Asset Pricing Theory and the Valuation of Canadian Paintings

Douglas J. Hodgson and Keith P. Vorkink
University of Quebec at Montreal and Brigham Young University

March 31, 2003

Abstract

The valuation of Canadian paintings is analyzed empirically. Using a sample of auction prices for major Canadian painters for the period 1968-2001, we run hedonic regressions to analyze the influence of various factors, including painter identity, on auction prices, as well as to construct a market price index. This index is used in a second stage analysis in which we analyze the properties of Canadian art viewed as an investment asset. We consider the extent to which standard asset pricing theory, as incorporated in the capital asset pricing model (CAPM), can account for price movements in the market for Canadian paintings.

1. INTRODUCTION

It is not unusual in modern western society to find on the front pages of major daily newspapers reports on the latest blockbuster sale of a major painting. During the art market boom of the late 1980's, such events were frequent occurrences, as the media reported on the latest all-time record-breaking price paid for a painting, and the public shook its head in wonder and amusement. There seems to be a genuine fascination among the general public, even those who are not collectors and have no interest in art history, with the valuation of fine art works. This fascination can even lead to political controversy, as happened in Canada in 1990 when a work by the American abstractionist Barnett Newman was purchased by the National Gallery of Canada at a price considered by many Canadians to have been excessive. One argument made by those in favor of the purchase was that the painting could be thought of as an investment - it was an asset being added to the capital stock of the nation, the monetary value of which had the potential for substantial future appreciation. This question of the investment value of art is never far from the surface in public discussion of art prices - the public seems to find particularly fascinating those stories of paintings purchased at thrift shops for nominal sums that turn out to be long-lost and very valuable works of acknowledged masters, or of small collectors with a prescient "eye" who have a knack for purchasing at a low price the early works of young artists who subsequently go on to celebrity and high market valuation.

Although the vast majority of people who purchase art do so because they enjoy looking at it, so that the price of any painting incorporates a portion that can be thought of as being paid in exchange for immediate consumption by the purchaser, it cannot be ignored that paintings are durable, capable of surviving in close to their original condition for centuries if properly maintained, and that therefore some portion of the price can be thought of as representing the discounted present value of the sums that may be paid by potential future owners in exchange for the consumption they may obtain from the painting. Two elements of uncertainty thus enter into consideration for a person contemplating the purchase of a painting: uncertainty over the future evolution of one's own taste (i.e. the possibility that one will lose interest in the painting before it has fully "paid for itself" in consumption benefits), and uncertainty over the future evolution of tastes of society in general. In fact, the latter category of evolution can occur quite rapidly, with different painters and historical styles coming into and out of vogue. This dependence of the price of a painting on the expected present value of a future consumption stream of uncertain monetary value is analogous to that of the dependence of a stock on the expected present value of a sequence of uncertain future dividend payments.

This latter consideration suggests that an analysis of the prices of art works within the context of, and using the tools of, asset pricing theory could yield some useful insights. The valuation of art works is an area that has received considerable attention from economists (see the books of Reitlinger (1961) and Grampp (1989)), with the investment properties of paintings being a particular focus of academic investigation (see, for example, Stein (1977), Baumol (1986), Goetzmann (1993), Pesando (1993)). The existing literature on art as an investment focuses on a few questions regarding the statistical properties of time series of art returns, in particular the first two moments of the return distribution. A time series index of prices and returns, for a given category of art work, is generally estimated from individual sale data at auctions using either the "repeat-sale regression" or the "hedonic regression" method, described in more detail in Section 2. The sample average returns and return variances are compared to those that were observed in the same time period for such financial assets as bonds and stocks. Covariances with the stock market and the associated market betas are often also computed.[1] Results in the literature vary depending on the time period and the "portfolio" of paintings under consideration, with some studies finding the return on art to be very low on average relative to stocks on bonds and some finding it to be high. One feature of art returns that does seem to be robust is that they are much more variable than stocks or bonds, so that art would tend to be a risky investment. The correlations of art portfolios with the stock market tend to be positive, but are often close to zero. A non-positive correlation would suggest that art, despite its high variance, can serve a useful function in a diversified portfolio as an element that counters, or is at least neutral to, general market risk. There does seem to be a vague impression among the general public that fine art can indeed function as a form of portfolio insurance, with articles about art as an investment more likely to appear in the popular press during periods of bear stock markets.

Most of the existing academic literature on art as an investment is concerned with European and American paintings. In the present paper, we conduct an empirical analysis of the valuation of Canadian paintings. We consider the behaviour of prices of oil and acrylic paintings, over the period 1968-2001, for a portfolio of major Canadian painters. Preliminary to our analysis of the investment properties of Canadian art, we estimate a price index and a return series using hedonic methods, reported in Section 2. The results of our hedonic regression are of some independent interest, as they allow us to gauge the influence on the auction prices of paintings of a number of separate factors, including the identity of the artist, the auction house, the size of the painting, and the medium and support. Our findings suggest a number of hypotheses regarding the valuation of art works that may be of particular interest to economists and that may suggest further avenues of research. We should note that we depart from the literature in estimating the hedonic regression using the semiparametric efficient adaptive estimator of Bickel (1982), motivated by the high leptokurtosis present in our auction price data and by our sample size of nearly 13,000 sales. The resulting estimates of returns are

[1] The "beta" of a financial asset is the ratio between the covariance of the asset's return with that of a general market portfolio and the market variance. Beta represents the degree of non-diversifiable risk incurred in the holding of the asset, and is, according to the capital asset pricing model (CAPM), the sole factor that should influence the equilibrium price of an asset.

more precise than would be obtained using ordinary least squares, an important consideration because these *estimated* returns are treated as being *observed* returns when we proceed to the analysis of the investment properties of paintings. The results of this latter analysis are presented in Section 3. We compare the investment properties of Canadian art with those of Canadian government bonds and Canadian stocks. We estimate the capital asset pricing model (CAPM) and also apply the conditional CAPM of Bollerslev, Engle, and Wooldridge (1988), in which conditional covariances and conditional betas are permitted to vary over time.

2. THE HEDONIC REGRESSION

Our objective in this paper is to analyze the pricing of Canadian art from the standpoint of asset pricing theory. To this end, we would like to have a time series representing general movements in the market for Canadian art. However, such an index is not readily available, but must be inferred from the many individual sales of paintings which occur over time. Each painting is, to a certain extent, a unique object, and therefore the price at which a given painting sells, whether at auction, in a gallery, or privately, cannot be taken as a general indicator of the level of the art market. In addition to reflecting the general level of the market at the time of sale, the price will be affected by such factors as the identity of the artist, the size, medium, and support of the painting, the location of the sale (the auction house, gallery, city or country in which the sale occurs), the condition and quality of the work itself, as well as a host of idiosyncratic factors such as the buyer's tastes and resources. Our problem in this section is to employ appropriate econometric techniques to the end of inferring a general index from a myriad of individual transactions.

The various approaches that have been taken to address this problem can be placed into two general classes, the "repeat-sale regression" method and the use of hedonic regression. The former approach, used, for example, by Baumol (1986), Goetzmann (1993), Pesando (1993) and Pesando and Shum (1999), is based on a comparison of the prices at which an identical art work was sold in different time periods in order to compute a rate of return for the given art work and time interval, and then effectively averages over all art works for which such repeat-sales occurred to obtain an average rate of return in each time period. The application of the method to obtain a price index for paintings has obvious data problems - the identification of repeat sales of the same painting may be difficult to make based on published sale data, and the number of such repeat sales may be too small to construct an accurate price index. These problems are significantly mitigated in the work of Pesando (1993) and Pesando and Shum (1999), as these authors analyze the valuation not of paintings but of prints, for which multiple impressions of the same image can effectively be considered as identical objects.

The hedonic regression method is more frequently encountered in the literature, having been employed in dozens of studies of prices of art works and collectibles, a few recent examples being Chanel, Gérad-Varet, and Ginsburgh (1996), Czujack (1997), and Locatelli-Biey and Zanola (2002). The essential approach is to gather price data on a number of art sales through time (auction sales, for example), and to then regress the price of each work (or its logarithm) on other available characteristics of the work, such as the artist, the size, the medium, the auction house, the time period, etc. Many of the regressors, such as those associated with the time period, will take the form of a set of dummy variables. For the time-period dummies, the estimated coefficients will form a time series representing time variation in the general market for the type of art work under consideration. We report below the results of our estimation of a hedonic regression for a group of important Canadian painters for the period 1968-2001.

2.1. Data

Records of sales of Canadian paintings at auction were used to constitute the data set for our study. Data for auctions held between 1968 and 2001 were collected by the authors from records published by Campbell (1973-75, 1980), Sotheby's (1975, 1980), and Westbridge (1981-2002). Sales are recorded in these publications for an enormous number of artists, including quite minor ones. We chose to restrict our analysis to artists considered to have made contributions of some lasting importance to the development of Canadian art, so that we can claim to have assembled a sample of paintings by "major" artists that should be expected to have solid long-term investment value. Our criterion for an artist to be "important" is that his or her work be mentioned in Reid's (1973) survey of the history of Canadian painting. In addition to being a principal reference on Canadian painting, Reid (1973), having been published near the beginning of our sample period, provides us with a list of painters who had achieved some degree of renown, and presumably of investment value, by this time.

We only consider oil and acrylic paintings - the vast majority of our observations are for oils. The number of painters listed in Reid (1973) and for whom we have at least one recorded sale of an oil or acrylic painting is 152, and the total number of sales in our data set is 12,821. We have only included sales for which the auction house's attribution is confident, so that paintings listed as being "school of" or "in the manner of", say, Cornelius Krieghoff are excluded. For each painting, we recorded, in addition to the identity of the artist, the height and width in centimetres, the medium and support, the auction house, and the half-year of the sale. Since the vast majority of auctions occur in fairly concentrated time periods (autumn auctions are mostly in October and November, and spring auctions in April and May), we have followed the standard practice in the literature on art pricing by using a semi-annual time index.

Throughout the empirical study, we use hammer prices as recorded in the publications listed above. No effort has been made to adjust or correct our numbers to account for such costs as auctioneers' commissions, taxes, insurance premia, maintenance and restoration costs, etc. These factors all act to reduce the monetary returns of owning paintings below the levels recorded here. Factors acting to augment the monetary returns to art owners, such as reproduction fees and exhibition lending fees are also omitted.

2.2. Econometric model

As mentioned above, our objective is to obtain from our several thousand individual auction sales records a price index reflecting the evolution of the art market over time. For practical reasons, we will construct semi-annual and annual indices, estimating a hedonic regression with time-period dummy variables. The model to be estimated can be written

$$p_i = \sum_{t=1}^{T} \gamma_t z_{it} + \sum_{j=1}^{J} \alpha_j w_{ij} + u_i, \;\; i = 1, ..., n, \tag{1}$$

where p_i is the logarithm of the price of sale i, the number of sales is $n = 12,821$, z_{it} is the value of a period$-t$ dummy variable, equal to 1 if painting i was sold in period t and equal to zero otherwise, with the number of time periods T being 66 when the data are grouped semi-annually and 33 when they are grouped annually. All auctions held during the months from January to June of a given year are considered to belong to the first half of the year, with the year's remaining auctions belonging to its second half. The semi-annual dummies thus run from 1968:2 to 2001:1. Due to the extremely low incidence of auctions during the summer months, we will consider an auction year in the same way as one would consider a school year or a hockey season, so that, for the purposes of forming an annual price series, the auction year is considered to run from July 1 of a given calendar year to June 30 of the following one. We thus have 33 annual dummies, starting with the 1968-69 auction year, followed by 1969-70 and concluding with 2000-2001. Our estimates of the vector of associated parameters $\{\gamma_t\}_{t=1}^{T}$ will form our price indices, to be used in the asset pricing analysis of the following section.

The regressors $\{w_{ij}\}$ in (1) represent the other characteristics of painting i. These include 151 dummy variables for the painting's artist, 19 medium/support dummies, and 35 auction house dummies (in all three cases, one dummy was omitted to avoid collinearity with the time period dummies, hence 151 painter dummies corresponds to a sample of 152 painters). Three additional variables reflecting a painting's dimensions - height, width, and surface area - were included. Equation (1) can be written more concisely as

$$p_i = x_i'\beta + u_i, \ i = 1, ..., n, \tag{2}$$

where $x_i' = (z_{i1}, ..., z_{iT}, w_{i1}, ..., w_{iJ})$ and $\beta = (\gamma_1, ..., \gamma_T, \alpha_1, ..., \alpha_J)'$. Note that we have J=208 and T=66 or T=33, for semi-annual and annual dummies, respectively, giving us a dimension K for the parameter vector β of 274 or 241.

A note should be added on the interpretation of the dummy parameters. In the next section, we will analyze the rate of return on Canadian paintings, considered as financial assets. If we knew the time period dummies $\{\gamma_t\}_{t=1}^{T}$, we could compute the rate of return between, say, periods t and $t+1$ as follows:

$$r_{t+1} = \exp\left(\gamma_{t+1} - \gamma_t\right) - 1.$$

We can proceed similarly for the characteristic-related dummies. We will see below that the dummy for A.Y. Jackson was omitted from the regression (1), in other words it was arbitrarily set equal to zero. The dummy parameters α_j for each of the remaining painters can then be seen as reflecting their market values vis-à-vis Jackson. The percentage difference between the value of a work by painter j and a Jackson, controlling for all the other factors in our analysis, will be

$$\exp\left(\alpha_j\right) - 1.$$

2.3. Estimation

The regression (1) and (2) can be, and usually is, estimated by ordinary least squares (OLS). Under the standard assumptions, OLS will be consistent and asymptotically normal, and will be asymptotically efficient if the disturbances $\{u_i\}$

are normally distributed. An application of the Jarque-Bera (1980) normality test to our OLS residuals yielded an enormous statistic of 10,537 (the test has a chi-squared null distribution with two degrees of freedom), with an associated $\chi^2(1)$ kurtosis statistic of 10,033. Hence, there is reason to suppose that a substantial efficiency loss is borne when estimating the model by OLS, relative to maximum likelihood or to a robust estimator such as least absolute deviations. For our purposes, efficiency is a major concern. This is because our estimates of the time-period dummies $\{\gamma_t\}_{t=1}^{T}$ and, more specifically, of the associated returns $\{r_t\}_{t=2}^{T}$, will be treated in our analysis of the following section as being observed series of prices and returns. Thus, it is essential that these parameters be estimated as precisely as possible. In fact, a principal reason why the estimation of semi-annual (as opposed to quarterly or monthly) indexes is so frequently encountered in the literature is that the general paucity of auction data from the summer months makes the reasonably precise estimation of monthly or quarterly dummy parameters very difficult (Flôres, Ginsburgh, Jeanfils (1999, p.208)).

To achieve greater precision in our estimates of the time-period dummies, we have chosen to estimate (2) adaptively, according to the procedure of Bickel (1982). This estimator is designed to deliver fully asymptotically efficient estimates when the distribution of the disturbances $\{u_i\}$ is of unknown functional form. Given our strong evidence that the disturbances are not normally distributed, and in the absence of any compelling economic argument favoring the adoption of some other specific functional form for the error distribution, we shall treat this distribution as unknown and proceed to compute a semiparametric analogue of the maximum likelihood estimator (MLE). We will assume that the disturbances are independent and identically distributed (iid) with a density function $f(u)$. The version of the Bickel (1982) estimator we use incorporates a further assumption of symmetry of this distribution, so that $f(u) = f(-u)$.

If the functional form of $f(u)$ were known, computation of the maximum likelihood estimator of β would be a straightforward matter. With $f(u)$ being unknown, the basic approach to computing an efficient semiparametric analogue to the MLE does not change much, with the principal complication being the necessity to use the data to compute a nonparametric estimate of f to use in lieu of the unknown function. We outline below the mechanics of computing a slightly modified version of the Bickel (1982) adaptive estimator.

Using the OLS estimator $\widehat{\beta}$, compute the associated residuals $\widehat{u}_i = p_i - x_i'\widehat{\beta}$, $i = 1, ..., n$. For each residual $\widehat{u}_i$, $i = 1, ..., n$, one can use the remaining residuals to compute a kernel estimate of the level of the density f evaluated at $\widehat{u}_i$ as follows:

$$\widehat{f}_i(\widehat{u}_i) = \frac{1}{2(n-1)} \sum_{\substack{j=1 \\ j \neq i}}^{n} \left\{ K\left(\frac{\widehat{u}_i + \widehat{u}_j}{h_n}\right) + K\left(\frac{\widehat{u}_i - \widehat{u}_j}{h_n}\right) \right\},$$

where $K(\cdot)$ is a user-specified kernel weighting function and h_n is a user-specified bandwidth parameter that satisfies the asymptotic condition $h_n \to 0$ as $n \to \infty$[2]. We will also require the following estimate of the first derivative of f :

$$\widehat{f}_i'(\widehat{u}_i) = \frac{1}{h_n 2(n-1)} \sum_{\substack{j=1 \\ j \neq i}}^{n} \left\{ K'\left(\frac{\widehat{u}_i + \widehat{u}_j}{h_n}\right) + K'\left(\frac{\widehat{u}_i - \widehat{u}_j}{h_n}\right) \right\}.$$

We then have the estimated (negative of the) score of f, evaluated at $\widehat{u}_i$:

$$\widehat{\psi}_i(\widehat{u}_i) = \frac{\widehat{f}_i'(\widehat{u}_i)}{\widehat{f}_i(\widehat{u}_i)},$$

where some trimming conditions may need to be specified in the computation of $\widehat{\psi}_i$, depending on the kernel employed. In our empirical application, we will use a normal kernel with a bandwidth parameter specified using the rule-of-thumb approach of Silverman (1986). Although trimming is theoretically required to calculate $\widehat{\psi}_i$, we elect not to trim, due to the large size of our sample (Monte Carlo evidence prevented by Hsieh and Manski (1987) and Hodgson (1998, 1999) show that adaptive estimators with normal kernels behave well with very little trimming for sample sizes in the 100-200 range).

The sample score vector and information matrix of the likelihood function can be approximated, respectively, by the following semiparametric estimators:

$$\widehat{S}_n = n^{-1} \sum_{i=1}^{n} x_i \widehat{\psi}_i(\widehat{u}_i)$$

and

$$\widehat{\mathcal{I}}_n = \widehat{\ } n^{-1} \sum_{i=1}^{n} x_i x_i',$$

[2] See Silverman (1986) for a good introduction to the topic of nonparametric density estimation.

where $\widehat{} = n^{-1}\sum_{i=1}^{n}\widehat{\psi}_i\left(\widehat{u}_i\right)^2$. The adaptive estimator $\widetilde{\beta}$ is then computed using the following one-step Newton-style adjustment of the OLS estimator $\widehat{\beta}$:

$$\widetilde{\beta} = \widehat{\beta} + \widehat{\mathcal{I}}_n^{-1}\widehat{S}_n.$$

Under conditions specified by Bickel (1982), $\widetilde{\beta}$ will be consistent and asymptotically normal,

$$\sqrt{n}\left(\widetilde{\beta} - \beta\right) \xrightarrow{d} N\left(0, \mathcal{I}^{-1}\right),$$

where the asymptotic covariance matrix $\mathcal{I}^{-1}$ is consistently estimated by $\widehat{\mathcal{I}}_n^{-1}$.

2.4. Results

The results of our estimation of the hedonic regression (1)-(2) are discussed here and reported in Tables 1-6 and in the Appendix.

2.4.1. Time series price index and estimated returns

As mentioned above, the hedonic regression was run twice, for two different sets of time-period dummies, viz. semi-annual and annual. In Tables 1 and 2 are reported the semi-annual and annual results, respectively. For each time period, we have provided the number of observations recorded in the period, along with the estimated dummy parameter, its standard error, and the estimated rate of return, stated as a percentage, with the associated standard error. The numbers are interesting in several ways. Perhaps most striking is the very high volatility of the market, particularly prior to 1988, a phenomenon present in both data periodicities. Perhaps not merely coincidentally, the reduction in return volatility apparent in the late 80's corresponds with a general increase in the number of observations. This latter is to an extent due to problems of data availability, particulary in the very early years of the period, but probably also represents a general thickening and maturation of the Canadian art market in these years. The higher estimated volatility prior to 1988 may be partially due to imprecise estimates resulting from sparser data - the estimation error is clearly higher in this period - but cannot be entirely, or even predominantly, ascribed to this cause. Rather, we would contend that the thinness and immaturity of the market, coupled with an atmosphere of general macroeconomic instability in Canada during these years, would provide more likely explanations. Deeper investigation of this issue is warranted. We can also see that grouping the data annually leads to substantial reductions in standard errors. Similarly, the standard errors reported here for the adaptive estimator are generally about 30% below the OLS standard errors (not reported), suggesting that our precision gains in using the adpative estimator are not negligible.

Looking at the annual returns, we can see that the market value grew very rapidly during the 1970's, with an average annual return between 1971 and 1981 of over 21%. This average return is quite high, even considering the high inflation of this period. A deep dip in the early 1980's can probably be ascribed to the general recession of this period, but the market gradually recovered during the remainder of the decade, with a moderate dip in the early 90's probably being also due to these years' macroeconomic slowdown. The market was generally stable during the 1990's.

2.4.2. Painters

The 152 painters included in the study are identified in the Appendix, along with information on the number of works sold for each painter, and the estimated regression dummy parameter and standard error. As mentioned above, one dummy variable, that representing A.Y. Jackson, was omitted to prevent collinearity with the time period dummies. Thus, each painter's dummy estimate can be interpreted as representing his/her market value vis-à-vis that of Jackson. Of course, we cannot analyze these results in complete detail, but we believe that the information presented in Table 3 may be of interest to some readers. Here, we provide results on the "Top 25" Canadian painters, i.e. those with the 25 highest dummy point estimates, ranked in descending order. For each of these painters, in addition to restating the information reported in the Appendix, we compute the percentage difference between the value of one of his/her works and a work of Jackson, controlling for the other variables included in the regression. In the following discussion of these results and of the artists, we will often rely on information provided by Reid (1973), without specific citation in each case.

In analyzing Table 3, a few considerations should be borne in mind. First, the ranking is not necessarily statistically significant. The reported standard errors allow us to infer the significance of the parameter estimate relative to A.Y. Jackson, but not relative to any of the other artists on the list. Secondly, the precision of these estimates varies widely by artist, depending on the number of observations available, the latter varying from a low of 1 for Jean-Baptiste Roy-Audy to a maximum of 1246 for A.Y. Jackson. Thirdly, the hedonic regression estimates a reduced form model in which no attempt is made to distinguish between supply and demand influences on price. It would be highly desirable to estimate a fully specified and identified supply-demand model of this market, but we have not attempted to do so here.

The painter by far the most highly valued in the Canadian art market is Tom Thomson (1877-1917). This is hardly surprising, as Thomson is widely considered to be the greatest painter Canada has ever produced. His historical role in the development of Canadian art is enormous - he is credited by historians as being the first Canadian painter to develop an indigenous and characteristic national style which responds in an intuitive and original manner to the country's rugged landscape. His work provided the impetus for the development of the Group of Seven, an ensemble of landscape painters who built on Thomson's vision and style and who are today the artists whose names are probably most recognizable to the Canadian public as a whole, at least among those whose first language is English. Several other members of our top 25 were associated with the Group of Seven at one time or another, including Frank Carmichael, Lawren S. Harris, Fred Varley, A.J. Casson, J.E.H. MacDonald, A.Y. Jackson, and Edwin Holgate.

Among the painters on our list for whom very few observations are available, most are early pioneers of Canadian art, of great historical importance and interest, and whose existing works are relatively rare. In this category fall William Berczy (1744-1813), James Duncan (1806-1881), Jean-Baptiste Roy-Audy (1778-c.1848), Paul Kane (1810-1871), and W.G.R. Hind (1833-1889). Aside from their inherent quality, these painters' works are also valued for their historical interest and their scarcity, the latter factor highlighting the importance of distinguishing between supply and demand influences on the art market. Duncan, for example, was principally a watercolourist, and only a relatively small number of oils from his hand have come down to us. He is best known for his landscape views of the island of Montreal. Aside from the beauty of his pictures, they are of considerable interest to historians and to lovers of Montreal because they provide us with priceless information as to the appearance of the city shortly before and during its transformation from a tiny colonial settlement into a major port and industrial centre.

Most of the painters on our list are associated with one or another of the two major Canadian urban centres during the period when most of the artists considered here were active, viz., Montreal and Toronto. Thomson and the Group of Seven were mostly based in Toronto, and the lion's share of their paintings depict the rural wilderness of the province of Ontario (of which Toronto is the capital). Thus, when it is said that their market value is due in large measure to the fact that there is a uniqly Canadian sensibility in their art, it may be more accurate to say that the sensibility reflected is a regional sensibility unique to Ontario, and that these artists are so highly valued because Ontario is Canada's most populous province and among its richest. The regional aspect is worth stressing for a couple of reasons. First, Canada is a geographically vast, sparsely populated country in which regional identifications tend to be extremely strong. Second, the existence of a dominant region such as Ontario, and dominant urban centre such as Toronto, can have an important impact, from a purely economic standpoint, on the style and content that is valued in the art market as a whole. In this context, it is worth citing the work of Valsan (2002), whose comparison of the markets for Canadian and American paintings finds a relation of the latter to the former analogous to the relation of Ontario to the rest of Canada noted here.

Nevertheless, a number of painters associated, in whole or in part, with the city of Montreal or, more generally, with the predominantly French-speaking province of Quebec, find their way onto our list. Aside from the aforementioned Duncan, one can cite the Group of Seven painters Jackson and Holgate, as well as Cornelius Krieghoff, James Wilson Morrice, Maurice Cullen, and the francophones Paul-Emile Borduas, Jean-Paul Riopelle, Jean-Paul Lemieux, and Clarence Gagnon. Setting aside the early figure of Roy-Audy, the most highly valued francophone artists are Borduas (1905-1960) and Riopelle (1923-2002). This is not surprising, as these two represent the pillars of the fecund abstract and surrealist school that emerged in Montreal in the late 40's and 50's. What may initially seem surprising is the placement of Borduas ahead of Riopelle. After all, Riopelle may well be the most famous Canadian painter. He was the only Canadian artist to achieve significant critical renown outside Canada, and he is the only Canadian mentioned in Arnason's (1986) comprehensive survey of the history of modern art. His death in 2002 was front-page news throughout Canada, and he was accorded a state funeral in Montreal.

One can nevertheless posit several hypotheses to explain Borduas' higher market valuation. Firstly, from the standpoint of Canadian art history, he is arguably of greater importance than Riopelle. His position is somewhat analogous to that of Tom Thomson in that he was a seminal figure whose innovation and leadership spearheaded an original and important new direction in Canadian art. He was the author of the revolutionary "Refus Globale" of 1948, a document signed by many progressive artists (including Riopelle) that challenged the stifling, ultra-conservative cultural climate that prevailed in Quebec at the time, due largely to the social and political hegemony enjoyed by the province's Roman Catholic hierarchy. Secondly, from a supply-side standpoint, his lifespan was over two decades shorter than that of Riopelle, and his paintings are therefore presumably harder to come by, a hypothesis consistent with the fact that, in our sample, there were three times as many Riopelles as Borduas sold at auction.

There is a third potential explanation, perhaps more compelling than the first two, for the high valuation of Borduas relative to Riopelle. It derives from the structure and functioning of the post-war market for avante-garde art, as analyzed and interpreted by Galenson (2000). In a study of American modern artists, Galenson (2000) finds that the function relating the auction value of an artist's work with the artist's age at the time of the execution of the work has a shape that depends heavily on whether the artist was born before or after 1920, i.e. on whether or not the artist's professional career commenced before or after the mid-1940's. For artists born after 1920, the function is tilted more significantly in favour of paintings executed early in the artist's career. Galenson (2000) interprets this finding as reflecting changes which occurred in the American art world in the post-war era. The emphasis among collectors and critics shifted from a concern from good craftmanship in a work of art to a concern for striking originality and formal innovation. This latter attitude is above all associated with the ideas of the influential New York critic Clement Greenberg. In a world where craftmanship receives relatively high value, one can expect an artist's works to increase in value with the artist's age, as his or her craft is increasingly perfected and higher quality works result. In a world where formal novelty is valued, young artists are encouraged to make breakthroughs in the solution of arcane formal and technical problems, and are often under great pressure to hit a "home run" at an early age in order to garner and maintain critical attention. It is not hard to see that, in such an environment, there is an increased tendency for the early works of an artist to be those that gain the greatest notoriety and market value.

Galenson's (2000) conclusions are relevant to us because a comparison of the careers of Borduas (born in 1905) and Riopelle (born in 1923) conforms in large measure with his analysis. Borduas received a classical training in painting and worked for many years as an assistant and pupil of the "Old Master" Ozias Leduc, working principally at the decoration of rural churches. He was well into his thirties before turning to a modern idiom in painting, but once doing so, he continued to produce important, original, high-quality work until the very end of his life. Riopelle, on the other hand, came of age in the post-war avant-garde climate of abstract formal innovation, and his best-known works by a large margin are his abstract-expressionist canvases of the late 40's and 50's. The critical reputation of the works produced during the remaining four decades of his life is much lower than his early work (Riopelle famously described himself in the 1970's as being a "has-been"). We therefore hypothesize that the overall lower market value of Riopelle's work relative to Borduas is due to a declining age profile in the former, with many low-priced late works more than compensating for the presence of some high-priced early works. A more complete and formal analysis of this hypothesis would be of interest.

We conclude our discussion of Table 3 by remarking on the anomolous case of Emily Carr. In addition to being the only woman to crack the top 25, she is one of the rare examples on this list of an artist whose principal geographical identification is not with Ontario or Quebec. She worked in British Columbia, and her art is deeply influenced by her physical surroundings, with her paintings typically depicting thick forests, west coast aboriginal villages, and totem poles.

2.4.3. Medium and Support

The dummy estimates for selected medium/support combinations are reported in Table 4. There were twenty different medium/support combinations included in the regression, but we have only reported estimates for those for which we had at least 50 observations. The oil on canvas dummy was omitted, so the parameter estimates in Table 4 reflect the contribution to a painting's value of a given medium/support in comparison to that of oil on canvas. Two things are particularly noteworthy here: first, that medium and support are essential components of a painting's value, and second, that oils painted on canvas command a substantial premium, with acrylics on canvas, for example, being devalued by over 40 per cent in comparison.

2.4.4. Auction House

Paintings in our sample were sold at 36 different auction houses, and we have reported in Table 5 the dummy estimates for those 16 for which we had at least 100 observations, with the Sotheby's dummy being omitted from the regression. The estimates indicate a strong correlation between the house at which the painting is sold and the price, with Christie's showing a 42% premium over Sotheby's and three houses showing devaluations of over 40% compared to Sothby's. The differences among the houses may be due geographical location or to segmentation of the market into houses specializing in paintings of different levels of quality, but these are questions that we leave for future investigation.

2.4.5. Size

Our parameter estimates for the dimensions - height, width, and surface area - are given in Table 6. We can see that the height of a painting can have an appreciable impact on its price, with a one centimetre increase leading to an augmentation of about 2.2%. The parameter estimate for width is, surprisingly, negative and statistically significant, but is of quite small magnitude, while the parameter for surface area is of negligible magnitude. That height would be so much more highly valued than width is a bit surprising, considering the predominant position of landscape paintings, usually of horizontal format, in Canadian art (Valsan (2002)). We can only suggest an explanation based on considerations of supply - perhaps horizontal paintings are in overabundant supply on the Canadian art market, leading to a scarcity-driven premium on compositions with a vertical format.

3. Asset Pricing Tests

We conduct tests of the returns to our art index in the framework of the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965). The following equation demonstrates the main result of the CAPM, stating that the expectation of the return on asset i, denoted as $R_{i,t}$, in excess of the return on a risk-free security, $R_{f,t}$, is a linear function of the expected excess return on the market portfolio, $R_{m,t}$:

$$E_{t-1}\left[R_{i,t}\right] - R_{ft} = E_{t-1}\left[R_{m,t} - R_{f,t}\right]\beta_{i,t}, \tag{3}$$

where $\beta_{i,t} = \frac{cov_{t-1}(R_{m,t},R_{i,t})}{var_{t-1}(R_{m,t})}$ is the conditional "beta" for asset i in period t, and the subscripts on expectations and covariances indicate conditional moments. Assuming that no dynamics exist in the conditional expectations, (3) reduces to the unconditional CAPM

$$E\left[R_{i,t}\right] - R_{f,t} = E\left[R_{m,t} - R_{f,t}\right]\beta_{i}. \tag{4}$$

There is an extensive empirical literature on the unconditional CAPM, most of which has tested how well this model can explain stock returns, with important early work by Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973).[3] However, the CAPM has been used as a model to explain the returns on other assets. For example Bryan (1985) uses the CAPM to perform asset pricing tests of art, while Gyourko and Nelling (1996) use the CAPM to analyze the performance of Real Estate Investment Trusts (REIT). In a similar fashion to these and other studies of the CAPM, we use the following empirical version of the unconditional CAPM:

$$r_t = \alpha + \beta r_{M,t} + e_t, \tag{5}$$

where r_t is the excess return on the art index in period t (return on the art index minus the yield on a risk-free security), $r_{M,t}$ is the excess market return, e_t is a disturbance, and α and β are parameters. The CAPM suggests that β measures how much of the return to a particular asset (in our case art) is priced as systematic risk, or the portion of returns that are generated by the asset's correlation to that of the market. A simple t-test of the parameter will test if any portion of the asset's return is systematic, i.e. if $\beta = 0$.

If there is some component of returns that is not due to market risk exposure, as measured by β, but is persistent, it will appear in the intercept, α. If the CAPM is the true model describing returns, $\alpha = 0$, whereas a finding that $\alpha \neq 0$ would signal average returns that cannot be explained by market risk. A t-test of $\alpha = 0$ will test the CAPM's ability to explain the returns of a particular asset. One could also test for the significance of additional regressors in (5). For example, in analyses of stock returns, Banz (1981) includes market size and Fama and French (1992, 1993) consider a firm's book value to market value ratio as well as size.

Alternative to the unconditional model, if we believe the dynamics in the conditional moments play an important role then our estimation and testing should allow for these moments to move over time. To do so we redefine the $\mathbf{r}_t$ (now bolded) as a vector that includes the excess return on the art index as its first element and the market portfolio as the second element. We also define the conditional covariance matrix of $\mathbf{r}_t$ to be $\mathbf{H}_t$. This reformulation leads to the following return model for a single asset's return

$$E_{t-1}\left[r_{i,t}\right] = \varphi \frac{H_{i2,t}}{H_{22,t}} \tag{6}$$

where φ is $E_{t-1}\left[r_{m,t}\right]$ and $H_{i2,t}$ corresponds to the off diagonal element of $\mathbf{H}_t$, or the conditional covariance of $r_{i,t}$ with $r_{m,t}$ or the market return.

[3] See Campbell, Lo, and MacKinlay (1997) for a more comprehensive discussion of empirical tests of the CAPM.

Empirically, (6) can be written down in the following manner:

$$\mathbf{r}_t = \boldsymbol{\alpha} + \frac{\varphi}{H_{22,t}}\mathbf{H}_{i,t} + \mathbf{e}_t \tag{7}$$

where $\boldsymbol{\alpha} = [\alpha|0]$, $\mathbf{H}_{i,t}$ is a 2x1 vector with the covariance between asset i in the first element and the market variance in the second, and $\mathbf{e}_t$ is a vector of residuals. In order to arrive at a completely specified econometric model we must specify the form of our conditional covariance matrix $\mathbf{H}_t$ and our disturbance process $\{\mathbf{e}_t\}$. Perhaps the most popular parametric model of conditional covariances are of the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) family. Models of this type were developed by Engle (1982) and Bollerlsev (1987) with a vast literature of models and empirical applications. GARCH models of volatility have been shown to be a relatively parsimonious model of time-varying second moments and quite successful in capturing the time series behavior of volatility. In our modeling of the covariances we will draw heavily from the Baba, Engle, Kraft, and Kroner (BEKK) model.[4] Our general model of conditional volatility will be the following modified version of the BEKK model:

$$\mathbf{H}_t = \mathbf{C}^T\mathbf{C} + \mathbf{A}^T\mathbf{e}_{t-1}\mathbf{e}_{t-1}^T\mathbf{A} \tag{3.1}$$

where $\mathbf{C}$ and $\mathbf{A}$ are defined as

$$\mathbf{C} = \begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix}$$

$$\mathbf{A} = \begin{bmatrix} a_{11} & 0 \\ a_{21} & a_{22} \end{bmatrix}.$$

Hence, conditional covariances will have an unconditional component as measure by $\mathbf{C}$ and the dynamic component will allow last period's return shock, $\mathbf{e}_t$, to influence the conditional covariance as measured by $\mathbf{A}$. We call our version an ARCH model because we only allow last period's shock to influence covariance while the more general GARCH models include an autoregressive term in the conditional covariances. Given our model defined above our parameter vector to estimate will have 8 elements: α, φ, c_{11}, c_{12}, c_{22}, a_{11}, a_{11}, a_{12}, and a_{22}. Last, we will assume the distribution of the conditional residuals to be multivariate normal for the purposes of estimation.

[4] This model is named after a working paper authored by Baba, Engle, Kraft and Kroner and is referenced by Engle and Kroner (1995).

3.1. Data and Estimations

We make use of the art price index developed in the previous section to generate a series of art returns. We construct a series of 65 returns by calculating percent changes in the semi-annual (July - December and January - June) index data and a series of 32 returns using the annual (July - June) data. To construct excess returns we subtract from our art returns the yield of a maturity-matched Canadian Government Bond, where yields are obtained from the Bank of Canada. For the semi-annual data, we use the yield on 6-month to maturity bonds at months ending June and December. We use the yield on bonds with maturities ranging one to three years for the annual data.[5]

Our measure of market returns is taken from Morgan Stanley Capital International's (MSCI) Canadian equity index. This is a broad based Canadian equity index that includes capital gains as well as dividends on over 85% of the country's market capitalization. We construct returns to the market portfolio, $R_{m,t}$, as the percent change in this index from July 1 to December 31 and January 1 to June 30 for the semi-annual data and July 1 to June 30 for the annual data. We are only able to obtain data on the market index starting January 1969 and so our semi-annual sample includes 61 observations and the annual sample includes 30 observations.

Summary statistics for the art index returns, risk-free rates, and market returns are found in Table 7 and a plot of the semi-annual data is shown in Figures 1-2, which also include CPI-based measures of inflation. In general our results are similar to earlier studies. For example, Mei and Moses (2002) find that during the last 50 years the annual return to art based on New York auctions was 8.2% with a standard deviation of 21%, while our studies find Canadian art returning 8.5% annually with a standard deviation of 17%. We find that Canadian market equity index returned 15.6% annually, with standard deviation of 24%. Our correlations show that, both on a semi-annual or annual basis, art did provide diversification benefit to a portfolio of Canadian equities. This is similar to Mei and Moses (2002) in the relationship between US equities and art, but in sharp contrast to Goetzmann's (1993) finding based on London art auctions and the London Stock Exchange index returns.

Results from estimating the CAPM on our two data sets are found in Table 8. For the unconditional CAPM, whose results are found in Panel A, we find that

[5] These maturities are not idential to the art index return horizons but were the closest yields associated with maturities greater than or equal to one year.

art is has less systematic risk than the market as evidenced by our estimates of β being less than one (0.206 for the semi-annual data, and 0.359 for the annual data). The β estimated on the annual returns is statistically significantly different from zero, but the standard error on the semi-annual β is too large to admit statistical significance. These results also are in contrast with findings of Goetzman (1993) who estimates the β for the London art returns to lie above 1 with strong statistical significance. Again, our results support the notion that portfolios of Canadian art pieces would have provided a strong diversification benefit to Canadian equity holders over the past 30 years given the low correlation between the two series and the similar average returns and risks of both art and equities. The small absolute values of the point estimates of α and their respective standard errors suggest that we fail to reject the unconditional CAPM. Caution again must be used in this interpretation of the coefficients, and asymptotic t-tests, given the small data sets we use in our estimations. Consequently, we construct tests of market efficiency as found in Gibbons, Ross, and Shanken (1989) using the following formula:

$$\begin{aligned} GRS &= (T-1)\left[1+\frac{\hat{\mu}_M}{\hat{\sigma}_M^2}\right]^{-1}\frac{\hat{\alpha}^2}{\hat{\sigma}_u^2} \\ &\sim F_{1,T-2}. \end{aligned}$$

This test of market efficiency has an exact finite sample distribution under the assumption of normality and given that our sample sizes are small, this test may provide better market efficiency tests than asymptotic t-tests. Panel A provides Jarque-Bera normality tests of the residuals from the unconditional CAPM regressions, and indicates that normality appears to be a reasonable assumption. In the final column of Panel A, the Gibbons, Ross, and Shanken (1989) statistics, denoted GRS, and their associated p-values indicate that we cannot reject the notion that our art index return behavior is described by an unconditional CAPM.

A finding of $\alpha = 0$ can have a number of possible interpretations. The one posited above is that returns to the art market are adequately captured by the CAPM, and that only systematic risk is important for returns in this market. A second possibility is that there are returns not related to systematic risk, but that they are offset by the costs associated with art ownership (costs referred to earlier but which we have not explicitly attempted to measure). Among the pecuniary and non-pecuniary returns associated with art ownership that we have also not attempted to measure are the fees that may be obtainable through loans to gallery or museum exhibitions or through reproduction rights, and the direct utility afforded by a picture to its owner. Another way of looking at it is in considering that, under the maintained hypothesis that the CAPM holds, then the unmeasured costs and benefits of holding art referred to here balance one another exactly (since under the CAPM, any such imbalance would result in a non-zero α, positive if costs outweigh benefits and negative otherwise).

Estimation of the conditional CAPM using the semi-annual data, found in Panel B of Table 8, yields similar conclusions. The estimated α is both economically and statistically insignificant, suggesting that the conditional CAPM cannot be rejected by the data. An estimated value of .032 for φ is consistent with an annual equity premium of 6.5% which is roughly equivalent to US equity premiums estimated using stock market data over the same horizon. We do find that allowing second moments to move over time in an ARCH model adds little to the model. Specifically, the coefficients in the **C** matrix, which represent the unconditional portion of conditional covariances, are statistically significant, while the coefficients in the **A** matrix, which represent the conditional or time-varying portion of conditional covariances, are not significant. The insignificance of the time-varying nature of the conditional covariances is partially caused by our small data set and partially driven by the length of our returns. Most ARCH and GARCH modelling uses data of a higher frequency (daily, weekly, or monthly) and most research finds that the higher the frequency the richer the dynamics of second moments. Using semi-annual data, a low frequency of returns, may cloud our ability to capture the dynamics of second moments.

Acknowledgements

For their comments, we thank Georges Dionne, John Galbraith, and seminar participants at Journées du CIRPÉE (Montreal, 2002) and the Montreal Econometrics Workshop. Financial support from the Montreal Institute of Mathematical Finance is also acknowledged.

4. APPENDIX

The following is a list of all 152 painters included in our study, in alphabetical order. The three numbers given in parentheses for each artist represent, respectively, the number of observations, the dummy parameter estimate for the painter, and the associated standard error:

William Armstrong (10, -2.5288, 0.1719); William E. Atkinson (10, -2.9040, 0.0669); Marcel Barbeau (28, -2.8138, 0.1058); Maxwell Bates (169, -1.9513, 0.0528); William Beatty (350, -1.5475, 0.0333); Henri Beau (84, -2.0644, 0.0625); Frederic Marlett Bell-Smith (237, -1.5492, 0.0396); Louis Belzile (21, -3.5003, 0.1202); Aleksandre Bercovitch (20, -3.2828, 0.1228); William Berczy (2, 1.2258, 0.3817); George Theodore Berthon (4, -2.3420, 0.2708); B.C. Binning (16, -1.0550, 0.1429); Ronald Bloore (7, -2.5194, 0.2093); Paul-Emile Borduas (56, 0.6804, 0.0748); Joseph Bouchette (3, -3.9160, 0.3130); Fritz Brandtner (41, -1.8293, 0.0874); Miller Brittain (4, -2.1444, 0.2835); Bertram Brooker (33, -1.9075, 0.0958); Archibald Browne (115, -3.1804, 0.0534); Franklin Brownell (102, -1.7625, 0.0570); William Blair Bruce (23, -1.9855, 0.1143); William Brymner (107, -1.5099, 0.0550); Dennis Burton (14, -3.2367, 0.1463); Jack Bush (35, -1.3777, 0.0937); Oscar Cahen (3, -1.5984, 0.3170); Frank Carmichael (68, 1.1390, 0.0676); Emily Carr (182, 0.7177, 0.0489); A.J. Casson (579, 0.0700, 0.0290); Jack Chambers (2, -0.9730, 0.3843); W.H. Clapp (43, -1.8069, 0.0844); Paraskeva Clark (34, -2.1551, 0.0945); Alex Colville (5, -0.0304, 0.2436); Charles Comfort (105, -1.5519, 0.0553); Stanley Cosgrove (709, -1.1038, 0.0275); Graham Coughtry (5, -3.1163, 0.2452); William Cresswell (25, -2.0739, 0.1097); Maurice Cullen (204, -0.1570, 0.0414); Jean Dallaire (54, -0.7721, 0.0760); Rodolphe de Repentigny (8, -1.0488, 0.1930); James Duncan (2, 0.9118, 0.3831); Wyatt Eaton (5, -1.7262, 0.2431); Allan Edson (70, -2.0339, 0.0674); Marcelle Ferron (63, -2.2649, 0.0731); Lemoine Fitzgerald (63, -0.7250, 0.0712); Tom Forrestall (15, -1.6062, 0.1973); Daniel Fowler (1, -2.0596, 0.5422); Joseph Franchere (108, -2.1790, 0.0558); John A. Fraser (10, -1.6450, 0.1718); Louise Gadbois (117, -3.5359, 0.0600); Charles Gagnon (2, -0.9240, 0.3826); Clarence Gagnon (234, 0.0592, 0.0389); Pierre Gauvreau (15, -1.2929, 0.1418); Charles Gill (22, -2.8866, 0.1172); Eric Goldberg (36, -2.5217, 0.0922); Hortense Gordon (24, -2.7891, 0.1125); Richard Gorman (6, -3.1351, 0.2227); Theophile Hamel (11, -1.3427, 0.1647); Lawren P. Harris (5, -2.3675, 0.2421); Lawren S. Harris (364, 0.8866, 0.0329); Robert Harris (127, -1.7755, 0.0512); Prudence Heward (40, -2.0050, 0.0869); Randolph Hewton (123, -1.7887, 0.0590); William G.R. Hind (2, 0.0984, 0.3827); Tom Hodgson (11, -3.1535, 0.1664); Edwin Holgate (104, -0.2250, 0.0552); William R. Hope (4, -3.4231, 0.2705); Yvonne McKague Housser (86, -2.1649, 0.0613); Jack Humphrey (38, -1.7479, 0.0936); Charles Huot (44, -1.9976, 0.0843); Jacques Hurtubise (7, -2.1691, 0.2056); Gershon Iskowitz (17, -2.1881, 0.1335); A.Y. Jackson (1246, 0, 0); Otto Jacobi (102, -1.8244, 0.0565); C.W. Jeffreys (12, -1.5110, 0.1574); Jean-Paul Jerome (28, -3.4884, 0.1048); Frank Johnston (701, -0.8889, 0.0273); Paul Kane (7, 0.1248, 0.2053); Roy Kiyooka (1, -3.8628, 0.5407); Dorothy Knowles (43, -2.0714, 0.0861); Cornelius Krieghoff (472, 1.0400, 0.0311); Ludger Larose (24, -2.5270, 0.1129); Fernand Leduc (4, -1.1838, 0.2705); Ozias Leduc (41, -0.6804, 0.0866); Joseph Legare (8, -1.2237, 0.1919); Jean-Paul Lemieux (142, 0.1061, 0.0491); Ernst Lindner (8, -1.4078, 0.1924); Arthur Lismer (429, -0.3445, 0.0307); Kenneth Locchead (8, -1.9923, 0.1927); Alexandra Luke (2, -1.9796, 0.3824); John Lyman (77, -1.2186, 0.0641); J.E.H. MacDonald (406, 0.0672, 0.0326); Jock MacDonald (38, -1.0214, 0.0899); Thomas Mower Martin (264, -2.3458, 0.0382); Marmaduke Matthews (21, -2.4633, 0.1199); Jean McEwen (72, -2.3342, 0.0706); Isabel McLaughlin (11, -2.5150, 0.1639); Ray Mead (7, -2.4424, 0.2066); John Meredith (14, -2.2113, 0.1462); David Milne (98, 0.7502, 0.0579); Guido Molinari (6, -1.8016, 0.2254); James Wilson Morrice (191, 0.7704, 0.0427); Edmund Morris (40,-2.3422, 0.0874); Jean-Paul Mousseau (6, -2.7993, 0.2212); Louis Muhlstock (51, -2.7717, 0.0785); Kazuo Nakamura (27, -2.2942, 0.1059); H. Ivan Neilson (4, -3.2622, 0.2706); Lilias Torrance Newton (8, -2.7501, 0.1924); Jack Nichols (2, -3.0500, 0.3823); John O'Brien (3, -1.2969, 0.3121); Lucius R. O'Brien (24, -1.3425, 0.1122); Will Ogilvie (22, -2.7436, 0.1194); Paul Peel (78, -0.1055, 0.0645); Alfred Pellan (64, -0.9243, 0.0708); Sophie Pemberton (12, -2.5541, 0.1591); Antoine Plamondon (8, -1.8052, 0.1923); Christopher Pratt (3, 0.5187, 0.3120); William Raphael (80, -1.6400, 0.0631); Gordon Rayner (2, -4.3117, 0.3854); George Reid (90, -2.3449, 0.0603); Jean-Paul Riopelle (150, 0.3102, 0.0485); Goodridge Roberts (609, -0.6468, 0.0292); Sarah Robertson (37, -1.7654, 0.0912); William Ronald (38, -2.8152, 0.0924); Jean-Baptiste Roy-Audy (1, 0.3384, 0.5398); Joseph Saint-Charles (40, -2.9836, 0.0887); Henry Sandham (50, -2.2059, 0.0786); Carl Schaefer (27, -1.0083, 0.1056); Charles H. Scott (21, -2.7520, 0.1211); Marian Scott (18, -3.4891, 0.1292); Jack Shadbolt (67, -1.5123, 0.0712); Gordon A. Smith (75, -2.4670, 0.0687); Jori Smith (69, -2.7141, 0.0686); Michael Snow (1, -3.1115, 0.5407); Francoise Sullivan (1, -3.5141, 0.5400); Philip Surrey (97, -1.4724, 0.0580); Marc-Aurele de Foy Suzor-Cote (236, -0.4487, 0.0392); Tom Thomson (95, 1.7381, 0.0578); Robert Todd (3, -1.6705, 0.3123); Fernand Toupin (43, -3.0129, 0.0897); Harold Town (41, -2.2172, 0.0897); Tony Urquhart (10, -2.5434, 0.1719); Fred Varley (121, 0.2981, 0.0519); Frederick Arthur Verner (97, -0.3233, 0.0583); Adolph Vogt (8, -1.8144, 0.1922); Horatio Walker (79, -1.1572, 0.0633); Homer Watson (248, -1.2998, 0.0389); Gordon Webber (3, -3.0030, 0.3132); W.P. Weston (93, -1.1653, 0.0620); Robert Reginald Whale (39, -2.1395, 0.0897); Joyce Wieland (1, -2.6118, 0.5401); Curtis Williamson (36, -3.0842, 0.0920); Walter Yarwood (7, -2.4214, 0.2056)

5. REFERENCES

References

[1] Arnason, H.H. 1986. *History of Modern Art (3rd ed.).* Englewood Cliffs, NJ; Prentice-Hall Inc.

[2] Banz, R. 1981. The relation between return and market value of common stocks. *Journal of Financial Economics* 9:3-18.

[3] Baumol, W.J. 1986. Unnatural value: Or art investment as floating crap game. *American Economic Review* (Papers and Proceedings) 76:10-14.

[4] Black, F., M. Jensen, and M. Scholes. 1972. The capital asset pricing model: some empirical tests. In Jensen, M. (ed), *Studies in the theory of Capital Markets*, New York, Praeger.

[5] Bollerslev, T. 1987. A conditional heteroskedastic time series model for speculative prices and rates of returns. *Review of Economic and Statistics,* 69: 542-547.

[6] Bollerslev, T., Engle, R., and Wooldridge, J. 1988. A capital asset pricing model with time-varying covariances. *Journal of Political Economy* 96:116-131.

[7] Bryan, M. 1985. Beauty and the Bulls: The Investment Characteristics of Paintings, *Economic Review of the Federal Reserve Bank of Cleveland*, Q1, 2-10.

[8] Bickel, P. 1982. On adaptive estimation. *Annals of Statistics* 10:647-671.

[9] Campbell, J., W. Lo, and A. C. MacKinlay. 1997. *The Econometrics of Financial Markets*. Princeton: Princeton University Press.

[10] Campbell, H. 1973-75. *Canadian Art Auction Record, vol. 3-6, 1971-1974.* Montreal, Bernard Amtmann, Inc.

[11] Campbell, H. (ed.). 1980. *Canadian Art Auctions, Sales and Prices, 1976-1978.* Don Mills, Ont. General Publishing Co.

[12] Chanel, O., Gérad-Varet, L.A., and Ginsburgh, V. 1996. The relevance of hedonic price indexes: The case of paintings. *Journal of Cultural Economics* 20:1-24.

[13] Czujack, C. 1997. Picasso paintings at auction, 1963-1994. *Journal of Cultural Economics 21:229-247.*

[14] Engle, R., 1982, Autoregressive conditional heteroskedasticity with estimates of the variance of UK inflation, *Econometrica,* 50, 987-1008.

[15] Engle, R., and K. Kroner, 1995, Multivariate simultaneous generalized ARCH, *Econometric Theory* 11, 122-150.

[16] Fama, E., and K. French. 1992. The cross-section of expected returns. *Journal of Finance* 47:427-465.

[17] Fama, E., and K. French. 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33:3-56.

[18] Fama, E., and J. MacBeth. 1973. Risk, return, and equilibrium: empirical tests. *Journal of Political Economy* 71:607-636.

[19] Flôres, R., Ginsburgh, V., and Jeanfils, P. 1999. Long- and short-term portfolio choices of paintings. *Journal of Cultural Economics* 23:193-210.

[20] Galenson, D.W. 2000. The careers of modern artists: Evidence from auctions of contemporary art. *Journal of Cultural Economics* 24:87-112.

[21] Gibbons, M., and S. Ross, and J. Shanken. 1989. A test of the efficiency of a given portfolio. *Econometrica*. 57: 1121-1152.

[22] Goetzman, W. N. 1993. Accounting for taste: Art and the financial markets over three centuries. *American Economic Review*. 83: 1370-1376.

[23] Grampp, W.D. 1989. *Pricing the Priceless.* Basic Books.

[24] Gyourko, J., and E. Nelling. 1996. Systematic Risk and Diversification in the Equity REIT Market," *AREUEA Journal*, 24, 493-515.

[25] Hodgson, D.J. 1998. Adaptive estimation of cointegrating regressions with ARMA errors. *Journal of Econometrics* 85:231-267.

[26] Hodgson, D.J. 1999. Adaptive estimation of cointegrated models: Simulation evidence and an application to the forward exchange market. *Journal of Applied Econometrics* 14:627-650.

[27] Hsieh, D.A. and Manski, C.F. 1987. Monte Carlo evidence on adaptive maximum likelihood estimation of a regression. *Annals of Statistics* 15:541-551.

[28] Jarque, C.M. and Bera, A.K. 1980. Efficient tests for normality, homoskedasticity, and serial independence of regression residuals. *Economics Letters 6:255-259.*

[29] Lintner, J. 1965. The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics* 47: 13-37.

[30] Locatelli-Biey, M. and Zanola, R. 2002. The sculpture market: An adjacent year regression index. *Journal of Cultural Economics* 26:65-78.

[31] Mei, M. and M. Moses. 2002. Art as an investment and the underperformance of masterpieces. *American Economic Review* 92:1656-1668.

[32] Newey, W. and K. West. 1987. A simple positive semi-definite heteroscedasticity and autocorrelation consistent covariance matrix. *Econometrica.* 55: 703-708.

[33] Pesando, J.E. 1993. Art as an investment: The market for modern prints. *American Economic Review* 83:1075-1089.

[34] Pesando, J.E. and Shum, P.M. 1999. The returns to Picasso's prints and to traditional financial assets, 1977 to 1996. *Journal of Cultural Economics* 23:183-192.

[35] Reid, D. 1973. *A Concise History of Canadian Painting.* Toronto; Oxford University Press.

[36] Reitlinger, G. 1961. *The Economics of Taste.* London; Barrie and Rockcliff.

[37] Sharpe, W. 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance* 19:425-442.

[38] Silverman, B. 1986. *Density Estimation for Statistics and Data Analysis.* London; Chapman and Hill.

[39] Sotheby's. 1975. *Canadian Art at Auction, 1968-1975.* Toronto; Sotheby's & Co. (Canada) Ltd.

[40] Sotheby's. 1980. *Canadian Art at Auction, 1975-1980.* Toronto; Sotheby's Parke Bernet (Canada) Inc.

[41] Stein, J.P. 1977. The monetary appreciation of paintings. *Journal of Political Economy* 85:1021-1035.

[42] Valsan, C. 2002. Canadian versus American art: What pays off and why. *Journal of Cultural Economics* 26: 203-216.

[43] Westbridge, A.R. 1981-2002. *Canadian Art Sales Index, 1977-2001.* Vancouver, Westbridge Publications, Ltd.

Table 1 – Time period dummies and estimated returns (semi-annual)

Time period	Number Of Obs.	Log-price dummy	Std. error	Estimated return (%)	Std error	Time period	Number Of Obs.	Log-price dummy	Std error	Estimated return (%)	Std error
68:2	39	7.21	.092			85:1	208	8.74	.047	8.08	6.54
69:1	61	7.57	.075	43.19	15.97	85:2	223	8.83	.046	9.31	5.73
69:2	57	7.81	.077	27.78	12.76	86:1	252	8.71	.044	-11.31	4.42
70:1	130	7.29	.055	-40.38	5.15	86:2	342	9.08	.042	46.29	6.63
70:2	68	7.22	.071	-7.47	7.52	87:1	337	8.95	.041	-13.12	3.64
71:1	168	7.28	.054	6.46	8.55	87:2	303	9.17	.043	24.48	5.34
71:2	120	7.44	.061	17.59	7.63	88:1	420	9.22	.041	5.99	4.48
72:1	170	7.48	.053	4.37	6.80	88:2	336	9.28	.041	6.15	4.36
72:2	155	7.45	.056	-2.90	5.85	89:1	356	9.26	.041	-2.40	4.03
73:1	134	7.63	.058	19.08	7.61	89:2	324	9.31	.042	5.15	4.42
73:2	132	7.63	.057	-0.10	6.65	90:1	325	9.24	.042	-6.51	4.00
74:1	145	7.89	.055	30.21	8.52	90:2	294	9.16	.043	-8.14	4.02
74:2	132	7.95	.057	5.65	6.94	91:1	187	9.04	.049	-10.62	4.60
75:1	58	7.99	.076	4.44	9.07	91:2	220	9.03	.047	-1.35	5.40
75:2	47	7.96	.084	-2.91	10.36	92:1	218	8.99	.048	-3.71	5.17
76:1	138	7.80	.057	-14.89	7.97	92:2	218	9.07	.047	8.65	5.80
76:2	92	8.09	.065	34.29	9.89	93:1	179	8.94	.050	-12.35	4.82
77:1	114	8.03	.059	-6.10	7.18	93:2	177	8.95	.050	0.14	5.77
77:2	91	8.17	.064	15.21	8.80	94:1	183	9.20	.050	28.97	7.39
78:1	137	8.24	.055	7.24	7.88	94:2	229	9.10	.046	-9.26	4.91
78:2	126	8.45	.056	22.37	8.21	95:1	235	8.91	.046	-17.36	4.17
79:1	120	8.61	.057	18.35	8.20	95:2	217	8.99	.048	7.92	5.59
79:2	123	8.68	.057	7.31	7.52	96:1	233	8.96	.047	-3.07	4.98
80:1	131	9.04	.055	42.71	9.75	96:2	236	9.01	.046	5.09	5.34
80:2	195	9.04	.048	-0.10	6.12	97:1	221	9.05	.047	4.59	5.37
81:1	225	9.23	.046	20.50	6.39	97:2	275	9.10	.044	4.94	5.23
81:2	205	9.09	.048	-12.52	4.61	98:1	254	9.06	.045	-3.95	4.58
82:1	189	8.74	.049	-29.47	3.87	98:2	335	9.08	.042	2.15	4.68
82:2	116	8.46	.058	-24.49	4.85	99:1	225	9.07	.047	-1.26	4.67
83:1	124	8.45	.057	-1.15	6.95	99:2	278	9.19	.045	13.03	5.51
83:2	121	8.67	.057	24.26	8.62	00:1	251	9.27	.046	8.10	5.11
84:1	115	8.53	.058	-13.06	6.13	00:2	298	9.33	.043	6.65	4.97
84:2	131	8.66	.055	14.22	7.91	01:1	322	9.27	.043	-6.16	4.11

Table 2– Time period dummies and estimated returns (annual)

Time period	Number Of Obs.	Log-price dummy	Std. error	Estimated return (%)	Std error	Time period	Number Of Obs.	Log-price dummy	Std error	Estimated return (%)	Std error
68-69	100	7.43	.062			84-85	339	8.71	.041	11.61	5.19
69-70	187	7.47	.048	3.65	7.06	85-86	475	8.77	.038	5.84	4.16
70-71	236	7.27	.047	-17.68	4.57	86-87	679	9.02	.036	24.43	4.23
71-72	290	7.48	.046	22.65	5.91	87-88	723	9.21	.036	20.30	3.63
72-73	289	7.55	.047	7.14	4.88	88-89	692	9.28	.036	7.54	3.21
73-74	277	7.78	.046	26.16	5.85	89-90	649	9.28	.036	0.43	3.02
74-75	190	7.97	.049	20.97	6.33	90-91	481	9.12	.038	-14.79	2.82
75-76	185	7.85	.051	-11.09	5.06	91-92	438	9.02	.040	-9.68	3.43
76-77	206	8.07	.049	24.02	6.92	92-93	397	9.02	.040	0.13	3.86
77-78	228	8.22	.047	16.82	6.20	93-94	360	9.08	.041	5.92	4.25
78-79	246	8.53	.045	35.92	6.95	94-95	464	9.02	.039	-6.22	3.64
79-80	254	8.87	.044	40.44	6.93	95-96	450	8.98	.040	-3.44	3.60
80-81	420	9.14	.039	31.18	5.72	96-97	457	9.04	.039	5.83	3.93
81-82	394	8.93	.040	-18.97	3.14	97-98	529	9.09	.038	5.18	3.72
82-83	240	8.46	.045	-37.59	2.82	98-99	560	9.08	.038	-0.34	3.35
83-84	236	8.61	.046	15.67	5.82	99-00	530	9.24	.039	16.64	3.91
						00-01	620	9.31	.037	7.28	3.50

Table 3 – Dummy estimates for top 25 painters

Rank	**Artist**	**No. obs.**	**Dummy estimate**	**Std. Err.**	**% change rel. A.Y. Jackson**	**Std. Err.**
1	Tom Thomson	95	1.7381	.0578	468.68	32.90
2	William Berczy	2	1.2258	.3817	240.69	130.04
3	Frank Carmichael	68	1.1390	.0676	212.35	21.13
4	Cornelius Krieghoff	472	1.0400	.0311	182.92	8.81
5	James Duncan	2	0.9118	.3831	148.87	95.35
6	Lawren S. Harris	364	0.8866	.0329	142.68	7.99
7	J.W. Morrice	191	0.7704	.0427	116.07	9.23
8	David Milne	98	0.7502	.0579	111.74	12.26
9	Emily Carr	182	0.7177	.0489	104.98	10.01
10	Paul-Emile Borduas	56	0.6804	.0748	97.47	14.77
11	Christopher Pratt	3	0.5187	.3120	67.99	52.42
12	J.-B. Roy-Audy	1	0.3384	.5398	40.26	75.71
13	J.-P. Riopelle	150	0.3102	.0485	36.37	6.62
14	Fred Varley	121	0.2981	.0519	34.74	7.00
15	Paul Kane	7	0.1248	.2053	13.29	23.26
16	J.-P. Lemieux	142	0.1061	.0491	11.19	5.46
17	W.G.R. Hind	2	0.0984	.3827	10.34	42.22
18	A.J. Casson	579	0.0700	.0290	7.25	3.11
19	J.E.H. Macdonald	406	0.0672	.0326	6.95	3.49
20	Clarence Gagnon	234	0.0592	.0389	6.10	4.13
21	A.Y. Jackson	1246	-	-	0	0
22	Alex Colville	5	-0.0304	.2436	-2.99	23.63
23	Paul Peel	78	-0.1055	.0645	-10.01	5.80
24	Maurice Cullen	204	-0.1570	.0414	-14.53	3.54
25	Edwin Holgate	104	-0.2250	.0552	-20.15	4.41

Table 4 – Dummy estimates, medium/support

Medium/support	Dummy estimate	Std err	% change rel. Oil/canvas	Std err
Oil/canvas	-	-	0	0
Oil (support unspecified)	-0.3609	.0379	-30.29	2.64
Oil/panel	-0.2824	.0177	-24.60	1.33
Oil/board	-0.3552	.0159	-29.90	1.11
Oil/canvas on board	-0.3205	.0422	-27.42	3.07
Oil/canvasboard	-0.4075	.0348	-33.47	2.31
Oil/paper	-0.4458	.0435	-35.97	2.78
Oil/masonite	-0.2811	.0364	-24.51	2.75
Acrylic/canvas	-0.5221	.0846	-40.67	5.02

Table 5 – Dummy estimates, auction house

House	Dummy estimate	Std err	% change rel. Sotheby's	Std err
Sotheby's	-	-	0	0
Waddington's	-0.2975	.0199	-25.73	1.48
Ritchie's	-0.5831	.0247	-44.18	1.38
Fraser Bros.	-0.2172	.0282	-19.52	2.27
Phillips Ward-Price	-0.5124	.0510	-40.09	3.06
Maynard's	-0.2244	.0337	-20.10	2.69
Christie's	0.3505	.0448	41.97	6.37
Lund's	-0.6341	.0477	-46.96	2.53
Pinney's	-0.1929	.0299	-17.54	2.47
Empire	-0.3012	.0283	-26.01	2.09
Joyner's	0.0053	.0162	0.53	1.63
Hodgins	-0.2488	.0501	-22.02	3.91
Maison des Encans	-0.3624	.0246	-30.40	1.71
Levis	-0.1736	.0512	-15.94	4.31
Heffel	0.2156	.0345	24.06	4.28
Jacoby	-0.1128	.0503	-10.66	4.50

Table 6 – Parameter estimates, size

Variable	Estimate	Std. Err.
Height	0.0218	0.0005
Width	-0.0063	0.0003
Surface Area	<0.0001	<0.0001

Table 7
Summary Statistics

Panel A: Semi-Annual Data

	Mean	Std Dev	Min	Max	Correlations Art	Market	Risk-free
Art Index (***R_t***)	0.045	0.150	-0.295	0.463	1	0.13	-0.24
Market (***$R_{M,t}$***)	0.069	0.134	-0.273	0.462		1	-0.22
Risk-Free (***$R_{f,t}$***)	0.040	0.170	0.016	0.089			1

Panel B: Annual Data

	Mean	Std Dev	Min	Max	Art	Market	Risk-free
Art Index (***R_t***)	0.085	0.173	-0.376	0.404	1	0.44	-0.33
Market (***$R_{M,t}$***)	0.156	0.237	-0.394	0.849		1	-0.01
Risk-Free (***$R_{f,t}$***)	0.086	0.030	0.045	0.165			1

This table gives summary statistics on variables Art Index Returns, Market Returns, and Risk-Free rates for semi-annual and annual horizons over the period June 1970 through December 2000. Art Index returns are measured from the hedonic regressions. Market Returns are the return of the value-weighted composite from the MSCI Canadian equity index including dividends. Risk-free rates are yield-to-maturities of bond with either six-month for Panel A or one-year horizons for Panel B, and are obtained from the Bank of Canada.

Table 8
CAPM Estimations (p-values in parentheses)

Panel A: Unconditional CAPM

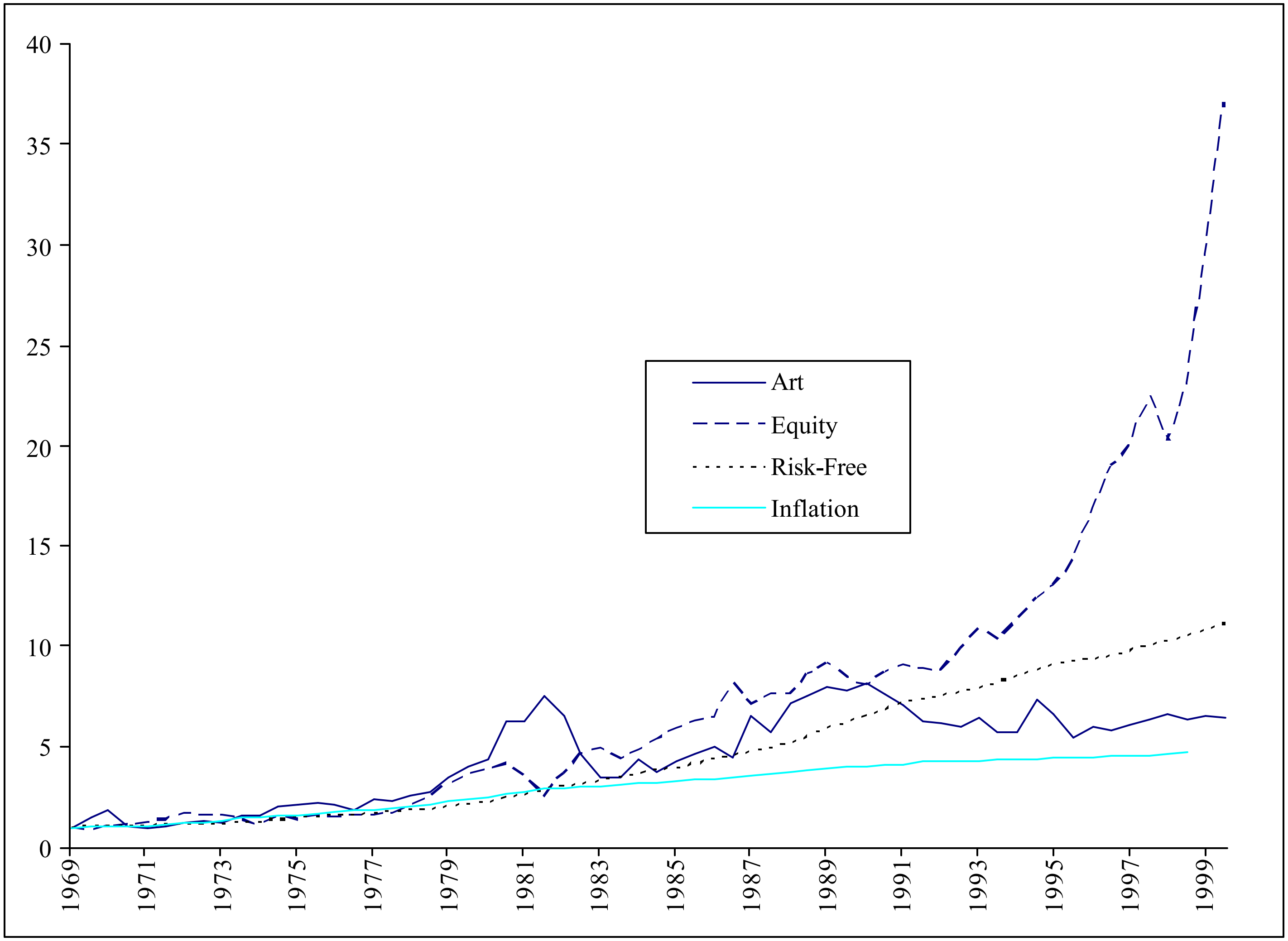
		a	ß	R^2	*J-B*	*GRS*
Semi-Annual	Est	-0.002	0.206	0.034	1.254	.560
	SE	0.022	0.167		(0.53)	(0.46)
Annual	Est	-0.027	0.359	0.188	1.624	.007
	SE	0.042	0.150		(0.44)	(0.93)

Panel B: Conditional CAPM

		a	*f*	c_1	c_2	c_3	a_1	a_2	a_3
Semi-Annual	Est	-0.003	0.032	0.154	0.026	0.134	-0.045	0.050	0.001
	SE	0.020	0.018	0.014	0.018	0.012	0.050	0.052	0.057

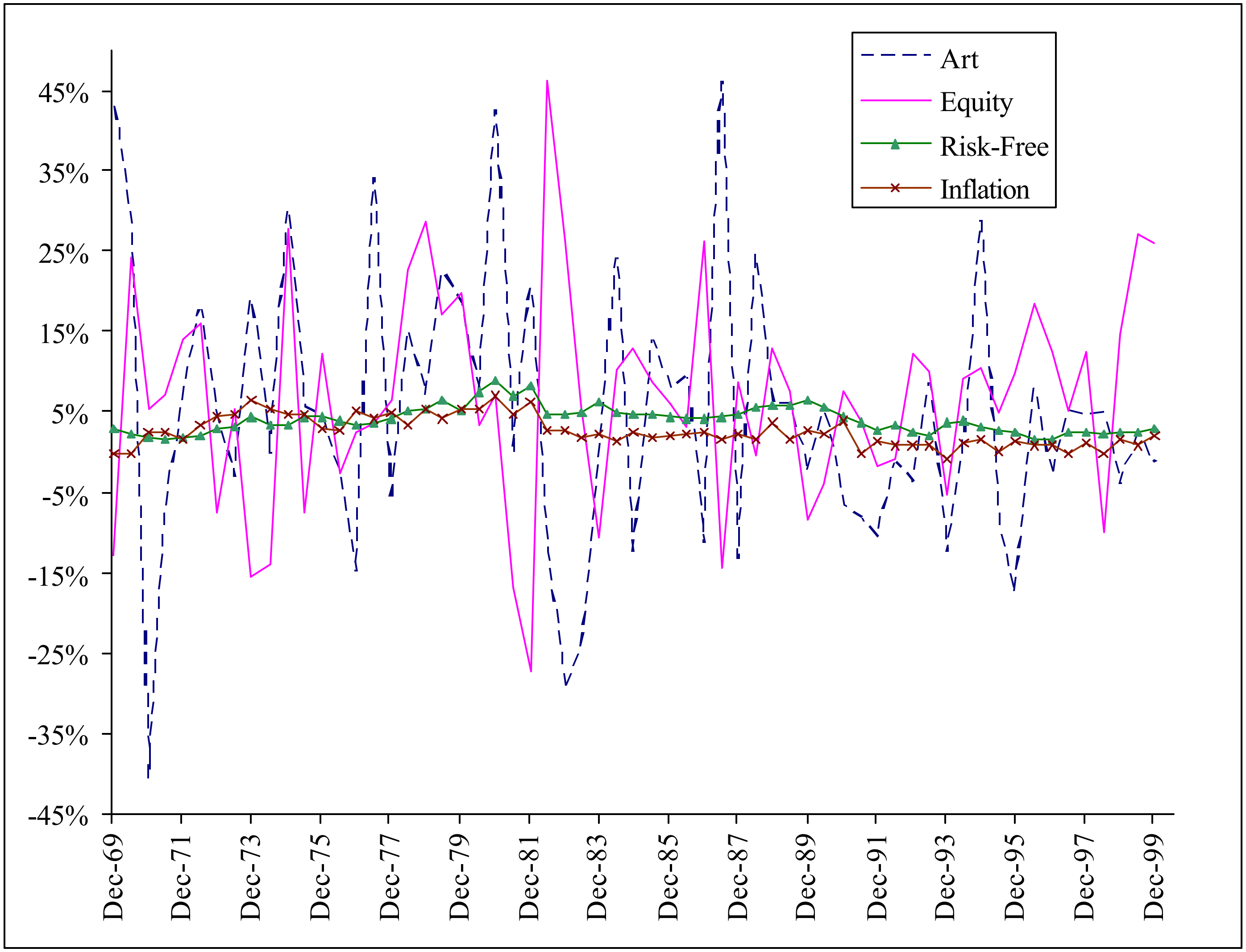
This table includes estimated coefficients (Est) and standard errors (SE) of coefficients from estimation of two different CAPMs using both semi-annual and annual Canadian art index returns. In Panel A, an unconditional CAPM is estimated using the following model: $r_t = a + ßr_{m,t} + u_t$, where r_t is the excess return on the art index and $r_{m,t}$ is the excess return on the MSCI Canadian equity index return. Standard errors in this panel are computed using Newey and West (1987) correction for the presence of heteroscedasticity and serial correlation. In this panel we also report the R^2, Jarque-Bera (*J-B*) normality test on the residual of the regression, and the Gibbons, Ross, and Shanken (1989) market efficiency test statistic (*p*-value below in parenthesis). In Panel B, we report the estimated coefficients and standard errors of the following conditional CAPM on the semi-annual data: $r_t = a + \frac{j}{H_{22,t}} H_{1,t} + u_t$ with the following conditional variance parameterization: $H_t = C^T C + A^T u_{t-1} u_{t-1}^T A$. Standard errors in this panel are computed by taking the inverse of the Hessian.

Figure 1



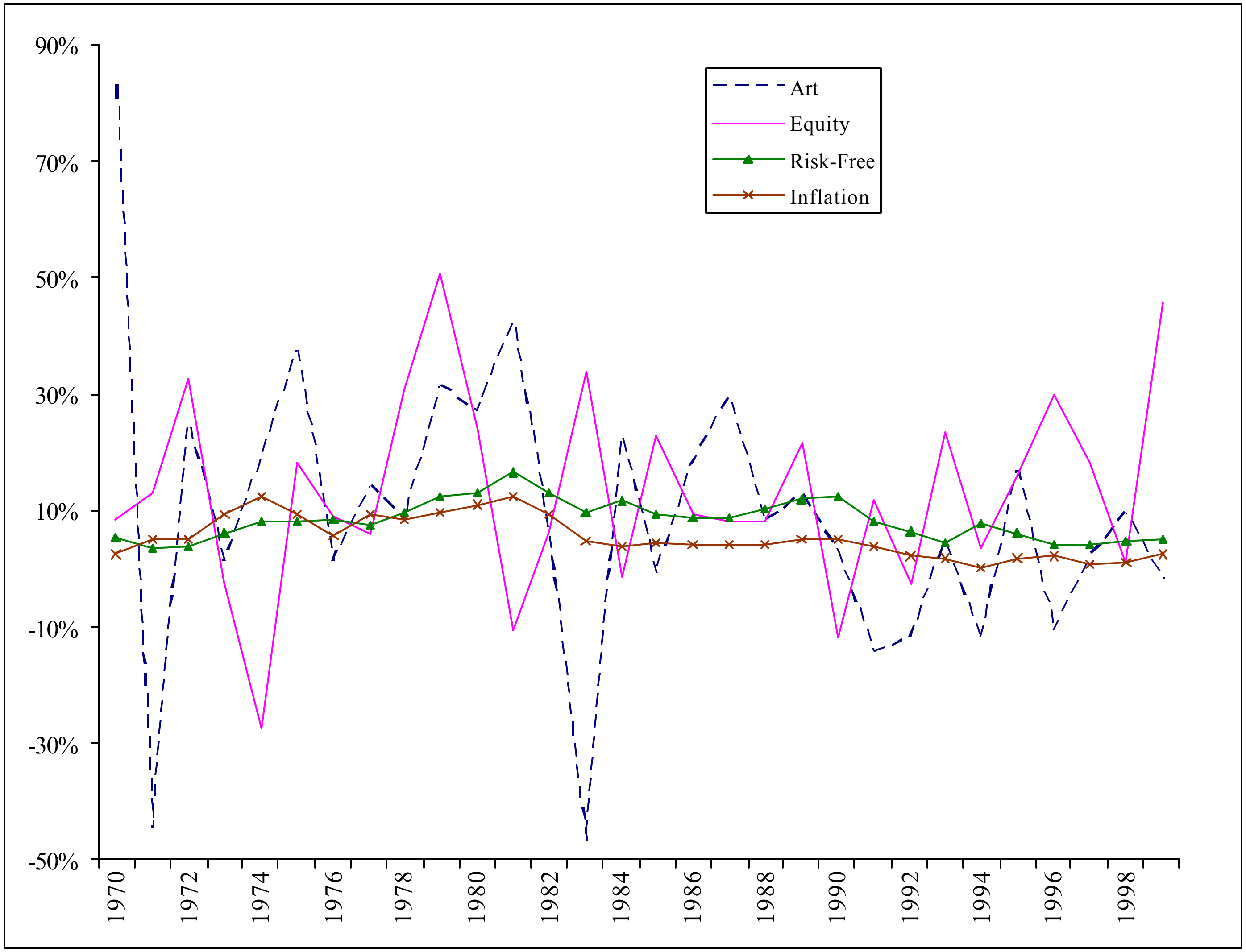
The above graph plots a time series of Canadian art prices, equities, and risk-free returns from the period July 1969 through December 2000. The first three series plots the current value invested in the respective asset with the initial investment being one Canadian dollar. The inflation line corresponds to the index level with the base month January 1969 (level = 1)

Figure 2



The above graph plots a time series of semi-annual Canadian art price index returns, equity returns, risk-free returns, and inflation rates from the period July 1969 through June 2000.

Figure 3



The above graph plots a time series of annual Canadian art price index returns, equity returns, risk-free returns, and inflation rates from the period January 1970 through December 1999.