Parker 86 or less				-0.331 ***	-28.2%	7.8%	-0.367 ***	-30.7%	8.0%
Age dummies - BC: Age 8									
Age 2-3							0.057 ***	5.9%	4.3%
Age 4							0.024 *	2.5%	4.0%
Age 5							0.010	1.0%	2.8%
Age 6							-0.033 ***	-3.3%	2.5%
Age 7							-0.024 **	-2.4%	0.6%
Age 9							0.047 **	4.8%	1.7%
Age 10							0.091 ***	9.5%	1.2%
Age 11							0.166 ***	18.1%	1.0%
Age 12							0.295 ***	34.3%	0.1%
Age 13							0.351 ***	42.1%	1.2%
Age 14							0.374 ***	45.3%	1.3%
Age 15							0.413 ***	51.2%	0.8%
Age 16-20							0.353 ***	42.3%	0.4%
Reputation factor	**Included**	**Excluded**		**Included**	**Excluded**		**Included**	**Excluded**	
Dependent variable	ln(price)	ln(price)		ln(price)	ln(price)		ln(price)	ln(price)	
R^2	0.805	0.795	0.010	0.825	0.816	0.009	0.830	0.821	0.009
F-value	3,110.31	3,030.76	79.55	2,389.62	2,305.71	83.91	1,908.60	1,825.39	83.22
Standard error of the estimate	0.374	0.364	0.010	0.355	0.364	- 0.009	0.350	0.359	- 0.009
Price of example bottle	157.94	152.21	5.72	155.24	151.59	3.65	144.64	144.60	0.04

The rest of the models in the set, numbers 9-12 are much closer to each other. The price effect of the reputation factor in this model is around 7.5%, which lies between the 11.1% and 4.3% of the two previous models. The price effect of Parker points approximately 7.5%, less than a percentage point lower than in model 3. The effect of ageing is also marginally lower compared with the models without the reputation factor. The price effects of production amount and vintage score variables are also almost flat when compared with model number 3 in the first set of regressions. However, the changes in regional and year of trade variables are considerable when compared with the first set of models. Differences in all but Burgundy and Pomerol are more than ten percentage points. Inside the year of trade variables the price effect for years 1999 and 2000 increases around 13%. This observation indicates that there have been some changes in the reputation of traded wines during the observation period.

The model statistics do not differ greatly, but by adding the reputation factor the r-squared values, which indicate how much of the price the model explains, increase by approximately 1%. Also the F-values tend to increase slightly, while standard error of the estimate remains flat or decreases marginally. There are some differences in the price of the example bottle in the first models of the two sets, but in the latter ones the difference in very small. In general it seems that the long-term reputation has significant effect on the price of wine and it should be included in the model. However, the reputation factor used here is only one possible tool to measure the long-term reputation, and different versions of this variable should be tested to find an optimal variable.

8.8 Pricing of Wine Château by Château

The last regression differs from the previous models quite drastically. It evaluates the price effect of each vineyard separately, instead of trying to measure the reputation and quality with more general proxies. Because the vineyard variable includes a lot of information about both quality and reputation of the wines, several other variables are excluded from the regression. First of all the regional / appellation dummies are left out, as all producers make wines only in one region and thus the information is included in the vineyard variable. The reputation factor is also excluded, as the name of the producer is likely to contain more information about reputation than

pure Parker points. The model statistics are presented in Table 15 and the regression results in Table 16.

Table 15

Table 15 presents the test statistics for the model 13. The r-squared is higher than for any other model, while the F-value is also quite high. The standard error is the smallest among the tested models. The price of the example bottle (8-year old Château Mouton Rothschild with Parker and vintage scores of 94 and production amount of 15,000 cases, traded at Christie's in the U.S. in 2003) is quite low at 142.69€.

Model statistics	Model 13
Dependent variable	ln(price)
R^2	0.899
F-value	3,784.25
Standard error of the estimate	0.269
Price of example bottle	142.69

The last model proves to be the most accurate, measured by the r-squared value, which is almost 0.90, compared with the value of 0.83 of model number 12. Also the standard error of the estimate is considerably lower than in the previous models. The accuracy of the model is not such a surprise as the regression now takes into account each winemaker separately and the name of the producer is likely to contain considerable amount of information. However, as the name of the producer contains information about the region, quality and reputation of the wine it is impossible to analyze how much each of these factors affect the value of the wine.

Most of the quantitative variables remain fairly stable. The price effect of Parker points is 7.2%, compared with 7.4% in model 10, which is the most comprehensive of the other models that still include Parker points as a quantitative variable. The ageing effect is slightly higher than in the other models at 5.2%, but the difference is relatively low. The scale of change is similar for the vintage score and production amount, which are 3.0% and -0.8% respectively. Also the qualitative factors used in the model are mostly very close to those of other models. Year of trade dummies present similar pattern, as do the auction house and location of trade variables. However, the odd lot variable, which indicates if the wines are traded in other than cases of 6 or 12 has changed significantly. The odd lots now seem to trade at a small discount, compared with around 5% premium in other models. Also the premium enjoyed by cases of 6 has diminished from around 10% to 5% when compared with case of 12. This supports the theory that more

expensive wines are more likely to trade in odd lots and small cases and now that the regression takes into account each wine the premium is included in the vineyard variable, rather than lot size variable.

As the Table 16 shows the differences between vineyards are huge. Romanée-Conti enjoys a more than 1,000% premium over the benchmark (Château Mouton Rothschild), while Château Ducru Beaucaillou trades on average at the discount of almost 60% against the benchmark. Rest of the wines lay between these two extremes.

8.9 Pricing in General

As mentioned previously, most of the results follow the existing literature and stated hypotheses, but there are a few surprises. The quantitative factors gave anticipated results, especially the importance of both Parker points and age have been widely known and discussed in existing literature. The relatively low importance of produced amount is nevertheless unexpected. The vintage rating and reputation are highly influential, but the price effect is lower than that of Parker points and age, which is not surprising.

From the pure qualitative factors the regional factors are the most important. Because of the very strictly selected data set some of the results provided unexpected results. The fact that there are significant and large price differences between locations of trade and auction houses is probably the single most surprising result in the study. I cannot explain these differences by any rational reason. The other unexpected results included the higher price for odd lots and half cases rather than full cases, but this can probably be explained by selection process – only exceptional wines are sold in odd lots. This theory is supported by the results of the last regression.

Table 16

Table 16 presents the 13th regression, which calculates price effect of each vineyard separately. The first column shows the names of variables and qualitative variable groups (bolded). The first group presents the quantitative variables and the following group is reserved for qualitative variables. The base case, against which the qualitative variables are tested, is shown after the name of the variable group. Second column presents the beta of the coefficient together with significance levels (*** = 1% significance). The last column shows the price effect of the variable (price effect = e^{beta}-1).

Variable	Beta	Price effect
Constant	-4.664 ***	
Parker points	0.069 ***	7.2%
Age	0.051 ***	5.2%
Production ('000's of cases)	-0.008 ***	-0.8%
Vintage score	0.030 ***	3.0%
Year of trade - BC: 2003		
2006	0.091 ***	9.5%
2005	0.005	0.5%
2004	-0.045 ***	-4.4%
2002	0.214 ***	23.9%
2001	0.266 ***	30.4%
2000	0.263 ***	30.1%
1999	0.185 ***	20.3%
Lot size - BC: Case of 12		
Case of 6	0.068 ***	7.1%
Odd lot	-0.018 ***	-1.8%
Auction house - BC: Christies		
Sothebys	0.037 ***	3.7%
Acker Merral	0.056 ***	5.8%
Zachys	0.077 ***	8.0%
Morrells	-0.075 ***	-7.2%
Location of trade - BC: USA		
Europe	-0.107 ***	-10.2%
Vineyard - BC: Château Mouton Rothschild		
Araujo Estate	0.029	2.9%
Barossa Valley Grange	0.004	0.4%
Caymus Vineyards	-0.330 ***	-28.1%
Château Ausone	-0.092 ***	-8.8%
Château Cheval Blanc	0.181 ***	19.8%
Château Cos d'Estournel	-0.807 ***	-55.4%
Château Ducru Beaucaillou	-0.857 ***	-57.5%
Château d'Yquem	-0.388 ***	-32.2%
Château Haut Brion	-0.071 ***	-6.8%
Château La Mission Haut Brion Red	-0.483 ***	-38.3%
Château Lafite Rothschild	-0.023 ***	-2.3%
Château Lafleur	0.081 ***	8.5%
Château Latour	0.054 ***	5.6%
Château Léoville Lascases	-0.450 ***	-36.2%
Château Lynch Bages	-0.680 ***	-49.3%
Château Margaux	0.077 ***	8.0%
Château Palmer	-0.649 ***	-47.7%
Château Pétrus	1.183 ***	226.5%
Château Pichon-Longueville Comtesse de Lalande	-0.594 ***	-44.8%
Domaine Beaucastel	-1.108 ***	-67.0%
Domaine Jean-Louis Chave	-0.503 ***	-39.5%
Joseph Phelps Vineyards	-0.786 ***	-54.4%
La Tâche	1.220 ***	238.7%
Marchesi Antinori Srl	-0.473 ***	-37.7%
Paul Jaboulet-Ainé	-0.900 ***	-59.3%
Rayas	0.169 ***	18.4%
Richebourg	0.938 ***	155.5%
Robert Mondavi Winery	-1.025 ***	-64.1%
Romanée-Conti	2.654 ***	1321.0%
Sassicaia DOC	-0.018	-1.8%

From the 13 models tested in this study, the most comprehensive ones (6, 12 and 13) seem to be the most accurate. The model number 6 includes all qualitative factors, but excludes the reputation factor and both the Parker points and age are estimated point-by-point. Model number 12 is identical to model 6, except that it includes the reputation factor. Model number 13 is the one that includes vineyard variables, but excludes the regional and reputation variables. They are able to explain most of the variation in prices and the standard errors of the estimate are relatively low for them. Model number 13 is the most accurate, but the results are impossible to be generalized to other wines, so the other two are more interesting from an academic viewpoint. For investors who are buying one of the wines included in this data set the last model however provides the best fit. Models 6 and 12 are both relatively accurate and comprehensive, the latter one offering somewhat better fit. The unexplained portion of price is most probably caused by lot and bottle specific factors discussed in section 2. To improve the model fit and to build more accurate models these should be included into regression.

9. Conclusions

This study discusses wine investments from a practical and investor-oriented point of view. The first part of the study introduced the main characteristics of wines as an investment and explained some of the most important practical matters. The valuation of wines, which are considered collectibles, differs greatly from traditional asset classes. Different factors that affect the pricing were divided into general and lot specific factors. This study is aimed to discuss the first category rather than the second. Further into valuation of wines, quality, reputation and scarcity are the three main factors driving the price of wine. However, as these are not observable as such, they have to be evaluated using several proxies to build a valuation model. The most important valuation proxies include expert opinions, vintage ratings, age of wine, lagged ratings and area of production. Points given by Robert Parker are the most influential expert opinions and they are used in this study. I obtained vintage charts from Wine Spectator and built a reputation factor that incorporates lagged Parker ratings from a ten-year period. Other variables used in the valuation models include the region / appellation of wine, auction house, location of trade, lot size and year of trade. The lot size factor is the only one evaluating the lot specific factors, which also include the bottle size, condition and provenance.

The very comprehensive data set used in this paper includes more than 20,000 traded lots of wine from more than 30 high quality producers mainly from vintages 1989 to 2001. The biggest limitation in the data set is the relatively short observation period, from 1999 to 2006. The wines used in this study are all rather young in order to minimize the effects of bottle specific factors that tend to increase with time. It turns out that wines have performed quite well in the observation period, the monthly return being 0.7% before holding and transaction costs, which is higher than those of corporate bonds or equities in the same period. Commodities provide investors with better returns however. But, if these costs are included the return turns out to be close to zero for the whole period. The volatility of wines is the highest of the asset classes compared here, at circa 7% monthly. Probably the most interesting characteristic for many investors is the correlation of wines with these other asset classes. The correlation coefficients are close to zero with both equities and bonds, but surprisingly high, more than 0.8, with

commodities. In general wines cannot be recommended for pure investment vehicles at the current transaction costs. If the costs would came down wines could be an interesting alternative for investors who want to diversify their portfolios. Some Internet exchanges already offer low transaction costs and the development of these new marketplaces could indeed make wine investments a viable option in near future.

I built total of 13 regression models to value wines. These are aimed to assess the factors that affect the price of wines and to ease the selection of wines for investors. The models 1-6 and 7-12 are similar, but the latter group includes the reputation factor in each of the regressions. These are built so that each regression introduces new variable groups to increase the accuracy of the models. It turns out that the last models of both groups are able to explain the price of wine most accurately. However the 13th model, which includes a vineyard variable turns out to offer the best fit. It however has its own limitations, most notably the difficulty of generalizing the results for other wines and the problem of observing the underlying factors that affect the prices.

The most important factors affecting the price of wines according to the models built are the region and appellation of the wines, grade given by Robert Parker, age of the wine and vintage score. Produced amount has surprisingly small negative effect on the price. Other factors that affect the price are the general market condition, or trends in the market as a whole, auction house, location of the trade and lot size. The prices in the U.S. are generally around 10% more expensive than in Europe, which is rather surprising. Also the differences between auction houses are large, more than 10% in some cases. Against expectations the full cases (case of 12 bottles) are less expensive than half cases and odd lots. This however seems to be due to the selection process. Most of the wines are traded in full boxes and only rare and very expensive and large bottles seem to be traded in other quantities.

I further studied how Parker points and age actually affect the price of wine. The results show that the effect of Parker points is strongest for wines that receive 95 or more points, being relatively small for wines that receive less than 90 points. In addition, the price effect of age is far from linear. After the wines enter the secondary market at the age of 2 to 4 years, they decline in price until the seventh year. This could be explained by rarity and high quality of young wines in

the market. After seventh year the price of wine starts to rapidly increase and reaches its peak at the age of 15 and after the age of 15 the price of wines on average starts to decline. Thus it seems that investors should either buy their wines from the primary market or to wait until the wines have reached the age of 6-8 years before buying them. The optimal holding period after that according to these results is 6 to 8 years, after which the prices of all but the best wines start to decline. For investment purposes the wines that receive more than 95 points from Robert Parker are safer choice than lower-ranked wines. The liquidity and the investment potential of higher-ranked wines is considerably better.

Further studies should be made on the bottle and lot specific factors. Even though some authors have speculated on how much these affect the price of wine, very little hard evidence is available. The data gathering might however prove difficult, but probably with the cooperation with some of the large auction houses this matter could be studied. In addition a study on the long-term performance of wines with recent data would shed more light on the potential of investment grade wines. The period in this study was rather short, 6 years, because of the data limitations. A period of 10 years or more, with monthly index, could provide better benchmark against other asset classes and enable significant statistical testing.

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