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ABSTRACT: For repeat transactions data from monthly auction hammer prices, we analyze the level and quality of Bordeaux wine returns using the Fama-French Three-Factor Model and the Capital Asset Pricing Model. Returns average up to 0.75% per month above those predicted by these models. Further, investment grade wines benefit from low exposure to market risk factors, thus offering a valuable dimension of portfolio diversification. These findings are consistent with simple theoretical considerations and support a documented growing interest in wine investments.

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G11: Portfolio Choice
G12: Asset Pricing

Keywords: Wine, Investment, Portfolio, Diversification

Version: November 2, 2006

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While many people consider buying wine and aging it for future consumption, few have historically viewed wine strictly as a financial investment. Yet wine possesses characteristics that allow it to be considered and analyzed as an investment vehicle. Most important among these is an active trading market; monthly wine auctions at the top six auction houses frequently exceed $15 million. In recent years, at least two mutual funds have formed to invest specifically in wine: the Ascot Wine Management Fine Wine Fund, founded in 1999 by a Bahamian company, has exhibited annual gains ranging from 10.9% to 13%; and the Orange Wine Fund, founded in 2001, is listed on the Euronext Stock Exchange in Amsterdam. Information published by these funds indicates that they are managed with an approach similar to that of hedge funds (*International Herald Tribune,* 2001).

Additional evidence of growing interest in wine investments is the recent founding of the American Association of Wine Economists and an associated research journal, the *Journal of Wine Economics*, introduced in May 2006. Other evidence suggesting that wines are increasingly viewed as investment vehicles comes from recent proposed changes to British pension tax law. UK self-invested pension plans (SIPPs) are similar to some US individual retirement accounts (IRAs) which allow individual to invest virtually tax free. The proposed changes would have broadened the allowable assets to include "residential property and certain other assets such as fine wines" (HM Treasury, 2005). Chancellor of the Exchequer Gordon Brown subsequently modified his position and ultimately classified these assets such that wine and other assets can be put into SIPPs but are ineligible for tax relief.[1]

[1]For a summary specific to wine-assets and SIPPs, see "The decanter.com Guide to Wine and Sipps" (www.decanter.com/specials/71476.html).

Given these recent trends in viewing wine as an investment vehicle, an open question therefore is whether wine returns compare favorably with historical financial returns on other assets, both in mean value and in volatility or covariance. This paper addresses that question, first by developing a simple conceptual framework to formulate specific hypotheses, and then by using both the Capital Asset Pricing Model (CAPM) and the Fama-French Three-Factor Model to test the hypotheses empirically (Fama and French, 1992). Our sample is formed from monthly repeat transactions data for individual wine-asset sales, which yields a time series of monthly returns. Consistent with our predictions, we find that the wines in our sample exhibit large, positive excess returns along with low exposure to commonly recognized market risk factors. These findings provide the first quantitative evidence that wine may be a viable investment asset, both alone and as part of a diversified portfolio.

The remainder of this paper is organized as follows. The first section summarizes related literature, section 2 presents key concepts and hypotheses, section 3 describes the data, section 4 presents the empirical model, section 5 reports the results, and section 6 concludes.

1. Related Literature

Wine exhibits unique characteristics relative to traditional financial assets. Some of these characteristics are similar to those exhibited by other tangible assets such as collectible art. Wine does not pay a dividend, investors must pay for its storage, and the time required to liquidate a collection of wine can extend to four or five months. The maturation process may extend from 20 to 40 years or more beyond bottling, and the precise time at which the wine should be consumed in order to maximize the tasting experience is unknown ex ante and is speculated upon by various experts. Further, a bottle of wine may break or may be otherwise deemed worthless if stored improperly.

While the subject of wine as an investment has been sparsely studied, extant results and recommendations are mixed. Krasker (1979) analyzed returns over the period of 1973-1977 and found no risk premium for storing red Bordeaux and California Cabernet Sauvignon wines produced since 1950. Jaeger (1981), by contrast, established risk premiums in excess of 12% using Krasker's methodology but extending the sample period to eight years beginning in 1969 and incorporating a significantly lower measure of wine storage costs. Jaeger argued that the four-year period studied by Krasker biased his procedure toward finding a subnormal rate of return, as those four years included a period of extreme surplus (high inventories) and declining prices in the wine industry. Additionally, the different assumptions about storage costs affect the premiums measured. Jaeger's estimate of storage cost was approximately $0.50 per case annually, an actual cost published by Freemark Abbey Winery. Krasker's estimate was over $16 per case for annual storage, but Jaeger noted that this value—besides being implausibly large—may be more accurately interpreted as reflecting a component of the financial return to wine storage not explained by other variables in the model.

Weil (1993) calculates the returns to an individual wine portfolio using detailed information across a 13 year (1980-1992) acquisition and holding period. The data used to calculate returns include the purchase price, sales tax, delivery costs, storage, auction house transaction costs, sale price, and hypothetical income tax rates. His results suggest that the return to wine assets is approximately 9.5% and increases to 11% if the portfolio is limited to Bordeaux wines. Weil concludes that these returns are much less than rates of return to NYSE stocks over the same period. Interestingly, the Bordeaux wines in the investor's portfolio exhibit lower return variation than other wines. Weil notes that this is not efficient since Bordeaux wines have a higher return and less risk. We extend this finding by calculating the excess returns of wine, returns over (or under) a risk-adjusted market return.

More recently, Burton and Jacobsen (2001) used a repeat-sale regression—an approach also used by Goetzmann (1993) to value the art market—to estimate the rate of return for red Bordeaux wines during 1986-96. Their findings include an annual nominal rate of return of almost 14% for a portfolio of 1982 wine but only 8.3% for a portfolio of 1961 wines. An aggregate portfolio of wines earned a nominal rate of 7.9% annually while a portfolio consisting of only those classified as "First Growth" earned 6.7%.[2] Of particular interest is the comparison to the Dow Jones Industrial Average: only the 1982 vintage portfolio outperforms the index over the period in question.

While these studies focused on establishing wine asset returns either in absolute terms or relative to a simple market return, they did not explicitly account for the risk of wine assets.[3] Our paper enhances this literature by both determining wine returns over a more recent time period and by investigating the degree of exposure and covariance between wine returns and common risk factors.

Other studies have focused on the determinants of wine prices. Combris, Lecocq, and Visser conducted two identical studies, one on Bordeaux wines (1997) and the other on Burgundy wines (2000). Employing the hedonic method and incorporating both label characteristics and sensory characteristics, they explored whether market prices respond to various measures of quality. Objective characteristics, including the name of the producer

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[2] In most of the Bordeaux, it is the wine producer (chateau) and not the land that is classified by growth. The original classification was developed in 1855 but has been brought up to date to account for name changes, property divisions and the promotion of Chateau Mouton Rothschild in 1973. The five growth classifications were originally established to distinguish among the quality of the wines produced in the area (where First Growth represents the highest quality).

[3] Jaeger (1981) discusses risk as an important factor in wine investments, but does not incorporate an explicit measure of risk in the empirical model.

(chateau), ranking of the wine (growth classification), color of the wine (red or white), and vintage year, were found to be significantly associated with the variation in prices. By contrast, a majority of the subjective characteristics, including visual and olfactory findings, gustatory findings, and grade as determined by a "jury" of four persons, were found not to be significantly associated with market prices. Jones and Storchmann (2001), on the other hand, found wine ratings ("Parker points") to be a significant determinant of Bordeaux prices, along with sugar levels, acidity, and aging. Similarly, Cardebat and Figuet (2004) found sensory variables to be a significant determinant of Bordeaux prices for 1996-1999 vintages, after controlling for reputation, and explained this contrast to Combris et al. (1997) in terms of a recent increase in competition and reduction of asymmetric information between producers and consumers.

Another set of literature addresses the hypothesis that collectibles act as a hedge against stock market risk by exhibiting a negative covariance with market returns or with inflation. Burton and Jacobsen (1999) summarize the research in this area. Specifically, they state that while research has shown that returns on collectibles may be negatively correlated with stock market returns (for items including coins, stamps, and art), there is no evidence that collectibles are a hedge against stock market declines since returns on collectibles have been historically flat during the periods examined. Wines were not studied in this context.

2. Background Concepts and Hypotheses

One key issue that previous studies appear to have neglected is a formal comparison of fundamental sources of value across equities, wine assets, and other collectibles such as art. A standard and long-established approach to estimating the market value of an equity relies on the discounted present value of its dividend payouts (Gordon, 1962). In this approach, cash payouts to investors comprise the ultimate source of investment value. Under the simplifying assumption that dividends grow at a constant rate g, and discounting at a constant rate r_e, the discounted present value at time t of an infinite stream of dividends can be explicitly expressed in a simple form. The exact valuation and the corresponding rate of return on the investment will depend on details of timing and whether or not dividends are reinvested. For purposes of comparison, we calculate the valuation P_t as of the beginning of period t, assuming that the dividend D_t is paid at the end of period t. Under these assumptions, the value of the equity is:

$$P_t = D_t \ / \ (r_e - g), \tag{1}$$

in the discrete-time case.[4] A basic prediction of this model and an immediate consequence of equation (1) is that the value of an equity grows at the rate g. The total nominal annual net rate of return earned by an equity investor is the sum of this capital appreciation rate g plus the dividend rate implied by equation (1), which equals:

$$\text{equity return} = D_t/P_t + g = (r_e - g) + g = r_e. \tag{2}$$

This simplified and standard analysis incorporates uncertainty only implicitly; g is typically interpreted as an expected value while r_e is set at a level that incorporates an appropriate risk premium. Thus, in general, $g < r_e$, a condition also needed as a technical requirement of the model to ensure a positive and finite valuation. Further, as a practical matter, the principle of opportunity costs suggests that the long-run growth rate of the aggregate economy constitutes a lower bound on values of r_e that are relevant to investors, and any risk premium would drive r_e above that bound. Combined with the accounting identity that no individual company can grow faster than the entire economy forever, this logic also ensures $g < r_e$.

[4] Alternate assumptions about the timing of cash flows, or alternate notation, will yield a slightly different expression for valuation.

The source of financial value of collectible artwork, by contrast, is ultimately derived from the consumption value of viewing the item. While the value of viewing a particular piece of art may vary over time and will typically vary from one individual to the next, any single painting or sculpture is a unique object that (apart from accidental damage or depreciation) will not change over time. Thus, at least in real terms, it is difficult to identify any reason why the consumption value of viewing any individual piece of art should be expected to increase over time, except possibly to the extent that close substitutes (such as other paintings by the same artist) may grow scarcer due to damage or loss. Further, this consumption value exists as a continuous stream, in that each owner has a constant opportunity to view the artwork while it remains in his possession.

This line of thought suggests that the pattern of returns to artwork resembles that of a perpetuity or consol, namely a (roughly) constant expected value of consumption in each period. If C denotes the value of viewing the artwork in each period, then the well-known perpetuity formula gives the present value of the artwork as $PV = C / r_a$ for an appropriate discount rate r_a, which need not be the same value as r_e applied to equity in equation (1). A notable property of this valuation is a complete absence of capital appreciation in equilibrium, at least in real terms. The total rate of return to an investor in art is then the stream of consumption value alone, which accrues in the form of viewing pleasure but not in any measurable financial form. This prediction is broadly consistent with many previous empirical findings: nominal returns to art investments have been found to be lower than for either equity or bond investments by Baumol (1986), Buelens and Ginsburgh (1993), Goetzmann (1993), Candela and Scorcu (1997), and Agnello and Pierce (1998) for paintings, and by Pesando (1993) for prints. Some negative real returns were reported by Agnello and Pierce (1998) while real annual returns of less than 1%

were reported by Baumol (1986), Buelens and Ginsburgh (1993), and Candela and Scorcu (1997).

One might similarly postulate that the fundamental source of financial value for wine likewise derives from its eventual consumption value. A crucial difference is that a bottle of wine must be consumed at a single point in time, rather than conferring a continuous and readily accessible stream of consumption benefits as is true of artwork.[5]

Further, the owner chooses the time of consumption. As Jaeger (1981) notes, wines typically exhibit an optimal storage period after which the gustatory experience is maximized and, while there is uncertainty regarding the optimal consumption date, rational behavior would suggest that most bottles (especially those purchased for investment purposes) would tend to be opened and their contents consumed near the expected optimal date. Thus, the nature of the financial returns to wine revolves around a single consumption event. If the optimal consumption value is C, then the present value of a bottle of wine is given by $PV = C / (1 + r_w)^T$ where the optimal consumption date occurs T periods in the future, and this present value grows at the rate r_w in each period. The rate of return to a wine investment is thus r_w.

Although this simple framework abstracts from explicit representation of uncertainty, it not only captures important financial features of equity, art, and wine assets, but also—as a first-order approximation—it implies two key hypotheses or predictions. First, although the discount rate r_w applied to wine valuation need not be the same as that applied to equity valuation, both will typically be established as the risk-free rate of interest plus some risk premium, and hence will be of similar orders of magnitude. Because the quality of wine is subject to several sources of uncertainty not shared by equities, including the optimal time of consumption, possibility of

[5]We assume that non-gustatory consumption benefits of wine, such as any collectible value of wine labels or the consumption value of viewing a well-stocked wine cellar, ultimately derive from drinking the wine and are thus secondary in their financial impact.

spoilage among some bottles, and uncertainty over how well a particular vintage will age, it is plausible that $r_w > r_e$ in many cases. Since the analysis above shows that the equilibrium return to investment equals r_e for equity and r_w for wine, one prediction is that, unlike the return to art, *the rate of return to wine investments should be similar to that of equities, and may even exceed them*. This prediction is consistent with the findings of Jaeger (1981) and Weil (1993), though not with those of Krasker (1989), and will be further tested below.

A second prediction follows from the observation that the fundamental source of financial value for wine derives from a consumption experience unique to each variety and vintage of wine. The economic value of that consumption experience will typically be an increasing function of an investor's financial wealth, which in turn is affected by the aggregate performance of equity markets to the extent that equity holdings comprise a significant share of the investor's total wealth. However, this is a second-order effect as the idiosyncratic risk of wines will typically overwhelm this correlated component of risk. An implication is thus that *the financial returns to wine should exhibit low correlations with returns on purely financial assets such as equities*. This property, if true, would make wine an attractive investment as a means of diversifying purely financial portfolios, especially if the first prediction is also true. We present the first empirical test of this second hypothesis below.

3. Data

The wine returns data in our sample are derived from an eight-year series of monthly auction "hammer price[6] data from The Chicago Wine Company on red Bordeaux[7] vintages ranging from

[6]A hammer price refers to the price at which the bidding stops and the item for sale is said to be "hammered down" (Ashenfelter 1989).

[7]Bordeaux refers to a wine-making area of France that straddles the Garonne and Dordogne Rivers. This area is world-famous for its reputation of being home to the finest red wine producers. The area benefits from a long and

1893 to 1998.[8] Founded by Philip H. Tenenbaum in May 1974, The Chicago Wine Company (TCWC) conducted its first fine wine auction in April 1977, making it the second company to conduct wine auctions in the U.S. TCWC represents one of the largest trading markets for wine assets. TCWC now conducts at least one live auction and one silent auction per month, significantly more annually than any other wine auction company in Chicago or the U.S. It should be noted that these open auctions constitute secondary-market transactions. Some wines sell as futures or are allocated on a limited basis and thus represent primary-market transactions. These are similar to equity IPOs and not accessible to most investors. While the returns to investing in wine futures are an interesting area, we leave this to future research.

We use data on red Bordeaux wines, a choice based on several features of this wine. First, red Bordeaux wines have been determined to benefit from extended aging (Jaeger, 1981). Perhaps related to this property, red Bordeauxs are purchased more often for investment purposes than for consumption relative to white wines and wines from other regions. Consequently, French wines, and in particular those from Bordeaux, comprise the greater part of the wine auction market (Burton and Jacobsen, 2001). Annual classified growth Bordeaux sales are approximately $7 billion as of 2005.

Returns data are calculated for each month from repeat transactions. The returns are calculated for every vintage[9], or year of production, and for every individual wine producer.[10] The calculation of monthly returns by vintage and producer is a three-step process. First, an average price per bottle is calculated for each year and month of trade by the vintage and

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warm growing season as well as soil composition, made up of topsoil poor in nutrients and subsoil rich in minerals (Clarke 1996).

[8]These data are readily available on The Chicago Wine Company's webpage of past auction hammer prices (http://www.tcwc.com/pauct.htm).

[9]Vintage refers to a particular year's grape harvest and may also refer to the wine of a single year (Oz Clarke, 1986)

[10]The sample is limited to wines with non-inferior bottle conditions. Wines with label conditions (stains, tears) as well as less than full shoulder fills are eliminated. The resulting data set therefore has consistent bottle conditions. This reduces return variance due to varying asset quality.

producer.[11] Next, the average return for each vintage and producer is calculated by the difference in the log of the average price for the month of trade and the log of the average price for the prior month of trade. If a trade did not occur in the prior month, the return is designated as missing. In the third step, a modified mean is calculated by winsorizing the sample as in Nissim and Ziv (2001), Dittmar (2004), and others.[12] For those portions of the analyses that require average returns by vintage and growth classification,[13] the data are categorized by classification and then averages are calculated for every year and month of trade by vintage and growth. Calculating averages as outlined above allows for a degree of smoothing of the returns data, which has been shown to exhibit a wide range of values. In addition, it mitigates the "declining price anomaly," a phenomenon in which identical lots of wine sold at a later time in a single auction are likely to sell for a lower price than those purchased earlier in the day (Ashenfelter, 1989).

The wine returns data are based on approximately 90 producers and include vintage years from 1893 through 1998. In total, the data include 13,662 wine asset returns recognized over the eight-year period 1996-2003. For the purpose of evaluating investment potential relative to equities, this period is fairly short; on the other hand, it includes a period of exceptionally high returns in the U.S. stock market, thereby providing a stringent benchmark for identifying excess

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[11] The prices used to calculate returns are the hammer prices as reported by TCWC. As is standard with calculation of traditional asset returns, brokerage costs, account fees, or other forms of transactions costs are not accounted for since they vary across investors, investment horizon, and investment scale. .

[12] This method replaces extreme values in the sample with limits. In this study, the entire sample is divided into groups; the groups representing the highest 2.5% and the lowest 2.5% return values are replaced. The replacement values are those maximum and minimum values as calculated by respective vintage and producer. For example, if a return for a 1982 Latour falls within the bottom 2.5% of the entire sample of returns, the value is replaced with the minimum average return for the sample of 1982 Latour returns. This process resolves the problem of inconsistent outliers resulting from data entry errors and lack of data cleaning.

[13] These are for First through Fifth Growth and for unclassified wines (*No Growth*).

returns. Of the 90 producers present in the sample, 47 belong to a growth classification.[14] Within the data set, there are 276 unique vintage and producer combinations and 83 unique vintage and growth groupings.

The three variables comprising the Fama-French Three-Factor Model, described below, are published monthly by Kenneth French and may be downloaded directly from his website.[15] The three factors consist of Rm-Rf, a measure of the value-weighted return on all NYSE, AMEX and NASDAQ stocks (from CRSP) net of the one-month Treasury bill rate, SMB (Small Minus Big), a measure of the difference in the average return on small and large market equity firms, and HML (High Minus Low), a measure of the difference in average return between high and low book-to-market equity firms.[16] Other data required to estimate the model include monthly U.S. Treasury returns, obtained from the CRSP government bond file.

3.1. *Descriptive Statistics*

Table 1 presents descriptive statistics. Average monthly returns by vintage and producer range from –4.38% (1961 Petrus)[17] to 7.48% (1966 Haut Brion), with the average of all monthly returns at a respectable 0.51%. When only those wines that are classified in the growth categories are analyzed, the average increases to 0.78%. Perhaps not that surprising to advocates of wine investment, more than 75 wines averaged 1% or more in monthly returns (see Table 2). The average minimum monthly return for all returns by vintage and producer is approximately –

[14]It should be noted that only five wines comprise the First Growth classification (Haut Brion, Lafite Rothschild, Latour, Margaux and Mouton Rothschild).
[15]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
[16]For a detailed description of the estimation of the factor returns, see Fama and French (1993).
[17]This number indicates that over the eight year trading period, 1961 Petrus has an average monthly return of -4.38%.

11%[18], with an average maximum return of 14% (see Table 1). The standard deviation of all monthly returns by vintage and producer is 6 %.

The average monthly returns as calculated by vintage and growth are similar though somewhat greater due to the difference in the weighting structure. When calculating averages by vintage and producer, each producer's average monthly return is given a weight of one. When calculating average returns by vintage and growth classification, the returns represent a mean of the average returns for all applicable producers in a given month. The monthly averages by vintage and growth range from –2.9% (1961 "no growth") to 4.2% (1979 "no growth"). The average for all returns by vintage and growth is 0.88% per month, with an average minimum of –13.2% and a maximum of 17.5%. When the sample is reduced to those wines categorized in one of the five growth classifications, the average monthly return is over 1 %. When analyzed further by growth classification, Second Growth outperforms the other classifications on average monthly return with 1.45% (see Table 1).

These monthly returns are similar to those found in prior studies. For the years 1986 to 1996, the annual nominal rate of return for an aggregate portfolio of red Bordeauxs was found to be 7.9% (Burton and Jacobsen, 2001). An average monthly return of 0.51 to 0.88% (6.2 to 11.1% annualized) occurs for all wines, while 0.78 to 1.03 (9.7 to 13.1% annualized) occurs for classified wines over the eight-year period from 1996 to 2003, which includes several depressed years in the equity market. Thus, relative to other asset classes, wine exhibits a strong positive return over the period.

There has been some debate over the extent to which additional non-pecuniary benefits associated with wine investment add to the monetary rate of return. Specifically, to what extent

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[18]This number is calculated by observing the lowest return for each wine (vintage – producer), and averaging these minimum returns across all wines (vintage – producer).

should investors consider the potential benefit of consumption? Strict economic theory maintains that the prices observed have already accounted for this option. Moreover, if markets are well functioning and complete, the rate of return on wine assets (net of costs and consumption benefits) should equal the rate of return on competing assets with identical risk (Burton and Jacobsen, 2001).

3.2. *Trading Frequency*

Table 3 presents the summary statistics with respect to the trading frequency of the wines. Of particular importance is the percentage of total returns accounted for by each growth classification. While the First Growth wines only account for 5.6% of the number of producers in the data, they account for approximately 20% of the trading volume. Another 20% of the trading activity comes from the trading of Second Growth wines. Third, Fourth and Fifth Growth wines, in total, account for only 9.4% of total returns although they represent 30% of the producers in the sample. The No Growth wines represent about 50% of both the number of producers and returns.

Table 3 reveals interesting patterns in monthly trading activity. For all growth classifications, wine trading volumes decline in February and March, increase in April and May, and decline again in June and July. Trading increases again in August, then declines in September and October. November, December, and January represent three consecutive months of substantial percentage increases. On average, the number of trades increases approximately 20% in November and another 20% in December. While beyond the scope of this study, future research may uncover seasonal trading strategies with arbitrage opportunities.

4. Empirical Model

The Fama-French Three-Factor Model (TFM) was developed in response to the research of the 1980s that revealed many empirical contradictions to the central CAPM. The CAPM predicts that expected returns are a function of their market β s and that the market β s suffice to describe the cross-section of expected returns on U.S. equities. Specifically, Fama and French (1992) confirm that, unlike the relationship between average return and β, there exists a strong negative relationship between firm size and average return and an even stronger positive relationship between book-to-market equity and average return, and that these two relationships persist in competition with other variables. Fama and French demonstrate that while the CAPM predictions hold for the pre-1969 period, they disappear for the 1963-1990 period. Thus, they augment the CAPM by including two additional variables, HML and SMB, as described above. The TFM has been shown to absorb common time-series variation in equity returns by producing intercepts close to zero and R squared values around 0.90. The empirical model is as follows:

$$R_{it} - RF_t = \alpha_i + \beta_{1i}(RM_t - RF_t) + \beta_{2i}(SMB_t) + \beta_{3i}(HML_t) + \varepsilon_{it}\,, \tag{3}$$

where R_{it} is the return on a wine asset i (wine or wine portfolio) during month t, RF_t represents the risk-free rate (one month bill rate), RM_t represents the month t value-weighted return on all NYSE, AMEX, and NASDAQ stocks, SMB_t is the month t size factor HML_t is the month t book-to-market related factor.

Under this model, evaluating the financial performance of a wine asset is straightforward. The regression intercept represents the average abnormal return (positive or negative) and thus indicates whether an asset provides return in excess of the risk-adjusted return. A positive intercept indicates that, on average, the asset earned a return higher than suggested by the exposure to market risk factors.[19]

The regression analysis in this paper includes both the TFM and CAPM. We include the CAPM, despite its relatively lower performance in explaining variations in asset returns, in order to estimate single-factor βs and to facilitate more traditional risk benchmarking of wine to other asset classes.[20]

The regression analyses include results based on average returns by vintage and producer, and by vintage and growth classification. The justification for separate regressions based on vintage comes from prior research on wine prices and returns. Vintage refers to a particular year's grape harvest and may also refer to the wine of a single year (Clarke, 1986). Research has shown that weather conditions during the growing season and the period of harvest play a significant role in forecasting long-run prices for wines (Corsi and Ashenfelter, 2003). Burton and Jacobsen show striking differences in returns based on vintage for red Bordeauxs, with 1961 and 1982 vintage portfolios beating the market return. These results correspond well with published data regarding the ranking of wine quality by vintage. For example, 1982 is only one of two vintages rated as "exceptional" while 1961 rated as "excellent" for vintages since 1960 (Counsil Interprofessionnel du Vin de Bordeaux, 2004).

Growth classification of a particular wine has also been shown in prior studies to contribute significantly to its price. Therefore, to test the significance of growth classification using our auction data and the TFM, we use a Least Squares Dummy Variable (LSDV) model to

[19]The goal of this research is to use established models to analyze the quality of the returns that wines exhibit. This goal is different from developing a model to best *explain* wine returns, which we defer to future research. Our approach compares the financial returns of wines to those of equities, thus addressing the benefits of adding wine assets to an otherwise diversified portfolio.
[20]Single factor βs are universally used by practitioners while multi factor βs are used less commonly.

include fixed effects representing the five growth classifications as well as the sixth classification of "no growth." This model is as follows:

$$R_{it} - RF_t = \alpha_0 + \sum{}_5 \alpha_{G1-G5} + \beta_{1i}(RM_t - RF_t) + \beta_{2i}(SMB_t) + \beta_{3i}(HML_t) + \varepsilon_{it}, \qquad (4)$$

where α_0 represents the intercept term for the "no growth" classification and $\alpha_{G1\text{-}G5}$ represents the incremental differences for the five classified growth intercepts relative to the "no growth" intercept. Similarly, to test for differences in slope coefficients across growth classifications, interaction terms consisting of the dummy variables based on growth classification and the Fama French factors are added to the LSDV model, and the test is conducted again. In total, LSDV regressions for eight vintage years are tested against their Ordinary Least Squares (OLS) counterparts. These eight vintage years include those vintages where returns exist for each of the growth classifications (including "no growth").[21]

5. Results

In the first test (LSDV vs. OLS), F statistics reject the null hypothesis that the LSDV model is not significantly different from the OLS model in five of the eight vintage years, with only one vintage year narrowly missing a marginal significance level of 0.90 (see Table 4). Table 5 presents the results of the second test of LSDV with interaction terms versus OLS. Here, F statistics reject the null hypothesis that the two models are not significantly different in each of the eight vintage years.

Based on these results, individual regressions are included in the TFM and CAPM analyses for each of the unique vintage and growth groupings. Further, given that the growth classifications are simply groupings of producers, individual regressions based on vintage and

[21]These eight vintages include 1982, 1985, 1986, 1988, 1989, 1990, 1995 and 1996.

producer are analyzed as well. Panel 1 of Table 6 presents summary TFM regression results. As shown, the average regression intercepts (Jensen's alpha[22]) are positive. The average intercept over the time period analyzed here for the 276 regressions by vintage and producer is 0.186. Omitting the non-growth classification, the average excess return (regression intercept) increases to 0.419.

The results from the regression analysis establish two key findings. First, average wine returns are positive and in excess of risk adjusted returns. Second, wine returns covary minimally with market returns and other commonly accepted risk factors. These results hold for regressions based on vintage and producer as well as on vintage and growth, and are consistent with the predictions of the theoretical framework presented above.

The results of the analysis by vintage and growth classification are largely equivalent, though somewhat greater due to the weighting structure discussed earlier. The average intercept for the 83 regressions by vintage and growth is 0.606. Again, if only the wines categorized within the five growth classifications are analyzed, the average intercept increases to 0.759. The significance of these results cannot be overstated. Investment grade wines provide, on average, substantially large, positive returns in excess of those forecasted by the Fama-French market risk factors. Specifically, these wines experienced monthly returns of 0.61 to 0.76% higher than those predicted by the Fama-French risk factors. On an annual basis, these compound to an annual excess return of 7.6 to 9.5%.

Figures 1 and 2 present the distributions of intercept values for the two sets of TFM regressions. Approximately one-fourth of the intercepts for the regressions by vintage and growth are significant. Figure 2 indicates that the majority of those are positive.

[22]This is a risk-adjusted performance measure that is the average return on a portfolio over and above that predicted, given the portfolio's beta and the average market return. This is the portfolio's alpha. In fact, the term is sometimes described as "Jensen's alpha."

Other regression results presented in Panel 1 of Table 6 provide evidence that wine assets covary minimally with commonly accepted market risk factors and thus provide a valuable source of diversification. The results show that there exists either a negative relationship between the wine asset returns and the Fama-French factors or an absence of a relationship (β s not significantly different from zero). For the 83 regressions based on returns by vintage and growth, the risk premium coefficient returned a significantly positive value in only six of the regressions. The remaining coefficients are either significantly negative (nine) or not significantly different from zero (68), with an overall average of -0.006. Results are similar for the coefficients for SMB, found to be significantly positive in five cases, significantly negative in five cases and not significantly different from zero in the remaining 73 regressions (average of -0.034). Results are similar for the HML coefficients , significantly positive in only two cases, significantly negative in eight cases and essentially zero in the remaining 73 (average of -0.042).

Further evidence that there exists a weak relationship between wine returns and the market risk factors is evident in the average R squared value of 0.09. The Fama-French factors, which have been shown to account for approximately 90% of the variation in stock returns, explain only 9% of the variation in wine returns on average. These results continue to hold in the regressions by vintage and producer. A mere 10% of the risk premium coefficients are significant with the majority significantly negative. With respect to the factor SMB, just over 8% of the coefficients are significant, and again, the majority are negative; 10% of the HML coefficients are significant and 87% of those are negative.

The CAPM regression results presented in Panel 2 of Table 6 are comparable to those of the TFM. The average intercepts for both sets of regressions are positive, indicating excess returns exist. The average intercept is 0.168 for the regressions by vintage and producer and

0.880 for those regressions by vintage and growth classification. The average coefficients on the risk premium are both effectively zero (0.007 by vintage and growth and –0.005 by vintage and producer) supporting the previous finding of low exposure to market return risk. Approximately 30% of the vintage and growth regression intercepts are significantly positive with the balance unable to reject the null hypothesis of $\alpha=0$. In both sets of regressions (by vintage and growth and by vintage and producer) only 10% of the coefficients on the risk premiums are significant (see Figures 3 and 4).

6. Conclusion

The research presented here provides new insights into the returns and risks associated with wine as an investment vehicle. This study reveals two notable characteristics of investment grade wine, both predicted by simple theoretical analysis. First, investment grade wine assets provide, on average, positive returns in excess of those forecasted by well accepted models that have been shown to explain much of the variation in average stock returns. This result is consistent with previous findings by Jaeger (1981), but contrasts strongly with earlier findings by Krasker (1979). Although our sample period is fairly short, it includes a period of exceptionally high equity returns which provide a stringent test of excess returns for alternative investments. Second, investment grade wine assets benefit from low exposure to market risk factors and, as a result, provide a valuable source of diversification for investors seeking hedge investments. This property has not been previously studied in the case of wine.

Using a well-documented investment analysis tool, we show that wines on average provide large, positive excess returns. Specifically, using the Fama-French three-factor model, we document average excess returns of more than 0.60 to 0.75% per month and 7.5 to 9.5% per year over returns predicted by factors shown to account for risk. Furthermore, our results suggest that wines have very little exposure to common market risk factors and have effectively zero betas. The simple conceptual framework that we used to predict these two properties appears not to have been developed elsewhere in the context of collectible investments. The same framework also predicts roughly zero real financial returns to artwork, consistent with many previous empirical studies. The theoretical analysis indicates that the contrasting empirical findings for art and wine represent rational patterns rather than market anomalies.

Future research could usefully expand on this systematic distinction in at least two ways. First, the investor's decision regarding the optimal time at which to consume a particular bottle of wine is a dynamic programming problem under uncertainty, similar to the problem of optimal harvesting and related problems that have been extensively studied elsewhere. Applying dynamic analysis to the optimization of wine investment and consumption decisions may yield further testable empirical predictions.[23] Second, because consumption reduces the remaining stock of any particular vintage, the possibility of strategic consumption arises as a way of driving up the price of remaining units. Again, incorporating this feature could generate additional testable implications.

Previous research on wine investments has pointed out many negative aspects of such investments. Investing in wine can be risky and the range of returns is significantly large. These characteristics have not changed. However, this paper provides alternative research that supports the argument for investment in wine assets. Since a hedging strategy is one that offsets or protects against risk, and since wine assets do not fluctuate according to market risk factors, investors committed to researching those wine assets expected to deliver strong returns can construct a credible case for assembling a wine cellar. And, if by some chance one of your wine

[23] The authors are grateful to Kirk Vandezande for raising this point.

assets declines substantially in economic value, you can always exercise the implicit option to consume, and drink your Bordeaux.

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Table 1: Monthly Wine Returns[1]

	Avg # Monthly Returns	Avg Monthly % Return	Std Dev Monthly % Return	Min Avg Monthly Return	Max Avg Monthly Return	Avg Min Monthly % Return	Avg Max Monthly % Return
Vintage & Producer	37	0.51	6.05	-4.38 [3]	7.48 [4]	-11.26	13.98
Vintage & Producer [2]	39	0.78	7.20	-2.71 [5]	7.48 [6]	-12.45	16.07
Vintage & Growth	49	0.88	7.08	-2.86 [7]	4.18 [8]	-13.19	17.54
Vintage & Growth [2]	47	1.03	7.29	-2.39 [9]	4.03 [10]	-13.10	17.99
First Growth	49	0.70	7.81	-2.39 [11]	2.65 [12]	-13.85	18.58
Second Growth	48	1.45	7.12	-0.22 [13]	3.85 [14]	-12.88	17.66
Third Growth	53	1.08	7.16	0.26 [15]	2.29 [16]	-12.15	18.91
Fourth Growth	33	0.91	6.84	-0.83 [17]	4.03 [18]	-12.57	16.73
Fifth Growth	44	1.07	6.50	-1.25 [19]	3.85 [20]	-13.36	16.45
No Growth	55	0.45	6.45	-2.86 [21]	4.18 [22]	-13.46	16.23

[1] *where the number of returns is 15 or more for any given vintage producer or vintage growth.*

[2] *includes only those wines classified in one of the five growth classifications.*

[3] *1961 Petrus*

[4] *1966 Haut Brion*

[5] *1893 Margaux*

[6] *1966 Haut Brion*

[7] *1961 No Growth*

[8] *1979 No Growth*

[9] *1995 Fourth Growth*

[10] *1893 First Growth*

[11] *1893*

[12] *1994*

[13] *1988*

[14] *1978*

[15] *1945*

[16] *1990*

[17] *1945*

[18] *1995*

[19] *1982*

[20] *1989*

[21] *1961*

[22] *1979*

Table 2: Top 75 Wine Assets by Average Monthly Return[1]

Vintage	Producer	Avg Monthly % Return	Vintage	Producer	Avg Monthly % Return
1966	HAUT BRION	7.48	1989	TROTTEVIEILLE	1.76
1982	LYNCH BAGES	4.95	1983	PICHON LALANDE	1.74
1990	PICHON LALANDE	4.39	1988	MOUTON ROTHSCHILD	1.72
1989	L'ENCLOS	4.32	1989	LYNCH BAGES	1.72
1989	CANON LA GAFFELIERE	4.07	1994	MARGAUX	1.70
1961	LATOUR	3.68	1990	PICHON BARON	1.69
1982	PETIT VILLAGE	3.25	1986	PICHON LALANDE	1.66
1988	LAFITE ROTHSCHILD	3.18	1995	MEYNEY	1.53
1995	PAVILLON ROUGE DU MARGAUX	2.77	1961	LYNCH BAGES	1.50
1970	HAUT BRION	2.75	1989	L'EVANGILE	1.49
1989	MOUTON ROTHSCHILD	2.73	1959	HAUT BRION	1.48
1985	MARGAUX	2.72	1945	MOUTON ROTHSCHILD	1.46
1986	GRUAUD LAROSE	2.69	1986	HAUT BRION	1.46
1990	GRUAUD LAROSE	2.66	1995	CALON SEGUR	1.45
1995	LYNCH BAGES	2.59	1982	LA MISSION HAUT BRION	1.44
1970	DUCRU BEAUCAILLOU	2.51	1995	LA MISSION HAUT BRION	1.38
1986	CHEVAL BLANC	2.49	1996	BELLEFONT BELCIER	1.36
1986	TALBOT	2.49	1989	PICHON LALANDE	1.33
1996	LEOVILLE POYFERRE	2.47	1989	GRUAUD LAROSE	1.32
1996	PAPE CLEMENT	2.44	1982	PAVIE	1.32
1990	MOUTON ROTHSCHILD	2.29	1989	BEL-AIR	1.32
1989	PICHON BARON	2.24	1982	GRUAUD LAROSE	1.28
1983	LEOVILLE LAS CASES	2.23	1986	MARGAUX	1.27
1985	COS D'ESTOURNEL	2.20	1995	DUCRU BEAUCAILLOU	1.26
1990	CERTAN DE MAY	2.12	1995	LEOVILLE LAS CASES	1.22
1988	LA MISSION HAUT BRION	2.11	1982	LEOVILLE LAS CASES	1.22
1982	COS D'ESTOURNEL	2.10	1996	MARGAUX	1.20
1990	HAUT BRION	2.07	1989	PALMER	1.19
1982	CALON SEGUR	2.00	1989	FIEUZAL	1.17
1989	FIGEAC	2.00	1990	TROPLONG MONDOT	1.17
1982	LAFITE ROTHSCHILD	2.00	1990	L'EVANGILE	1.11
1989	DUCRU BEAUCAILLOU	1.91	1970	LA MISSION HAUT BRION	1.10
1970	LAFITE ROTHSCHILD	1.90	1986	LAFITE ROTHSCHILD	1.08
1982	PETRUS	1.88	1970	LATOUR	1.06
1983	MARGAUX	1.87	1995	GRAND PUY LACOSTE	1.05
1998	CHEVAL BLANC	1.84	1998	HAUT BRION	1.04
1989	LEOVILLE LAS CASES	1.81	1990	CALON SEGUR	1.03
1990	RAUZAN SEGLA	1.78			

[1] *where the number of returns is 15 or more for any given vintage producer.*

Table 3:
Trading Frequency[1]

	# Producers	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% Total Producers	% Total Returns
Total	90	1335	1241	808	986	1185	1148	1083	1288	1083	944	1133	1428	13662		
1st Growth	5	266	250	170	202	224	232	218	250	207	170	213	283	2685	5.6%	19.7%
2nd Growth	14	238	224	161	216	244	229	224	266	206	175	226	284	2693	15.6%	19.7%
3rd Growth	9	60	56	39	45	48	46	48	59	54	47	61	64	627	10.0%	4.6%
4th Growth	7	27	21	15	24	29	30	25	30	28	26	30	29	314	7.8%	2.3%
5th Growth	11	34	29	19	18	28	32	23	26	26	34	35	41	345	12.2%	2.5%
No Growth	44	710	661	404	481	612	579	545	657	562	492	568	727	6998	48.9%	51.2%

[1]where the number of returns is 15 or more for any given vintage producer or vintage growth.

Table 4:
F Test for Fixed Effects Based on LSDV

	5 Growth Dummy Variables			
Vintage	Numerator	Denominator	F	
1982	31.58	26.05	1.21	
1985	66.19	21.63	3.06	***
1986	53.17	26.22	2.03	**
1988	44.40	13.07	3.40	***
1989	47.33	24.23	1.95	**
1990	27.90	15.30	1.82	
1995	52.69	13.78	3.82	***
1996	12.83	7.78	1.65	

***indicates 99% confidence level
**indicates 95% confidence level
*indicates 90% confidence level

Table 5:
F Test for Fixed Effects Based on LSDV with Interaction Terms

	5 Growth Dummy Variables & Interaction Terms			
Vintage	Numerator	Denominator	F	
1982	131.53	28.31	4.65	***
1985	278.12	22.13	12.57	***
1986	179.44	28.22	6.36	***
1988	223.50	12.84	17.41	***
1989	309.80	24.53	12.63	***
1990	105.19	16.43	6.40	***
1995	169.80	14.29	11.88	***
1996	21.20	8.68	2.44	*

***indicates 99% confidence level
**indicates 95% confidence level
*indicates 90% confidence level

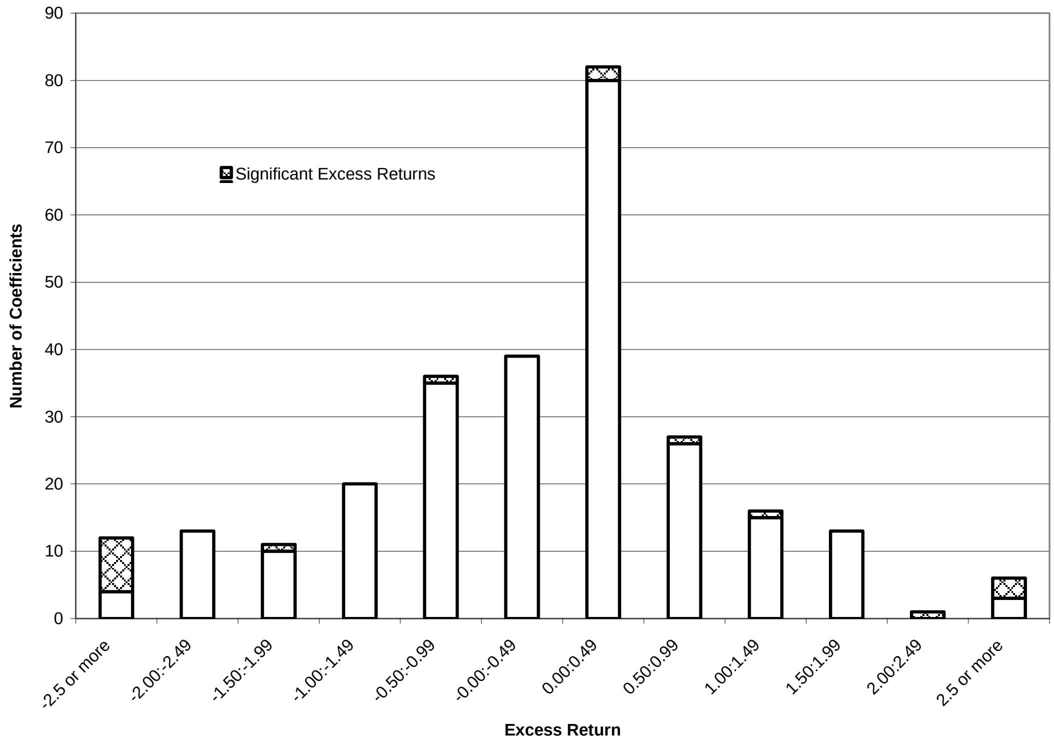
Table 6: Average Regression Results[1]

	# Regressions	Intercept	Rm-Rf	SMB	HML	R Squared
<u>Panel 1: Fama French 3 Factor Model</u>						
Vintage & Producer	276	0.186	-0.008	-0.012	-0.066	0.095
Vintage & Producer 2	122	0.419	-0.033	-0.049	-0.071	0.097
Vintage & Growth	83	0.606	-0.006	-0.034	-0.042	0.092
Vintage & Growth 2	62	0.759	-0.020	-0.037	-0.035	0.100
First Growth	22	0.478	-0.104	0.106	-0.030	0.094
Second Growth	18	1.330	-0.040	-0.149	-0.036	0.128
Third Growth	10	0.716	-0.049	0.037	-0.073	0.049
Fourth Growth	8	0.459	0.126	-0.264	-0.013	0.127
Fifth Growth	4	0.450	0.305	-0.053	-0.008	0.088
No Growth	21	0.154	0.037	-0.023	-0.063	0.067
<u>Panel 2: CAPM Model</u>						
Vintage & Producer	276	0.168	-0.005			0.031
Vintage & Producer [2]	122	0.389	-0.019			0.030
Vintage & Growth	83	0.880	0.007		.	0.038
Vintage & Growth [2]	62	1.046	-0.002			0.041
First Growth	22	0.775	-0.074			0.052
Second Growth	18	1.532	-0.045			0.032
Third Growth	10	1.027	-0.018			0.027
Fourth Growth	8	0.750	0.107			0.024
Fifth Growth	4	0.727	0.310			0.035
No Growth	21	0.439	0.053			0.026

[1]*where the number of returns is 15 or more for any given vintage producer or vintage growth.*

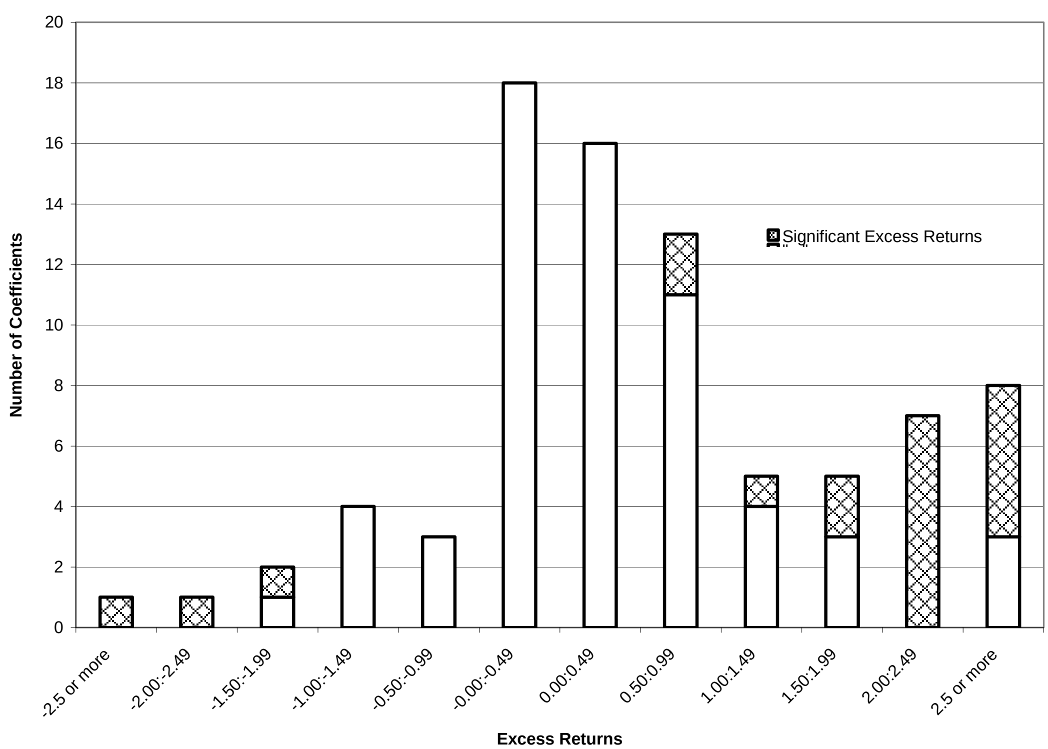
[2]*includes only those wines classified in one of the five growth classifications.*

Fig. 1: Excess Return[1] by Vintage and Producer
(Total of 276 Fama French Regressions by Vintage and Producer)



[1] return in excess of that predicted by exposure to common risk factors

Fig. 2: Excess Return[1] by Vintage and Growth
(Total of 83 Fama French Regressions by Vintage and Growth)



[1] return in excess of that predicted by exposure to common risk factors

Fig. 3: Betas by Vintage and Producer
(Total of 276 CAPM Regressions by Vintage and Producer)

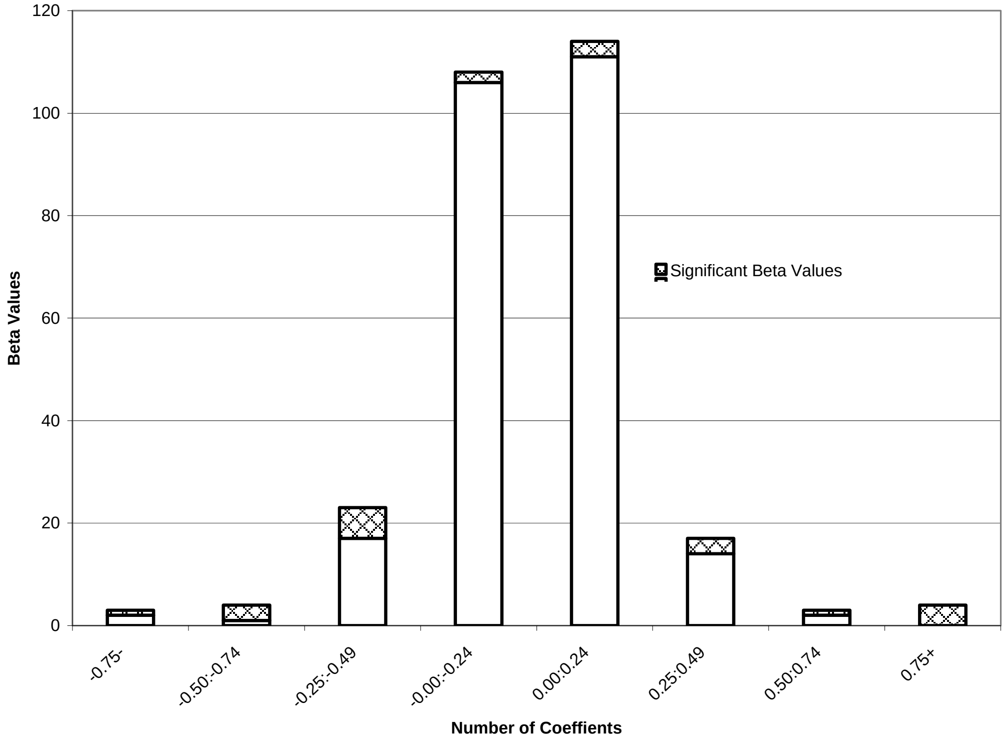


Fig. 4: Betas by Vintage and Growth
(Total of 83 CAPM Regressions by Vintage and Growth)