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The Estimation of Quality-adjusted Rates of Return in Stamp Auctions

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ABSTRACT

The stamp auction market exemplifies markets in which a dominant feature is the quality variation in the traded assets. The observed price changes are a mixture of the "true" price change and the quality variation. This paper applies the time series signal extraction method to obtain estimates of quality-adjusted rates of return and quality-adjusted price indexes for stamp auction price series. The method is applicable to other areas in which there is quality variation or in which values are observed with error. Some features of stamps as an investment are also examined.

EMPIRICAL RESEARCH IN FINANCE during the last 20 years has greatly increased our understanding of risk and returns for members of the important class of capital assets that are regularly and frequently traded on organized exchanges. This class includes assets such as stocks, bonds, bills, commodity futures, and currencies. However, for assets not so traded, such as urban and agricultural land, houses, paintings, and other consumer durables, our knowledge is comparatively meager.

In part, this difference in knowledge is due to the amount of data that are available. Price and quantity data that are available for infrequently traded assets are not easily analyzed by standard or well-known techniques, because repeated observations of prices over time are not generally available for the *same* asset (or a perfect substitute for it). The best that can usually be done is to construct a series from any "similar" items that happen to come to market during the period. The price changes that are observed will be a "mixture" of the "true" price change and the effect of quality variation.

The purpose of this paper is to estimate "quality-adjusted" rates of return in the stamp auction market in which quality variation among the items offered for sale is a dominant feature. The need to quality-adjust return data is particularly important for nonfinancial assets. However, it is also of use in financial return series which may be observed with error. For example, Weinstein [27], who examined returns on newly issued corporate bonds, was forced to use returns on portfolios of bonds with the same ratings because new bond issues are not available each period from a given corporation. The changing membership of the

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portfolios will induce quality variation in the return series if there is quality variation among bonds of the same rating. He found that the variance of abnormal returns per month was higher in the issue month relative to the subsequent 6-month period. Also, the sample autocorrelations of the observed series of returns were consistent with a first-order moving-average process. These could be plausibly interpreted as arising from a random walk new issue pricing process imbedded in quality variation noise. However, a direct quantitative comparison of his results with the present study is not possible because of the special manner by which he constructed the new issue return series.

The effect of quality variation has often been either ignored or treated deterministically in the methods that have been used to construct price indexes. The "hedonic" multiple regression approach has been used, for example, by Griliches [10] for automobiles and by Berry and Bednarz [2] for houses, to avoid the difficulty of selecting items of the same quality each period. However, the determination of the relevant attributes of the commodity to use in the regressions is an empirical matter. When the attributes are numerous or are difficult to measure (as they are for collectibles) the "hedonic" method may not be useful.

Bailey et al. [1] avoided the difficulties of quality variation by basing their index on sales prices of the same properties at different times. However, in a market with infrequent resales of the same item, the number of such pairs of transactions would be inadequate for their regression method even over a period of several decades.[1]

Keen [16] and Stein [22] have constructed price indexes for the fine painting auction market. Unlike most stamps, the paintings that are brought to auction are unique. If the auctioned paintings are considered to be a random sample from the population of the artist's paintings, then the observed series of price changes includes a stochastic change in quality. However, Keen and Stein treated the quality variation as deterministic. Keen grouped the paintings of an artist by size, period, etc. and assumed that the relative value of one group of paintings compared to another group remained constant over time. Stein treated the auctioned paintings as a random sample from a single hypothetical population of auctionable paintings.

The method that is used in this paper to estimate quality-adjusted returns is adapted from signal extraction theory (see, e.g., Wiener [29], Cleveland [5], Cleveland and Tiao [6]). The rate of return models which best fit the stamp auction data can be interpreted as an underlying random walk log-price process embedded in a stochastic noise process which represents the quality variation among items of the same type. This special model can be applied whenever the market in which trading takes place can reasonably be regarded as "efficient" in the sense that the prices in the true (but unobservable) component can be presumed to incorporate all publicly available information.

Section I describes the stamp auction data that are used in this study. The methods of Box and Jenkins [3] are used in Section II to estimate time series models for the observed auction price series. The parameter estimates are then

[1] For further examples see the papers in Griliches [11]. Most of the work in these studies is empirical and uses list or catalog prices rather than actual transaction prices.

used in Section III to obtain a quality-adjusted auction rate of return series. In Section IV, the derived series of quality-adjusted rates of return are used to estimate a quality-adjusted price index for the stamp series. Section V uses the observed and quality-adjusted auction return series to address some questions regarding stamps as an investment.

I. The Stamp Auction Data

The data used in this paper are the actual transaction prices realized in auctions at the Robert A. Siegel Auction Galleries, Inc. [21], of New York, for the period January 1963 to June 1977. The 5¢ 1847 used, 10¢ 1847 used, 90¢ 1869 used, $3 1893 unused, and $4 1893 unused United States stamp issues (types) were selected for study because they were the most regularly auctioned types of stamps during the period of the sample.[2] There were 84 auctions in which all five types were sold.

Several lots of the same type may be offered at an auction. Since the closing lot price might be influenced by the prices realized on previous lots of the same type in a way that is not a factor in the opening lot price, the opening lot price for each type was used for the price series.[3]

The same items are not resold at each auction. It is assumed that the items offered at auction are a random sample from the population of all auctionable items of the type and that this population remains constant over time. The groupings of lots by type provides observable proxies over time for the unobservable resale prices for an initial portfolio of items.[4]

II. The Estimated Time Series Models

Box-Jenkins analysis was used to identify ARIMA models for the observed auction price series. The diagnostics support the hypothesis that the observed log-price data follow a first-order integrated moving-average, IMA(1, 1), model which can be written as

$$R_t^o \equiv (1 - B)\ln P_t^o = \mu + (1 - \theta B)c_t \tag{1}$$

where the c_t are i.i.d. with zero mean and variance σ_c^2.[5]

The parameter estimates for the 84 auctions are shown in Table I. All of the θ values are significantly positive.[6] The estimates of long-run log-price drift, μ, are

[2] Brookman [4] provides a detailed discussion of the nineteenth century United States postage stamps.

[3] In fact, Box-Jenkins analyses were also performed using closing price and average price with results similar to those reported in this paper.

[4] More details of the institutional features of the stamp auction market, the grading system and bidding procedures can be found in Taylor [23].

[5] Higher order ARIMA (p, d, q) models were also estimated. The diagnostics showed no gain over the IMA(1, 1) model. For more details, see Taylor [23].

[6] The variable period changes in log-prices between auctions were used, instead of the commonly used scaling of rates of return to an average length period, because the R_t^o series were found to be unrelated to the time between auctions. This is consistent with relatively large quality variance and

Table I

Estimated IMA(1,1) Model for the Observed Prices
$$(1 - B)\ln P_t^o - \mu = (1 - \theta B)c_t$$
and Standard Deviations of the Quality-adjusted Returns[a]

	θ ($\sigma(\theta)$)	μ ($\sigma(\mu)$)	σ_c	Quality-adjusted Standard Deviation
5¢ 1847 used	0.8840[b] (0.0490)[c]	0.0313 (0.0869)	0.5497	0.0638
10¢ 1847 used	0.9175[b] (0.0410)	0.0302 (0.0847)	0.6135	0.0506
90¢ 1869 used	0.9637[b] (0.0303)	0.0071 (0.0963)	0.630	0.0229
\$3 1893 unused	0.9793[b] (0.0063)	0.0246 (0.0700)	0.468	0.0097
\$4 1893 unused	0.8387[b] (0.0596)	0.0251 (0.0677)	0.5083	0.0820
Series of averages	0.9198[b] (0.0420)	0.0236 (0.0504)	0.3369	0.0270

[a] Eighty-three returns in each series. The average period between auctions is 61.39 days.
[b] Estimated value is at least 2 standard deviations from 0.
[c] Standard errors are in parentheses.

the sample means of the observed changes in log-prices. They are consistent with the observed upward drift in auction prices over the sample period. This does not mean that there must be a deterministic log-price path. The log-price series may, and in the sample did, decline as well.

III. Time Series Decomposition of the Auction Data

This model can always be interpreted as a random walk log-price process (signal) imbedded in uncorrelated quality-related noise provided that the moving-average parameter θ is positive.[7] The observed return process will be interpreted as the sum of two unobservable stochastic processes

$$R_t^o = R_t + S_t. \tag{2}$$

a very small signal/noise ratio, because quality change between auctions does not depend on the time between auctions. In a stochastic setting, the commonly used adjustment would exaggerate the signal/noise ratio in the observed series.

[7] See, for example, Box and Jenkins [3], pp. 121–24.

The first component, R_t, arises from an underlying, quality-adjusted random walk log-price signal which would be observable in the auction market if there were no quality variation among items of the same type. The second component, S_t, is a noise process attributed to the stochastic change in quality between auctions. The quality levels for the same type of stamp are assumed to be independently and identically distributed.

The observed values of the first-lag correlations between log-price changes are close to -0.5 and the θ values are close to 1. This is consistent with a variance of the underlying quality-adjusted returns which is very small compared to the variance of the quality change component (i.e., a small signal/noise ratio).

The signal extraction method is applied to the observed auction-to-auction return series to provide the minimum mean square error estimator of the unobservable R_t series

$$\hat{R}_t = \frac{1-\theta}{1+\theta} R_t^o + \frac{1-\theta}{1+\theta} \{\theta(R_{t+1}^o + R_{t-1}^o) + \theta^2(R_{t+2}^o + R_{t-2}^o) + \cdots\}. \tag{3}$$

This symmetric moving-average estimator uses the entire series of observations to obtain $\hat{R}_t$.[8] The weights in the moving-average sum to 1. If $\theta = 0$, all the weight is assigned to the current central observation. As θ increases toward 1, increasing weight is given to leading and lagging observations in the symmetric moving-average.[9]

Following the procedure established by Cleveland [5], the minimum mean square error forecasts (or backcasts) of future (or past) values are computed for use in place of the "missing observations" at each end of the observed series. For example, at the end of the series the same set of weights is used to obtain

$$\hat{R}_n = \frac{1-\theta}{1+\theta} R_n^o + \frac{1-\theta}{1+\theta} \{\theta(\hat{R}_{n+1}^o(n) + R_{n-1}^o) + \theta^2(\hat{R}_{n+2}^o(n) + R_{n-2}^o) + \cdots\} \tag{4}$$

where

$$\hat{R}_{n+1}^o(n) = \mu - \theta\hat{c}_n \tag{5}$$

and

$$\hat{R}_{n+j}^o(n) = \mu, \qquad j \geq 2. \tag{6}$$

Smoothed values for other observations near the ends of the sample can be similarly obtained.

[8] For stationary time series, the weights in the moving-average estimator of the signal and the stochastic properties of the signal extraction error, $R_t - \hat{R}_t$, were given by Kolmogorov [17], Wiener [29], and Whittle [28]. The estimator was extended to homogeneously nonstationary time series whose dth differences are stationary by Cleveland [5] and Cleveland and Tiao [6]. Given the identified component models and the history of prices, these point estimators are conditional expectations in the probability sense of being unbiased ex post estimates of the signals that have previously occurred in the auctions. These symmetric moving-averages are not expectations in the economic sense of being forecasts of future signals.

[9] See, for example, Cleveland [5].

A. Time Series Parameter Estimates

The estimated parameter values from Table I, substituted in Equations (3) through (6), provide the "quality-adjusted" rate of return series $\hat{R}_t$.[10] Because the weights in Equation (3) sum to unity, the observed sample mean returns in Table I are estimates of the corresponding quality-adjusted mean returns. The quality-adjusted return standard deviations which are estimated as $(1 - \theta)\sigma_c$ show that almost all of the observed variance has been attributed to the quality change between the auctions.

The $\hat{R}_t$ series for the five types are similar but not identical. The peaks and troughs do not always occur in the same auction. All of the estimated quality-adjusted returns in the 10¢ 1847 and $3 1893 series are positive. The θ value for the $4 1893 series is the smallest of the five and the resulting $\hat{R}_t$ series is not as smooth as the other series. The $4 1893 quality-adjusted return series has the greatest number (14) of negative returns and the largest variance. This reflects a few unusually large price declines in the $4 1893 auction price series which, when smoothed by the moving-average, resulted in a quality-adjusted decline.

In keeping with the univariate treatment of the price series, the five individual observed stamp returns for each holding period were averaged and the results for this series of averages are shown in Table I.[11] The estimated standard deviation of the series of quality-adjusted average returns is 0.027, while the standard deviation of the observed series of averages is 0.46.

The characteristic "over adjustment" of the moving-average filter is reflected in the j-lag autocorrelations, θ^j, of the $\hat{R}_t$ series.[12] This means that, even though the hypothesized quality-adjusted returns are uncorrelated, the point estimates of these returns are autocorrelated. For the five stamp series, the first-lag autocorrelations in the $\hat{R}_t$ series range from 0.84 to 0.98.

The mean square error of the estimator of R_t is given by

$$E(R_t - \hat{R}_t)^2 = 2\sigma_c^2 \frac{\theta(1 - \theta)^2}{1 + \theta}. \tag{7}$$

The root mean square errors of the estimates are found from the square root of this formula to be, respectively, 0.062, 0.05, 0.023, 0.01, and 0.078.

B. Cross-Sectional Variances

These time series results which imply that most of the auction-to-auction price variation is due to the auction-to-auction changes in the quality of the lots sold can be corroborated by an examination of the price variability among lots of the

[10] The average rate of return after the transaction fee can be computed by subtracting 0.223 for annual trading. Additional expenses include insurance, taxes, and mailing charges, but these are comparatively minor costs.

[11] The stamp series have been treated as univariate series. A more complete (but not necessarily more informative) analysis would include their treatment as (possibly) cross-correlated multiple series. Then, multiple time series decomposition and estimation methods developed by Hannan [12] and Hillmer [14] could be applied.

[12] See Cleveland [5], for example.

Table II

Time Series and Cross-Section Estimates of Log-Quality Standard Deviations

	Time Series Estimate		Cross-Section Estimate			
	$\hat{\sigma}_q$[a]	$\hat{v}_{ts}$	$\hat{\sigma}_{cs}$	$\hat{v}_{cs}$	Lots	Auction
5¢ 1847 used	0.517	0.116	0.593	0.176	38	April 4, 1967
			0.580	0.151	41	January 20, 1970
10¢ 1847 used	0.588	0.109	0.777	0.153	15	April 29, 1969
			0.535	0.113	19	May 5, 1970
90¢ 1869 used	0.618	0.123	0.599	0.132	13	April 9, 1969
			0.472	0.103	20	June 12, 1973
$3 1893 unused	0.463	0.084	0.434	0.086	7	March 6, 1968
			0.402	0.078	11	October 20, 1970
$4 1893 unused	0.466	0.081	0.463	0.089	8	March 6, 1968
			0.471	0.087	11	October 20, 1970

[a] $\hat{\sigma}_q$, time series estimates of log-quality standard deviation; $\hat{v}_{ts}$, coefficient of variation (relative to average, observed log-prices). $\hat{\sigma}_{cs}$ and $\hat{v}_{cs}$ are the corresponding cross-sectional estimates for each of the listed auctions.

same type that were sold in a given auction. Under the assumption of independence of prices and of quality of lots offered for sale in a given auction, the cross-sectional variance within an auction will provide an independent estimate of the quality variation within types of stamps. However, as mentioned previously, the prices within an auction might be correlated since the auctions have open bidding. Also, in some auctions the lots reflect the quality selectivity of a single collector whose collection is being sold.

There were few auctions with an adequate cross-section from which to compute the within-type variance. Those auctions are shown in Table II. The time series log-quality standard deviation estimate $\hat{\sigma}_q = \sigma_c\sqrt{\theta}$ and coefficient of variation $\hat{\nu}_{ts}$ (relative to average, observed log-prices) for each of the stamp types are shown in the left section of Table II. The estimated log-quality standard deviations and coefficients of variation are appropriately smaller for the "unused" stamp series than for the "used" series. This is consistent with the larger variety of characteristics such as color, type, and darkness of the cancellation or minor damage that can occur in the "used" stamps and which is reflected in the larger sample variances.

The cross-sectional observed log-price standard deviations $\hat{\sigma}_{cs}$ and coefficients of variation $\hat{\nu}_{cs}$ are shown in the right section of Table II. Again, the "unused" stamps show smaller variances and coefficients of variation than the "used" series. The within-auction estimates of quality variation are about the same as those obtained from the time series analyses. This evidence supports the attribution of most of the observed auction-to-auction price variance to the variation of quality among items of the same type that are offered for sale.

IV. A Quality-adjusted Price Index

A good index should provide the average return from investment in a group of assets during some time period and should permit comparison with other assets. The index should preferably use actual transaction prices to provide parameter estimates for the return distribution confronting investors.

As discussed in the Introduction, previously developed indexes for markets characterized by quality variation have either ignored the quality variation or treated it deterministically. In this paper, the symmetric moving-average formula which was used to estimate quality-adjusted returns will be used to estimate a quality-adjusted price index for the stamp auctions.

An observed price index for the five stamp types and the 84 auctions is illustrated in Figure 1 by the solid line. The vertical index scale is obtained from

$$I_t = \begin{cases} \exp\left\{\frac{1}{n} \sum_{i=1}^{n} \sum_{j=b+1}^{t} R_{ij}^{o}\right\} & \text{if } t > b \\ 1 & \text{if } t = b \\ \exp\left\{-\frac{1}{n} \sum_{i=1}^{n} \sum_{j=t+1}^{b} R_{ij}^{o}\right\} & \text{if } t < b, \end{cases} \tag{8}$$

where R_{ij}^{o} = observed auction return for type i at auction j, and b is the base auction (chosen as $b = 1$ in Figure 1).

The final level of the observed price index at June 29, 1977, is about 7.12 times the June 25, 1963, base auction geometric mean price level. There is considerable variance, but there is also a clear positive trend in the index.

The corresponding estimated quality-adjusted price index, $\hat{IQ}_t$, is illustrated by the dotted line in Figure 1. The estimated quality-adjusted price index can be written as an explicit function of the estimated quality-adjusted rates of return by replacing each observed R_{ij}^{o} in Equation (8) by the corresponding estimated quality-adjusted rate of return $\hat{R}_{ij}$ for stamp type i. Equation (8) shows that the exponent of the index is just an arithmetic average (overall n stamp types) of an appropriate number of successive estimated quality-adjusted rates of return. Consequently, the fact that the $\hat{R}_{ij}$ values are (under general conditions on the underlying probability distributions) conditional expectations of the unobservable R_{ij} values, indicates that $\hat{IQ}_t$ can be interpreted as the conditional median of the true (but unobservable) quality-adjusted auction price index IQ_t.[13]

A comparison of the two indexes shows that the quality adjustment has resulted in a much smoother series. The large price swings are almost entirely discounted as representing quality changes rather than "true" price changes. The estimated quality-adjusted index value for June 29, 1977, is 6.14 times that of the base auction. The sequence of point estimates of the quality-adjusted price index exhibits a pattern of geometric growth in price levels during the 14 years spanned

[13] Similarly, we can obtain the variance (conditional on the observations) of the true log-index $\ln IQ_t$. This provides a confidence interval for the true values of the quality-adjusted index, IQ_t. Details can be found in Taylor [23].

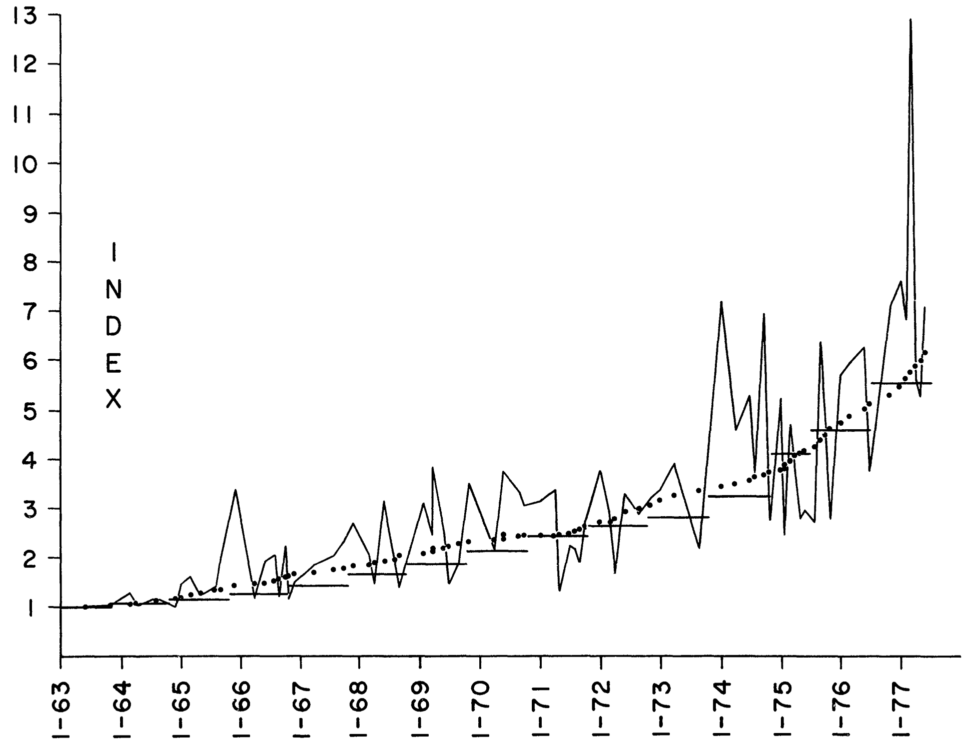

Figure 1. Observed and Quality-adjusted Auction Price Indexes and Scott Catalog Value Index Geometric mean price at June 25, 1963, auction is base = 1. ——, observed index; · · · · ·, quality-adjusted index; step function, Scott index.

by the sample. To repeat, this is a result of the small signal/noise ratio in the stamp auction data and, while consistent with a deterministic growth in price levels, is just the conditional expectation of growth.

Previous researchers have often used catalog (or list) prices to develop indexes because transaction prices were unavailable. The annually published Scott [25] catalog prices are widely used in the stamp market. They are obtained from a sample of dealers and auctioneers. They may not represent actual asking prices because dealers often offer discounts from the published prices. Furthermore, the most recent transaction prices reflected in the catalog can be 6 months old because of the publication lead time.[14] The geometric mean Scott price index for the "fine" grade of the five stamp types in our sample is represented by the step-function in Figure 1. Overall, it appears to be a lagged step-function estimate of the observed auction price index. This is consistent with the publishing lead time.

The Scott index values for "fine" stamps are very close to the quality-adjusted auction price index. As with the quality-adjusted index, the Scott index values never declined during the sample period. However, it is also true that none of

[14] See Herst [13], pp. 128–41, and Wagenheim [26], pp. 115–29, for discussions of catalog prices and the use of commercial catalogs.

the individual Scott price series declined during the sample period. In contrast, the quality-adjusted prices of the 5¢ 1847, 90¢ 1869, and $4 1893 series which were formally estimated from the actual transaction prices did show declines. The use of the commercial catalog values loses the large auction-to-auction price variation and ignores the variation in individual dealer judgments regarding the identification of a "fine" stamp.

V. Some Investment Features of Stamps

The quality-adjusted price index permits the estimation of holding period returns on stamps of the same quality as those initially purchased for the portfolio. In particular, the annual rates of return on the stamp portfolio are shown in Table III. These returns are between auctions which were held in January (or the closest auction) of each year. The quality-adjusted rates of return average 12% per annum from 1963 through 1976. The observed, unadjusted rates of return average 14.5% and have a standard deviation that is over 10 times larger than that of the quality-adjusted returns.[15]

For comparison, the annually compounded rates of return on common stocks are also provided. The average rate of return on the stocks is 8.7%. This series does not exhibit the alternating positive and negative returns that are found in the observed stamp series. Also, the stock returns have a standard deviation that is about 5 times larger than the quality-adjusted stamp standard deviation. The coefficient of variation of the stock returns is much less than that of the observed stamp returns but is considerably more than the coefficient of the quality-adjusted stamp returns.[16]

The average annual stamp portfolio return is not sufficient to compensate in annual trading for the auction commission. However, a longer holding period between the years 1963 and 1977, when prices were rising, provides a larger average return. For example, there are three observations of 4-year holding periods, beginning with the first auction. The average 4-year return for the observed series is 34.5% and the standard deviation is 32.4%. The average 4-year quality-adjusted return on the stamps is 48.44% and the standard deviation is 10.36%. The average of the after-commission quality-adjusted returns for the 4-year holding periods amounts to 6.53% per year.

A. A Capital Asset Pricing Model with Quality Variation

A capital asset pricing model with assets subject to quality variation in the portfolio relates expected quality-adjusted rates of return. It can be written as

$$E(R_t - R_{ft}) = \beta E(R_{mt} - R_{ft}) \tag{9}$$

where

$$R_t = R_t^o - S_t$$

[15] Stein [22] found an average U. S. auction return on paintings of 10.5% per year between 1946 and 1968 and a standard deviation of about 31%.

[16] These comparisons are made before the 20% commission is applied.

Table III

Annual Rates of Return

	Observed	Quality-adjusted	Common Stocks[a]
1963	0.006	0.033	0.164
1964	−0.005	0.123	0.153
1965	1.210	0.191	0.251
1966	−0.795	0.167	−0.086
1967	0.581	0.092	0.415
1968	−0.660	0.097	0.251
1969	0.917	0.136	−0.224
1970	−0.112	0.056	−0.045
1971	0.182	0.106	0.157
1972	−0.110	0.151	0.065
1973	0.762	0.079	−0.329
1974	−0.313	0.099	−0.317
1975	0.079	0.226	0.430
1976	0.293	0.147	0.337
Mean	0.145	0.122	0.087
Standard Deviation	0.571	0.053	0.254
Coefficient of Variation	3.94	0.431	2.91

[a] Fisher and Scholes, Center for Research in Security Prices, NYSE Master File; dividends reinvested; continuously compounded.

and

R_t = unobservable quality-adjusted stamp return
R_{mt} = market return
R_t^o = observed stamp portfolio return
S_t = unobservable quality change in the stamp portfolio
R_{ft} = return on an appropriate term government security
β = systematic risk in the stamp returns.

The corresponding regression equation is

$$(R_t^o - R_{ft}) = \alpha + \beta(R_{mt} - R_{ft}) + e_t \tag{10}$$

where

$$e_t = \epsilon_t + S_t$$

and the ϵ_t are i.i.d.

In the absence of a broader market index, the stamp returns will be related in Equation (10) to a New York Stock Exchange (NYSE) index. The estimated regression coefficients for Equation (10) are unbiased on the assumption that the quality variation, S_t, in the stamp auctions is independent of $R_{mt} - R_{ft}$ for the NYSE.[17] The estimated regression equation for the 14 observed annual

[17] See, for example, Theil [24]. Corrections will be made for biases in the standard errors of the estimators due to the negative autocorrelation in the e_t. Nonlinear regressions produced similar results. The standard errors of the estimates appear in parentheses below the parameters.

auction rates of return, $\bar{R}_t^o$, is

$$\bar{R}_t^o - B_t = \underset{(0.161)}{0.087} + \underset{(0.641)}{0.114} (R_{mt} - B_t) \tag{11}$$

where

R_{mt} = January-to-January NYSE returns with equal weighting, dividends reinvested and continuous compounding shown in Table III
B_t = return on 1-year Treasury Bill maturing at time t.[18]

The adjusted coefficient of determination is zero. The variation in the stamp portfolio returns is not explained by the market return. The estimates of both α and β are positive. However, they are not significantly positive. The standard error (0.641) overstates the standard error of the least squares estimate of β by about 10% because the first-lag autocorrelation of the residuals is -0.73 and the market returns are positively autocorrelated (0.12) if the sample autocorrelations are taken as estimates of the asymptotic correlations.

The returns computed from the published Scott [25] catalog prices for the five stamp types can also be used in the regression equation. Now, the estimated equation is

$$\text{Scott}_t - B_t = \underset{(0.011)}{0.07} - \underset{(0.046)}{0.044} (R_{mt} - B_t) . \tag{12}$$

Again, the coefficient of determination is zero. The estimate of α is significantly positive. The autocorrelation of the residuals is 0.07. Therefore, the standard errors of the estimates should not be understated. Most of the variability of the Scott catalog return premiums which are "quality-adjusted" in the traditional manner is unsystematic.

The results are similar to those found by Robichek et al. [18] for alternative investments such as commodity futures and farm real estate and by Stein [22] for the fine painting auctions. These results cannot be taken as evidence in support of a relationship between the stamp and NYSE returns, but neither are they strong evidence that the β for the true (but unobservable) quality-adjusted returns is zero. The result in regression Equation (11) may simply reflect the low signal/noise ratio in the observed returns rather than low correlation between the true quality-adjusted returns and the NYSE index.

For comparison with Stein's annual returns for the fine painting auctions, assume that the model in Equation (11) is correct for the stamps. If the stamps are held for 4 years, then the 20% auction commission can be spread over this longer holding period. Then, the stamp portfolio is "superior" in performance relative to return on systematic risk even if the ownership services are valued by

[18] The use of annual returns permits a direct comparison with previous results such as Stein [22]. Also, the use of auction-to-auction returns over the varying periods between auctions, while providing more observations, does not correctly deal with the substantial quality variation component which is not dependent on the time between auctions. Dimson [7], Scholes and Williams [19], and Schwert [20] have addressed the estimation problem for infrequently traded assets. However, they do not address the joint problems of concern in using auction-to-auction returns here: varying periods between auctions and quality variation.

the investor at about 0% per year. Stein's work suggests that a corresponding figure of about 5.7% per year is appropriate for the fine painting auction market.[19]

Rental rates for stamps would provide an estimate of the ownership services or "viewing pleasure" return. Unfortunately, there are no leasing companies for the stamps. Stein found that firms that leased paintings charged 8% of the "value" of the painting per year. This might be taken as an upper bound on the services return since individuals seldom lease paintings. If the estimate of $-\alpha = -0.087$ in Equation (11) is interpreted as an estimate of the annual return from ownership services, this estimate is consistent with ownership services being valued at the 95% confidence level from about −40% to 23% per year.[20] In comparison, Stein found the net services yield from fine paintings to be between −13 and 15% per year. Both confidence intervals are wide and include the 0% return which is appropriate if traders in these markets were only interested in the financial return.[21]

B. Stamps as an Inflation Hedge

Many collector-investors consider 19th century stamps to be inflation hedges. Indeed, the Consumer Price Index (CPI) only doubled from 106.60 in June 1963 to 211.50 in June 1977 while the observed auction price index increased to more than 7 times the 1963 base.

Fisher [9] hypothesized that the nominal interest rate consists of an expected real return plus the expected inflation rate and that the expected real return is not related to the expected rate of inflation. Fama and Schwert [8] tested this hypothesis through regression models relating asset returns to the expected and unexpected inflation rates. The 1-month nominal return on Treasury Bills served as a proxy for the expected inflation rate. The CPI minus the Treasury Bill return provided the observable proxy for the unexpected rate of inflation.

The corresponding regression for the 14 observed annual rates of return in the stamp auctions is

$$\begin{array}{rcccc} \bar{R}_t^o = & 0.405 \; - & 4.633B_t \; + & 0.897(C_t - B_t) \\ & (0.730) & (12.569) & (9.066) \end{array} \tag{13}$$

where

$\bar{R}_t^o$ = observed annual rate of return
B_t = return on 1-year Treasury Bill maturing at time t
$C_t = \ln(\mathrm{CPI}_t/\mathrm{CPI}_{t-1})$, the annual change in the Consumer Price Index.

[19] Stein used a 15% painting auction commission. See, for example, Jensen [15] for measures of portfolio performance.

[20] This is before insurance and illiquidity costs are added. But, these costs can be reasonably estimated to be less than 0.5% per year. The negative values in the interval for the net services return, if meaningful, may indicate the existence of ownership factors that are not captured in the asset pricing model. Such aspects of stamp ownership are discussed in Wagenheim [26].

[21] In the extreme case of annual trading when the 20% commission is incurred each year, a portfolio consisting solely of stamps is "inefficient" after the commission is deducted unless the ownership services are valued at about 20.4% per year. Because the stamps will have superior performance to a collector who values their ownership services at more than 13.6% per year, they may be desirable even in annual trading to such individuals as part of an overall efficient portfolio. There are also stamp "mutual funds" in which investors can purchase shares of a portfolio of rare stamps.

The adjusted coefficient of determination is zero and the residuals are uncorrelated. The variation in the stamp portfolio returns cannot be explained by the proxies for the components of inflation. This is consistent with the finding by Fama and Schwert [8] that the behavior over time of expected inflation has a more important effect on the time series behavior of low variance assets.[22] The large standard errors of the estimates indicate that this is not strong evidence for or against the Fisher hypothesis for the stamp portfolio.

The result for the annual Scott catalog returns is

$$\underset{}{\text{Scott}_t} = \underset{(0.044)}{0.037} + \underset{(0.762)}{1.711 B_t} + \underset{(0.550)}{0.944(C_t - B_t)}\,. \tag{14}$$

Here, the coefficient of determination is 0.43. The coefficient of B_t is significantly positive and supports the hypothesis that the stamps were a perfect hedge against the expected rate of inflation (i.e., the true coefficient of B_t is equal to 1). The coefficient of the unexpected component of inflation is almost significantly positive. This result supports the hypothesis that the Scott catalog returns were a hedge against both components of inflation during the period 1963–77. However, this does not necessarily imply that the actual transaction returns [such as those used in Equation (13)] in the auction market were also inflation hedges because the Scott catalog prices (as noted earlier) may differ from actual transaction prices. The prices in the commercial catalogs in the period 1963–77 rarely declined. Even when the auction prices for certain issues declined over several years, the catalog prices just remained constant.

VI. Conclusion

The time series analysis of the auction price data provides a model of short-term price behavior that is capable of explanation in terms of the stochastic quality variation among auction items. The signal extraction method provides minimum mean square error estimates of the unobservable components of the auction series when the estimated parameter values are the correct model values. It is an appropriate estimation method if the objective is "optimal" ex post point estimates of the unobservable quality-adjusted return series. Under general assumptions (such as multivariate normality of the underlying distribution) these estimates and their autocorrelations can be interpreted ex post as conditional expectations and autocorrelations of the unobservable rates of return on average quality items.

The estimated quality-adjusted auction price index, in contrast to earlier ones, deals explicitly with the stochastic quality variation. The estimated growth in prices was similar to that of the commercial catalog index. The use of actual transaction prices, rather than catalog values and traditional grading systems, permits the quality-adjustment to reflect the auction market's assessment of the quality of each lot as indicated by the auction bidders' pricing actions.

The auction returns on stamps appear to be unrelated to the rate of inflation.

[22] Regressions that included lagged values of expected and unexpected inflation components were also estimated with similar results.

However, because of the large standard errors of the estimates, we cannot reject the hypothesis that the stamps were perfect hedges. The result for the Scott catalog returns is clearer support for the Fisher hypothesis. However, the catalog values may not be transaction prices.

Most of the risk in the stamp portfolio was found to be unsystematic relative to the NYSE index. However, the large standard error of the coefficient in the observed return regression does not allow us to reject the hypothesis that the true β value is unity. The stamps may be an attractive investment for an individual who highly values the ownership services they can provide. But, in auction-to-auction or annual trading, the after-commission returns on the stamps make them an inferior investment to an individual who is primarily concerned with short-term financial gain. Longer holding periods of 4 or more years might provide a different conclusion. Spreading the auction commission fee over these longer holding periods resulted in superior performance in the annual regressions even for investors who placed little or no value on ownership services. A cautionary observation can be made, however, that the upward movement in stamp prices that persisted for several decades, and which attracted investors and speculators to the auction market, need not continue. In fact, the market did decline after the period considered in the sample.

The requirement for adequate length time series that entailed the choice of the five sample series might have created a subtle selection bias if the fact that the selected stamps were traded more frequently was related to investment performance. However, the different frequencies of trading at auction could be a reflection of differing existing supplies of stamp issues regardless of differences in investment performance. Further study may shed light on this question. Future studies may also expand the sample in both time and cross-section and include sales data from other auction houses as well. Consideration should also be given to multifactor pricing models for these assets. Auctions are a widely used marketing method. Research in these and other directions will enhance our understanding of the mechanisms which generate auction rates of return.

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