Fiddling with Value:

Violins as an investment?

By

Kathryn Graddy

Brandeis University

and

Philip E. Margolis

Cozio Publishing

June 2009

The authors would like to thank, Victor Ginsburgh, Jonathan Hamilton, Ben Hebbert, Tim Ingles, Blake Lebaron, Michael Moses, and Bill Taylor and for their comments. We thank Michael Moses and Beautiful Asset Advisors for sharing the updated Mei Moses Art Index. We would also like to thank an anonymous referee for very helpful comments on an earlier version.

JEL: D44, G11, L82

Keywords: Investment, Violins, Auctions, Repeat Sales

Summary: This paper measures the returns to investing in violins using two different datasets. One dataset includes 337 observations on repeat sales of the same violins at auction and at dealer sales starting in the mid-19th century, and another dataset includes over 2500 observations on sales of individual violins at auction since 1980. Overall real returns for the dataset on repeat sales for the period 1850-2008 have been approximately 3.5%. Real returns to the overall portfolio of individual sales since 1980 have been about 3.3%. The price path has been stable with a slight negative correlation to stocks and bonds.

In this paper, we analyze the prices of violins using two different datasets: one dataset includes 337 observations on repeat sales of the same violins at auction and at dealer sales starting in the mid-19th century, and the other dataset includes over 2500 observations on sales of individual violins at auction since 1980. The purpose of this paper is to give some indication as to whether violins are a viable alternative investment that might be part of a diversified portfolio and to determine if some types of violins have had higher returns than other types of violins.

Despite the growing discussion of alternative investments in the economics and finance literature, the growing number of wealthy individuals, funds and syndicates that invest in violins, and the interest in violins as a collateralizable asset, the only previous study of violin prices published in an academic journal was a study by Ross and Zondervan of repeat sales of 17 Stradivaris (1989). This dearth of academic analysis is most likely due to the difficulty in gathering information on the sale prices of violins. Compared to real estate and even art, the market for high-end violins is "thin" and many violins are sold through dealers rather than auctions, resulting in difficulty gathering data.

To preview our results, overall real returns for the dataset on repeat sales for the period 1850-2009 have been approximately 3.5%. Real returns to the overall portfolio of individual sales at auction since 1980 have also been about 3.3%, not including transaction commissions. The price path has been stable with a slightly negative correlation to stocks and bonds. The overall returns mask differences in returns between different types of violins. It is believed that "better" violins are sold through dealers rather than through auction houses. Indeed, the real return on dealer sales for 1850-2008

was 4.32% and the real return to violins sold at auction for the same period was 2.86%. In the period since 1980, Modern Italian instruments sold at auction have increased steadily in price relative to Old Italian instruments sold at auction.

This paper proceeds as follows. In Section 2 we discuss the violin market and in section 3 we discuss the data and our estimation methodology. In section 4 we present our regression results, and in section 5 we interpret our regressions. We conclude in section 6.

2.0 The Market for Violins

2.1 How the Market Works

Fiddles – the term used by dealers and collectors to refer to even the finest violins -- are sold through both auction houses and dealers and also directly from one musician or collector to another. The main sellers and buyers of these instruments, other than dealers, are musicians, collectors (often foundations), and investors. Individual musicians have used various schemes to purchase a good instrument, including borrowing from banks that specialize in loaning funds against musical instruments and assembling syndicates to raise money. Most collectors, both private and institutional, loan out their instruments to talented musicians. The musician typically pays all insurance and maintenance costs (but not a rental fee); insurance costs range from about ½% to about 2% of the value of an instrument. There are also buyers who are interested in purchasing violins primarily as an investment, as part of a diversified portfolio. These instruments are then also loaned out to musicians, who pay insurance and maintenance.

Violins are sold through both auction houses and dealers. The relative size of the various markets is very difficult to gauge. Through conversations with dealers and

analyzing our auction data, we speculate that auction sales make up between 10% and 20% of the market. One advantage of transacting through a dealer is that it is easier to borrow and try out the instrument (though auction houses also accommodate a small number of potential buyers in this manner). Furthermore, dealers will often accept "trade-ins" as long as the fiddle is traded for one of a similar or higher value. The main advantages of buying (and selling) through auction is transparent pricing.

The importance of dealers in the violin market makes a calculation of returns more difficult than in markets where assets are primarily publicly traded. As auction prices are verifiable, auction prices are preferable data on which to analyze returns, as one cannot be certain about the reliability of price announcements of dealer sales. Furthermore, it is likely that only prices from favorable dealer sales are publicized. However, as the very top instruments are usually not sold through auction, but through dealers, a sample selection problem clearly exists. We approach this problem as follows. We first analyze our repeat sales data using all prices that we have collected, both from auctions and dealers. We then split the sample into two subsets. In the first subset, all second sales were at auction, and in the second subset, all second sales were through dealers. We then discuss sample selection bias resulting from just using auction sales and possible problems with sample selection bias using dealer sales. We can then discuss our hedonic estimates, which use only auction sales data, within this context.

2.2 Previous Work on Violin Prices

The one academic study that we know of is by Ross and Zondervan (1989). In this study, they examine a repeat sales dataset of 17 Stradivaris that were bought and sold a total of 29 times between 1803 and 1982. They find an average real return over this

period of approximately 2 percent, equal to the long-run real rate of interest. There have been several other attempts to measure returns to violins, but these studies have not used auction data nor have they been published in refereed journals.

3.0 Data and Methodology

3.1 Data on Repeat Sales

The data on repeat sales were gathered from both the original auction catalogues and price sheets from the main auction houses, from business records, and from secondary sources. These sources are listed in the Data Appendix. The auction sales data are all reliable and verifiable. It is the belief of the authors that the dealer sales data are reliable, but of course the prices are the result of self-reporting by dealers and buyers. In the later years, the dealer prices may suffer from further sample selection bias as many of the later dealer prices were collected from newspaper articles and the business press. Only sales that do well may be reported.

For our repeat sales database we have 259 fiddles comprising 337 observations – some of the violins in our dataset were sold more than twice. When we assembled the data, we excluded sales where the holding period was less than 5 years.[1] We did this for two reasons: first, we wanted to focus on longer-run returns, and second, several of the instruments appeared to have been sold twice in the same year by the same auction house. On average, in the overall dataset, violins were held for 32 years, with a minimum holding period of 5 years and a maximum holding period of 147 years. This does not necessarily mean that violins are held on average for 30-year periods; it is likely (especially for some of the longer holding periods) that some violins in our sample

[1] In one of the first studies of returns to art, Baumol (1986) excludes paintings with holding periods of less than twenty years. Goetzmann (1993), by design, excludes paintings with holding periods of less than ten years.

changed hands between recorded sales either privately or through dealers. In our dataset, we have 119 observations of repeat sales at auction, 124 observations of repeat dealer sales, 29 observations where the purchase was at auction and the sale was a dealer sale, and 65 observations where the purchase was through a dealer and the sale was at auction. These are typical high quality instruments by top Old Italian makers, including 168 instruments by Stradivari and 33 by del Gesù.[2]

We also split our regressions into two subsets. In the first subset, the purchase was either at an auction or through a dealer and the sale was at auction. In the second subset, the purchase was either at an auction or through a dealer, and the sale was through a dealer. We split the sample in this way to address the concern that better violins are often sold privately, and the returns to these violins may be different. The average holding periods are similar in each of the subsets, at 31 years when the sale is at auction and 32 years when the sale is through a dealer, though again, actual holding periods are probably because of unobserved transactions. Note that auction sales are overrepresented in our database, as they likely comprise only between 10 and 20% of the market.

For the regressions, we use prices including buyers' commissions. Other studies such as the Mei and Moses's (2002) study on art prices include commissions, and we would like this study to be comparable. Auction houses usually report prices including buyers' commissions; also, dealers usually report the price the buyers pay, and then keep a percentage for themselves, if they are acting as an intermediary. Sellers' commissions at auction are negotiable and unknown to us. We consider buyer's and dealers' commissions when interpreting our regression results below. We estimate the index in GBP as most purchases and sales were recorded in GBP.

[2] The complete repeat sales dataset can be found at http://people.brandeis.edu/~kgraddy/data.html

3.2 Data on Individual Sales

A complete description of the data collection for individual sales is in the Data Appendix. The characteristic that we focus on and include in our regressions and that is recognized to have a huge influence on price is maker. Altogether, the database consists of violins by more than 100 different makers spanning four centuries and representing virtually all of the important schools of violin making. As we control for maker in the hedonic regressions, we only included violin makers that had at least two observations in our dataset.

The schools represented in our data are the Old Italian School, comprising 1059 observations on violins made in Italy between 1580 and 1850, the Modern Italian School, comprising 1004 observations on violins made in Italy between 1820 and 1982, and the French school, comprising 394 observations on violins made between 1775 and 1948. The remaining observations were made up by various other schools, with the largest other school being Old non-Italian. Table 1 below provides summary statistics on these instruments.

Table 1: Summary Statistics for Individual Sales Dataset

	Mean	Min	Max
		All	
Sale Price	£44,207	£965	£1,832,004
Sale Date	1995	1980	2009
Year Built	1825	1580	1986
No. of makers	129		
No. of Observations	2669		
		Old Italian	
Sale Price	£76,158	£5,733	£1,832,004
Sale Date	1994	1980	2009
Year Built	1740	1580	1850
No. of makers	64		
No. of Observations	1059		
		Modern Italian	
Sale Price	£23,054	£965	£192,252
Sale Date	1996	1980	2009
Year Built	1910	1820	1982
No. of makers	44		
No. of Observations	1004		
		French	
Sale Price	£24,999	£2,785	£114,393
Sale Date	1995	1980	2009
Year Built	1853	1775	1948
No. of makers	10		
No. of Observations	394		

Prices are in 2005 GBP and include buyers' commissions.

Note that Old Italian instruments are on average over triple the price of Modern Italian and French instruments. Again, we report prices and estimate the indices in GBP.

3.3 Methodology

Each violin is a unique instrument, and the problems incurred in measuring returns to violins are similar to the problems incurred when measuring the returns to art. The result is that there will be some ambiguity in the construction of a single index of the movement of prices over time. One concern about simply using average prices is that price rises may be exacerbated during booms as "better" instruments may come up for sale—which has generally happened with art. In general average prices indicate variability over time in violin prices that might be better described as movements in the heterogeneity of the quality of the objects offered, rather than movements in prices for the same objects.

The two primary types of indices used for heterogeneous objects are based on regressions known as "hedonic models" and "repeat sales models." In hedonic models, differences in items are controlled for by including a small number of "hedonic" characteristics. Repeat sales models, in effect, include a dummy variable for each item (see Ashenfelter and Graddy (2003, 2006)) for a full discussion of the two types of indices and their use in estimating returns to art. A repeat sales model is better able to control for differences in items across time, but these models usually rely on only a small proportion of those items that have come to market. It is often argued that items that are sold twice are "different" from other items that come to market and thus sample selection issues are present. With hedonic indices, all items that are sold can be used, but the controls for differences in quality are incomplete. Complicating the usual analysis is that

we have both auction sales and dealer sales in our repeat sales dataset, but only auction sales in our hedonic dataset. Because of the concern that better violins may be sold by dealers, we cannot just ignore the dealer sales data as is done with other unique assets such as art.

Our strategy in this paper is to estimate both types of models with different datasets and with different subsets. We then compare estimates from both models and in this manner gain some confidence that our indices reflect true market movements.

3.2.1 The Repeat Sales Model

Our repeat sales model is based on the regression,

$$(1) \qquad \ln\left(\frac{P_{is}}{P_{ib}}\right) = \sum_{t=1}^{T} \beta_t \delta_t + \varepsilon_{it}$$

where β_t is the average return in period t of violins in the portfolio, the δ_t are dummy variables for each of the periods in the dataset, and $\varepsilon_{i,t}$ is an error term. The observed data consist of purchases and sales of auction price pairs, P_{ib} and P_{is}, of the individual violins (i indexes the instruments, b denotes purchase, and s denotes sale) that comprise the index, as well as the dates of purchase and sale. We estimate this model using the entire sample, a subsample including observations where the (second) sale was at auction and the purchase could have been through a dealer or at auction, and a subsample where the (second) sale was through a dealer, and the purchase could have been through a dealer or at auction.

Because of the relatively small number of observations, as in Goetzmann (1993), we estimate returns for 10-year periods. Please see Appendix A for a thorough discussion of the repeat sales model.

3.2.2 The Hedonic Model

Our regressions are based on the model

$$\ln P_{it} = \alpha X_i + \sum_{t=1}^{T} \gamma_t \tau_t + \eta_{it}$$

where P_{it} is the price of violin i at time t, X_i are hedonic characteristics which consist of 128 dummy variables representing maker and τ_t are 29 dummy variables representing years from 1981 to 2006. η_{it} is an error term. We estimate this model for the entire sample and separately for Old Italian instruments, for Modern Italian instruments and for French instruments.

4.0 Results

We first analyze and present the results for the repeat sales model for the full dataset and with subsets of the repeat sales dataset. We then estimate the hedonic model using the full dataset on individual sales. We then split the dataset on individual sales into the various schools and look at the relative returns of the various schools. Finally, we compare our results.

4.1 Repeat Sales Regression Results

The estimation results for the repeat sales model are presented in Table 2 below. We present OLS estimates and estimates using the standard Case and Shiller correction. The annual returns for the OLS regressions are then calculated as $e^{\frac{\beta}{10}} - 1$. The annual returns for the Case Shiller regressions are calculated as $e^{\frac{\beta+\sigma^2/2}{10}} - 1$, where σ^2 is defined as the cross-sectional variance of assets held in any 10 year period. We adjust the estimate by $\sigma^2/2$ because of the well-known problem that the regressions estimate the geometric mean across assets, but we are interested in the arithmetic mean across assets.

The cross-sectional variance is estimated as the coefficient on the number of periods held (estimated as .035 with a t-statistics of 2.29) in the second stage of the Case and Shiller regression.[3,4]

Table 2: Repeat Sales Regressions

	OLS (1st Stage)				Case Shiller (linear)			
period	β	t-stat	annual return	Index	β	t-stat	annual return	Index
1850-1859	0.186	0.57	1.88%	1.20	0.3769	1.14	4.02%	1.48
1860-1869	0.237	0.94	2.40%	1.53	0.204286	0.83	2.24%	1.85
1870-1879	0.725	3.12	7.52%	3.15	0.749723	3.39	7.97%	3.99
1880-1889	0.347	1.65	3.53%	4.46	0.324856	1.62	3.48%	5.62
1890-1899	0.630	2.55	6.51%	8.37	0.598302	2.48	6.35%	10.40
1900-1909	0.236	1.03	2.39%	10.60	0.265487	1.21	2.87%	13.80
1910-1919	0.577	2.72	5.94%	18.87	0.600631	2.95	6.38%	25.60
1920-1929	1.103	5.19	11.66%	56.84	1.065179	5.21	11.43%	75.59
1930-1939	-0.347	-1.7	-3.41%	40.18	-0.28098	-1.42	-2.60%	58.08
1940-1949	0.012	0.05	0.12%	40.67	0.020422	0.08	0.38%	60.33
1950-1959	0.708	2.84	7.34%	82.57	0.650701	2.65	6.91%	117.68
1960-1969	1.025	4.91	10.79%	230.09	1.074911	5.27	11.54%	350.87
1970-1979	1.783	11.63	19.52%	1368.61	1.7768	12.29	19.65%	2110.58
1980-1989	1.335	9.75	14.28%	5200.86	1.288993	10.08	13.96%	7794.78
1990-1999	0.353	2.56	3.59%	7399.75	0.361003	2.81	3.86%	11381.15
2000-2009	0.108	0.69	1.09%	8246.83	0.125018	0.83	1.44%	13124.44
adj -R2			0.950				0.938	
obs.			337				337	
Mean Return			5.84%				6.15%	

The data include sales through April of 2009.

[3] The constant is interpreted as a transaction-specific error and is estimated as .279 with a t-statistics of 4.24.

[4] The negative autocorrelation in period returns that is present during the very early periods is a known problem with repeat sales indices. Goetzmann (1992) proposed a Beysian correction that puts additional restrictions on the return path. As we are primarily interested in the returns in later periods and in averages over the entire time period we note the problem, rather than put additional assumptions and structure on the returns.

The mean return is then calculated as Tth root of the ratio of the index in period T divided by the index in period 1. Thus, our indices indicate that the mean nominal return for the period 1850-2009 is 6.15%.

The above regressions include both auction sales and dealer sales. Observations in which the second sale is at auction make up 54% of sales. As discussed above, auctions sales probably make up between 10 and 20% of the market. In order to understand whether the auction repeat sales are different from the dealer repeat sales, we separate the dataset into subsamples. We report the Case and Shiller estimates in Table 3 for the two different subsamples. The results are instructive. The repeat sales where the second sale was at auction averaged a mean nominal return of 5.49% per year since 1850, and the repeat sales where the second sale was to a dealer averaged a mean nominal return of 6.98% per year since 1850. If we split the sample into auction only sales and dealer only sales, the results are similar. The mean return to the auction only sales is 5.46% for the entire period, and the mean return for the dealer only sales is 6.93% for the entire period. The results indicate that dealer sales have resulted in higher returns than auction sales; there are two likely reasons for the difference. First, it could be that the returns to "better" violins are higher and that a higher percentage of these instruments are sold through dealers. Alternatively, it is possible that the dealer sales data that have been collected is a selected sample since successful sales as measured by high prices are more likely to be publicized.

Table 3: Repeat Sales Regressions: Subsamples

	Auction-Auction and Dealer-Auction Sales				Dealer-Dealer and Auction-Dealer Sales			
	Case Shiller (linear)				Case Shiller (linear)			
period	β	t-stat	annual return	1.00	β	t-stat	annual return	1.00
1850-1859	-0.221	-0.42	-2.07%	0.81	0.959	1.95	10.17%	2.63
1860-1869	0.531	0.75	5.57%	1.40	0.197	0.76	2.09%	3.24
1870-1879	1.038	1.71	11.06%	3.99	0.614	2.57	6.44%	6.05
1880-1889	-0.018	-0.04	-0.07%	3.96	0.553	2.42	5.80%	10.62
1890-1899	0.324	0.59	3.41%	5.54	0.487	1.84	5.09%	17.45
1900-1909	0.195	0.56	2.09%	6.81	0.335	1.19	3.51%	24.65
1910-1919	0.832	2.36	8.80%	15.84	0.455	1.84	4.76%	39.24
1920-1929	0.842	2.26	8.91%	37.19	1.265	5.27	13.60%	140.42
1930-1939	-0.912	-2.19	-8.61%	15.11	-0.173	-0.78	-1.61%	119.35
1940-1949	0.715	1.47	7.54%	31.27	-0.230	-0.78	-2.18%	95.74
1950-1959	0.530	1.24	5.57%	53.77	0.718	2.4	7.55%	198.32
1960-1969	0.975	3.42	10.37%	144.26	1.064	3.44	11.34%	580.82
1970-1979	1.806	10.88	19.93%	887.97	1.767	6.04	19.45%	3433.72
1980-1989	1.212	8.44	13.02%	3020.43	1.687	6.44	18.50%	18749.06
1990-1999	0.262	1.9	2.78%	3973.50	0.845	2.75	8.93%	44109.32
2000-2009	0.197	1.29	2.11%	4896.49	0.030	0.06	0.41%	45933.30
adj -R2			0.949				0.957	
obs.			184				153	
Mean Return			105.49%				106.98%	

The data include sales through April of 2009

Figure 1 below graphs the three indices; the all auction index, the index where a violin is sold at auction in the second sale, and the index where a violin is sold privately at the second sale. The three indices follow a similar path, though the auction sales have consistently underperformed the reported dealer sales.

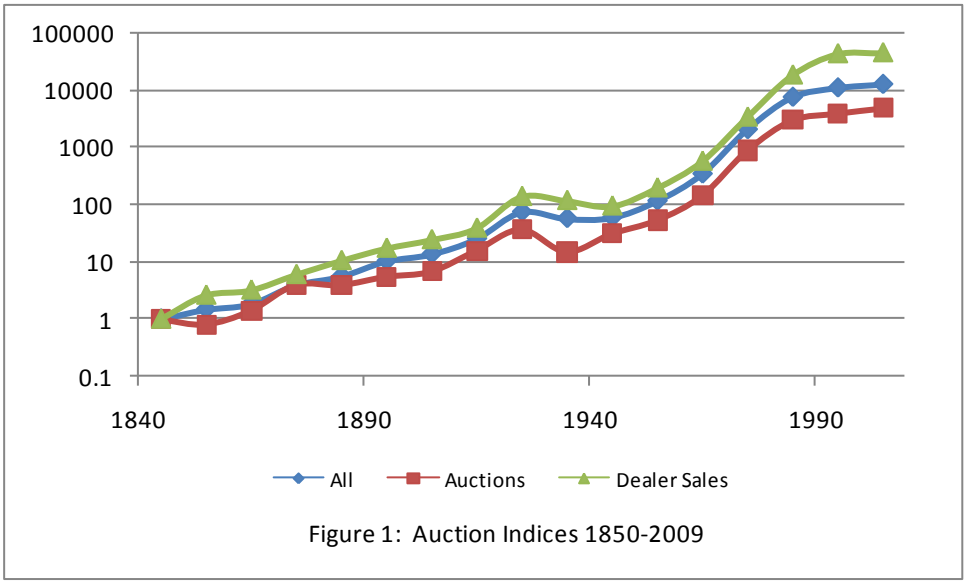

Figure 1: Auction Indices 1850-2009

4.2 Hedonic Model Regression Results

The full sample results for the hedonic model are presented in Table 4 below. Intuitively, γ in Table 4 for a particular period is the average of the natural logarithm of price, conditioning on the maker of the instrument. The index year in year t is then calculated as e^{γ_t}. The mean nominal return for the portfolio of violins included in the dataset for the entire time period is approximately 7.49% and the standard deviation in estimated returns over the period is approximately 9.24%. Note that when the regression is run only with time dummies, the R-squared is about .15, indicating that that the maker dummy variables explain about 60% of the variation in log price. Hence, the time dummies and the maker characteristics explain the series well.

Figure 2 below plots the nominal hedonic index for 1980-2008, both in GBP and in US dollars. The figure also plots nominal indices of total returns of the S&P, U.S. 10 year bonds[5], and the Mei Moses art index. The Mei Moses art index is a US dollar index. As Figure 2 demonstrates, the rise in violin prices has been steady. From 1980- 2008 it

[5] The source for total returns on the S&P and US 10 year bonds is Global Financial Data. The source for the Mei and Moses art index is Beautiful Asset Advisors.

has underperformed stocks and bonds. It does not seem surprising that the overall returns to violins are lower than other stocks and bonds; these instruments are primarily tools of trade and usually only secondarily considered to be an investment. Both to musicians and to most collectors and investors they provide non-monetary dividends in the form of enjoyment; musicians may enjoy monetary rewards in the form of more successful careers. Although in the figure it looks as if art has recently outperformed violins as an alternative investment, in the first quarter of 2009 the Mei and Moses art index was down 35%, making the returns to violins since 1980 similar to those of art.

Table 4
Hedonic Regression Results: Full Sample

year	γ	t-stat	Index	Return
1980			1.00	
1981	0.156857	1.74	1.17	16.98%
1982	0.188583	2.16	1.21	3.22%
1983	0.491044	5.89	1.63	35.32%
1984	0.571341	7.5	1.77	8.36%
1985	0.743109	9.79	2.10	18.74%
1986	0.694333	9.16	2.00	-4.76%
1987	0.910804	12.47	2.49	24.17%
1988	1.10146	15.17	3.01	21.00%
1989	1.151037	15.63	3.16	5.08%
1990	1.275318	17.1	3.58	13.23%
1991	1.300403	17.16	3.67	2.54%
1992	1.41717	18.48	4.13	12.39%
1993	1.481164	19.65	4.40	6.61%
1994	1.540986	19.52	4.67	6.16%
1995	1.600802	20.69	4.96	6.16%
1996	1.618454	20.33	5.05	1.78%
1997	1.567104	20.18	4.79	-5.01%
1998	1.672806	22.24	5.33	11.15%
1999	1.641515	21.25	5.16	-3.08%
2000	1.668991	22.41	5.31	2.79%
2001	1.638644	22.07	5.15	-2.99%
2002	1.755917	23.3	5.79	12.44%
2003	1.769383	22.62	5.87	1.36%
2004	1.744384	23	5.72	-2.47%
2005	1.762941	23.98	5.83	1.87%
2006	1.897455	25.69	6.67	14.40%
2007	1.790318	23.66	5.99	-10.16%
2008	1.921782	25.52	6.83	14.05%
2009	2.094461	22.17	8.12	18.85%

Years	29	F-statistic: 111.25	
Makers	128	F-statistic: 74.10	
Constant	8.846	(0.068)	
R-squared	0.821		
Obs	2669		
Mean Return			7.49%
Standard Deviation of Return			9.24%

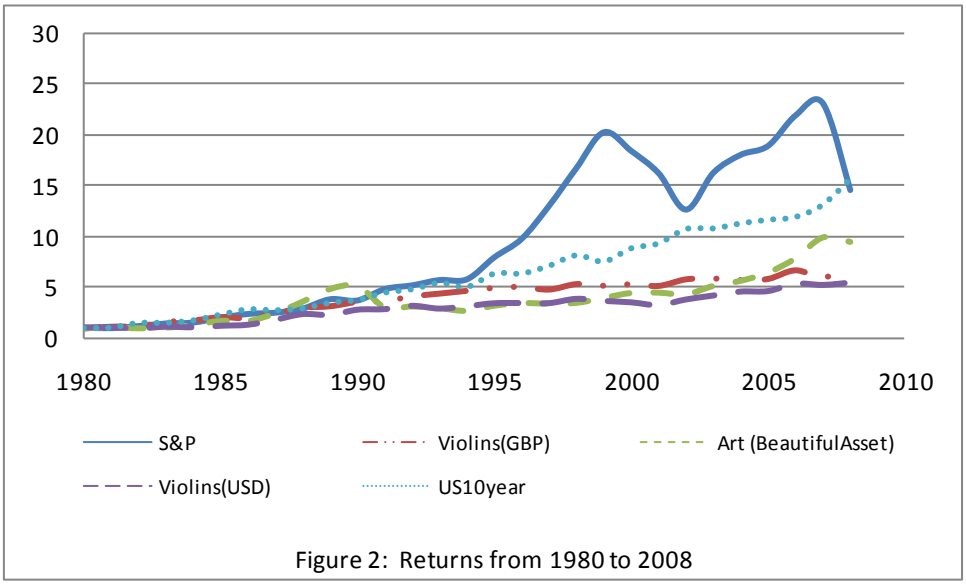

Figure 2: Returns from 1980 to 2008

We have several different schools of violin making in our dataset. It is interesting to break the dataset up into subsamples and compare returns between these samples.

4.2 Results for the Various Schools

Table 5 below breaks up the individual dataset into a sample of instruments from the Old Italian school of violin making, a sample containing violins made by the Modern Italian school, and a sample made by the French school. The price indices are plotted in Figure 3.[6] Very interestingly, Modern Italian instruments have steadily outperformed Old Italian and French instruments.

[6] In a previous version of the paper, we estimated separate returns for Stradivari's and del Gesu's. These returns were very volatile, and a number of periods could not be estimated due to lack of data. Even with the new data, these returns remain very volatile, as every sale has a large impact on the index. In this version, we have therefore decided to group these sales with other Old Italian instruments.

Table 5
Hedonic Regression Results: Indices and Returns

	Old Italian		Modern Italian		French	
Year	Index	Return	Index	Return	Index	Return
1980	1		1		1	
1981	1.15	13.93%	1.00	-0.11%	1.33	28.66%
1982	1.09	-4.94%	1.19	17.76%	1.54	14.26%
1983	1.37	22.24%	2.05	54.11%	2.03	28.08%
1984	1.50	9.43%	2.33	12.78%	1.99	-2.34%
1985	2.18	37.15%	2.28	-2.03%	2.52	23.65%
1986	2.09	-4.07%	2.47	7.76%	1.56	-47.82%
1987	2.36	12.34%	3.03	20.67%	2.72	55.67%
1988	2.73	14.43%	3.62	17.60%	3.10	13.05%
1989	2.83	3.70%	3.96	9.15%	3.11	0.21%
1990	3.42	18.81%	4.32	8.64%	3.37	7.95%
1991	3.12	-9.08%	4.96	13.78%	4.12	20.26%
1992	3.51	11.62%	6.05	19.90%	3.87	-6.34%
1993	3.56	1.54%	6.54	7.82%	4.33	11.18%
1994	4.23	17.09%	6.62	1.11%	4.89	12.19%
1995	4.54	7.14%	6.29	-5.11%	5.51	11.94%
1996	4.73	4.06%	7.33	15.30%	5.59	1.44%
1997	3.81	-21.65%	6.86	-6.55%	4.39	-24.17%
1998	4.71	21.22%	7.54	9.49%	4.79	8.72%
1999	4.65	-1.31%	7.76	2.84%	4.06	-16.50%
2000	4.05	-13.73%	8.50	9.15%	4.86	18.09%
2001	4.14	2.24%	8.65	1.74%	3.97	-20.33%
2002	5.18	22.41%	8.97	3.63%	4.56	13.88%
2003	5.06	-2.48%	8.21	-8.96%	4.99	9.04%
2004	5.52	8.76%	7.95	-3.14%	5.18	3.70%
2005	4.83	-13.36%	9.14	13.92%	4.28	-18.97%
2006	5.92	20.40%	10.02	9.23%	5.06	16.65%
2007	5.13	-14.35%	9.13	-9.38%	4.46	-12.65%
2008	5.22	1.68%	11.90	26.58%	6.18	32.72%
2009	6.50	21.92%	12.01	0.89%	7.95	25.17%
Years	29		29		29	
Makers	64		43		9	
Cons.	yes		yes		yes	
R2	0.80		0.82		0.75	
Obs	1059		1004		394	
Mean Return		6.67%		8.95%		7.41%
Std. Dev.		13.73%		12.75%		20.57%

Includes sales through April 2009

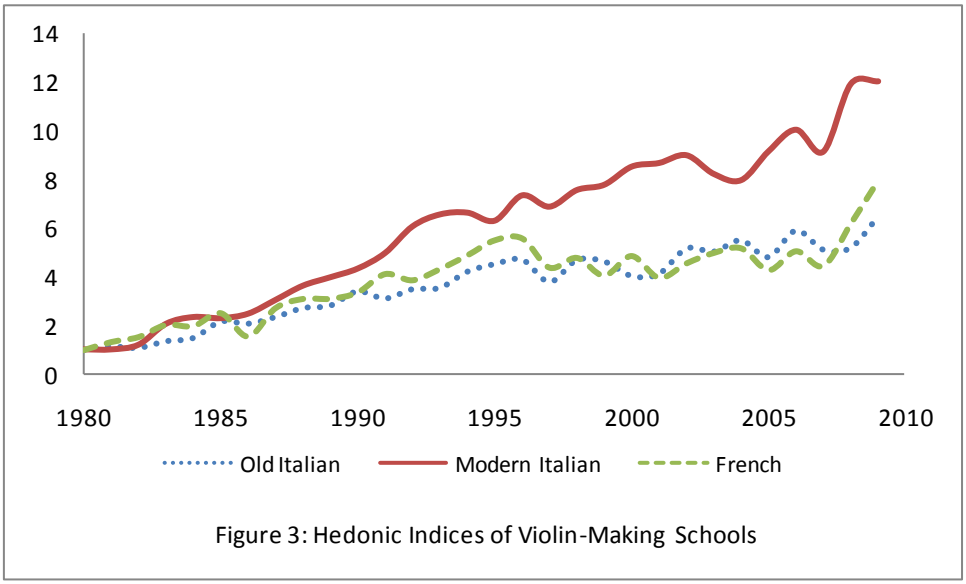

Figure 3: Hedonic Indices of Violin-Making Schools

It is interesting to look at the relative prices of the various makers in our dataset. In Appendix Tables 1-3 we present the regression coefficients on each of the makers in the Old Italian school, the Modern Italian school, and the French school. One point to note from these tables is that the range in prices for different makers is much greater for the Old Italian school than it is for the French school or the Modern Italian school. Furthermore, in this dataset of prices, unsurprisingly, Stradivari and del Gesù (Guarneri), appear to be the most valued Old Italian makers, and Pressenda and Rocca are the most valued Modern Italian makers.

The results from the hedonic dataset are so consistently greater year by year for the Modern Italian school that it is interesting to speculate why the differences in returns may be occurring. There is a large absolute price difference between Modern Italian and Old Italian instruments, and due to the run-up in the past couple of decades in violin prices relative to inflation, Old Italian instruments have become unaffordable to many musicians. Furthermore, they are in short supply. Many participants in the trade believe that there is a growing realization that Modern Italian violins are very good instruments and are now purchasing these instruments. Because of the expense of Old Italian instruments, Modern Italian instruments have been promoted into the set of "professional" violins.

Given the difference in returns to instruments belonging to the Old Italian School and instruments belonging to the Modern Italian School, it is interesting to look for differences in returns between 19th and 20th century Modern Italian instruments. These regression results are available on request, but the primary conclusion is that there is virtually no difference in returns to Modern Italian violins constructed in the different decades. Furthermore, one can look if there are differences in returns between Old Italian instruments constructed prior to 1750 and those constructed after 1750. Again, there are no differences in returns.

4.3 Comparing the hedonic and repeat sales results

If we compare all returns for fine violins at auction in the repeat sales dataset for the period 1980-2009, we get returns of 6.28% vs. returns of 7.49% for the equivalent period in the individual sales dataset. These numbers are not significantly different from one another – the estimated mean for the repeat sales data relies on just three data points

which are estimated returns for the various decades. The closest comparison that we can make between the two datasets is to compare auction only repeat sales of Old Italian instruments with individual sales (auction only) of old Italian instruments. When we do a repeat sales Case and Shiller regression on this subset (auction only and Old Italian only) which contains 85 observations (vs. 119 if observations on all schools are used), we get returns of 5.4% from 1850-2009 and we get returns of 5.83% for the period 1980-2009. This compares with a return of 6.67% for Old Italian instruments in the individual sales dataset.

The difference in point estimates probably exists for a number of reasons. Firstly, the period returns are only estimates of the actual returns -- it is reassuring that the averages of these estimates are still relatively close. Secondly, it could be that the correction for taking the average of the logarithms in the repeat sales model could be underestimated, skewing the repeat sales mean slightly downwards.[7] Thirdly, in the repeat sales model, we have imposed constant returns within decades. Finally, this may be resulting from unobservable time-invariant effects that drop out in the repeat sales regressions, but are biasing the results in the hedonic regressions (see Hausman and Taylor *Econometrica* (1981)).

The end result that our hedonic indices using auction results are similar for the period to the repeat sales indices using auction results gives us confidence in our results, as neither dataset nor method is ideal.

5.0 Interpretation

[7] In the Case and Shiller correction, the transaction-specific error is not used in calculating the cross-sectional variance of asset returns; furthermore the individual asset returns in a particular period are assumed to be i.i.d, which may not be an appropriate assumption for an infrequently traded asset.

Before we begin to interpret our results, it is interesting to summarize our results and compare real returns overall and for the various subsamples of our data, with real returns on other assets. We present these returns through the end in Table 6 below. In order to compare full year results for all assets, we report returns in this table through 2008.[8] The first point to note is that in the long run, violins appear to have outperformed both art and treasury bonds. From 1980 to 2008, it appears the stocks, bonds, and art have all outperformed violins, but as noted earlier, in the first quarter of 2009, the art market was down 35%; this downturn is not reflected in these numbers. The violin market appears to have held up so far for this time period. The 1980 to 2008 data also indicate that violins have been less volatile than other assets.

[8] Data through April 2009 were used to calculate the violin returns. In the case of the repeat sales indices, these returns would be identical to returns calculated through April 2008 because of the assumption of constant returns in any 10 year period. In the hedonic indices, the coefficient on the 2009 dummy variable was not used to calculate the returns.

Comparison of Real Returns

Asset	mean	standard deviation	Correlations S&P 500	U.S. Bonds	Art (Mei Moses)	All Violins (Auction)	Old Italian (Auction)	Modern Italian (Auction)	French (Auction)
Individual Sales Data	1980-2008								
S&P 500	6.55%	17.87%	1.000						
US Treasury Bonds	6.83%	9.45%	0.143	1.000					
Art (Mei Moses)	4.57%	17.22%	0.025	-0.136	1.000				
Fine Violins (Auction)	3.33%	7.78%	-0.136	-0.150	0.184	1			
Old Italian (Auction)	2.34%	11.17%	-0.0538	-0.1574	0.216	0.7124	1		
Modern Italian (Auction)	5.40%	14.93%	-0.218	-0.0289	-0.0827	0.6038	0.1416	1	
French (Auction)	2.96%	18.39%	-0.1569	-0.0827	-0.0947	0.6995	0.4408	0.297	1
Repeat Sales Data									
S&P 500 (1875-2008)		6.12%							
US Treasury Bonds (1850-2008)		2.47%							
Art (Mei Moses) (1875-2008)		2.26%							
Fine Violins (1850-2008)		3.50%							
Fine Violins (Auction)		2.86%							
Fine Violins (Dealer Sales)		4.32%							

Notes: The total return series for stocks and bonds were taken from Global Financial Data.
Returns for art were provided by Beautiful Asset Advisors.
The inflation rates were taken from global insight.
Returns for violins were deflated using the UK price index, and returns for other assets were deflated using the US price index.

From the table, we can see that real returns in the two violin datasets, despite the differences in composition and the differences in periods, are nearly identical. Looking at the differences in the underlying returns to different types of violins, this is probably mostly coincidence. From the individual data subsets, we can see that Modern Italian instruments have outperformed Old Italian instruments, and yet Modern Italian instruments comprise only about 9% in our repeat sales sample but about 40% of our sample of the individual sales dataset. Furthermore, we have no dealer sales included in our individual sales dataset, but dealer sales at the second sale (which may indicate "better" instruments) comprise 46% of our repeat-sales sample.

It may be tempting to adjust our repeat sales returns for an estimated composition of 20% auction sales and 80% dealer sales. This would give us an overall real return of 4.02%. Yet, this doesn't address the relative composition of Modern Instruments vs. Old Italian instruments, and the returns are still subject to sample selection issues in that it is likely that only favorable dealer sales are reported in the press. Hence, we choose to report that overall returns in this dataset, noting the composition of the dataset, are 3.5%.

Note that the returns to violins are slightly negatively correlated with stocks. If we regress the real returns to violins on the real returns to the S&P from 1980 to 2008, we get an alpha coefficient of .0307 (t=1.87) and a beta of -.0593 (t=-.7), indicating uncorrelated returns of about 3%. As Mei and Moses (2002) noted for the art market, we are finding returns greater than the risk free rate that have low correlation with stocks. While at first glance this may appear surprising, the market for fiddles is illiquid, has high transactions cost and is at the end of the day a very small asset class. Many of the standard assumptions of the capital asset pricing model do not hold.

Furthermore, in keeping with the Mei and Moses approach, we have so far not taken into account the role of commissions. The effect of commissions on returns could be significant, depending on the assumptions regarding holding period of assets and total commissions; seller's commissions are not published and are negotiable and buyers commissions depend upon the price paid and have changed over time. If we assume an average commission rate of 15% and we assume that violins change hands on average approximately every 30 years, then the return should decrease by about .5% per year. However, if we were to assume a 30% commission rate (based on an average 20% buyer's commission plus a 10% seller's commission), and if we assumed more realistically that violins change hands every 20 years, than our returns should decrease by about 1.5%, which is very significant. When comparing the returns to holding stocks and bonds, commissions could play a very important role.

The final point to note in Table 6 is the low correlation of returns from Modern Italian instruments with returns from Old Italian instruments. This low correlation indicates that a portfolio of stringed instruments should be well-diversified amongst the various schools of violin making.

6.0 Conclusion

In conclusion, the real returns to a portfolio of all violins since 1980 have averaged about 3.3% and long-run returns since 1850 have averaged about 3.5%. Furthermore, they have a slightly negative correlation to stocks and bonds, making them a candidate for inclusion in a diversified portfolio based on past performance, and they have had a relatively low variance in returns. Probably most importantly to note is that even using only auction sales data (which may underestimate returns), returns to violins

compare very favorably to assets other than stocks, and have a slightly negative correlation to stocks and bonds.

References

Ashenfelter, O. and K. Graddy. "Auctions and the Price of Art." *Journal of Economic Literature,* 41, 2003, 763-787.

Ashenfelter, O. and K. Graddy. "Art Auctions." *Handbook on the Economics of Art and Culture,* V. Ginsburgh and D. Throsby, (eds.), Amsterdam: Elsevier, 2006, 909-945.

Bailey, M. J., Muth, R. F. and Nourse, H. O. "A Regression Method for Real Estate Price Index Construction." *Journal of the American Statistical Association*, 58, 1963, 933-42.

Baumol, W. J. "Unnatural Value: Or Art Investment as Floating Crap Game." American Economic Review Papers and Proceedings, 76, 1986, 10-14.

Case, K. E. and Shiller, R. J. "Prices of Single-Family Homes Since 1970: New Indexes for Four Cities." *New England Economic Review*, September-October, 1987, 45-56.

Catalog descriptif des instruments de Stradivarius et Guarnerius del Gesu (a facsimile of the notebook of Charles-Eugene Gand (1870-1889). published by Les Amis de la Musique: Spa, 1994.

www.cozio.com, online database of stringed instruments, published by Cozio Publishing.

Database Sales of String Instuments 1984-2006, published by Holfter GmbH: Stolberg, Germany.

Eichholtz, P.M.A., "A Long Run House Price Index: The Herengracht Index, 1628 1973." *Real Estate Economics*, 25, 1997, 175-192.

Goetzmann, W. N. "The Accuracy of Real Estate Indices: Repeat Sale Estimators." *Journal of Real Estate Finance and Economics* 5, 1992, 5-53.

Goetzmann, W.N. "Accounting for Taste: Art and Financial Markets over Three Centuries." *American Economic Review*, 83, 1993, 1370-1376.

Goodkind, H. K. *Violin Iconography of Antonio Stradivari* 1644-1737. Larchmont, NY: 1972.

Hausman, J. A. and Taylor W.E. "Panel Data and Unobservable Individual Effects." *Econometrica*, 49, 1981, 1377-1398.

Hill, W.E. and Sons. *Antonio Stradivari: His Life and Work.* London: 1901.

Hosios, A. and J. Pesando. "Measuring Prices in Resale Housing Markets in Canada: Evidence and Implications," *Journal of Housing Economics*, 1, 1991, 303-17.

Mei, J. and M. Moses. "Art as an Investment and the Underperformance of Masterpieces." *American Economic Review*, 92, 2002, 1656-1668.

Pesando, J.E. "Art as an Investment: The Market for Modern Prints." *American Economic Review*, 83, 1993, 1075-1089.

The Red Book: Auction Price Guide of Authentic Stringed Instruments and Bows, various editions, formerly published by Samuel W. Eden, currently published by Donald M. Cohen: Alexandria, VA.

Ross, M. H. and S. Zondervan. "Capital Gains and the Rate of Return on a Stradivarius." *Economic Inquiry*, 27, 1989, 529-540.

Segelman Trust. Papers of Gerald Segelman. (forthcoming as *Mr. Black's Violins: The Obsession of Gerald Segelman*, Cozio Publishing, Boston, 2009).

Smithsonian Institution. The Jacques Francais Business Records (including the business records of Emil Herrmann).

Appendix A: Repeat Sales Estimation Method

Our regression equation begins with a standard repeat sales model used to estimate real estate and art indices where it is assumed the return for asset *i* in period *t* can be broken up into the return for a price index of the portfolio of assets and an individual error term,

$$r_{i,t}=\beta_t+\varepsilon_{i,t}$$

where $r_{,it}$ is the continuously compounded return for a particular art asset *i* in period *t*, β_t is the average return in period t of paintings in the portfolio, and $\varepsilon_{i,t}$ is an error term.[9]

The observed data consist of purchase and sales of auction price pairs, $p_{i,b}$ and $p_{i,s}$ of the individual violins that comprise the index, as well as the dates of purchase and sale. Thus, the logged price relative for violin *i* held between its purchase date and its sale date may be expressed as

$$r_i=\ln\left(\frac{P_{i,s}}{P_{i,b}}\right)=\sum_{t=b_i+1}^{s_i} r_{i,t}$$
$$=\sum_{t=b_i+1}^{s_i}\beta_t+\sum_{t=b_i+1}^{s_i}\varepsilon_{i,t}$$

This summation suggests that the difference in logs of sale prices should be regressed on a number of dummy variables that span the period over which the asset is held. The coefficient on the dummy variable for a particular period will represent the

[9] This methodology was developed by Bailey, et. al. (1963) and used by Case and Shiller (1987), Hosios and Pesando (1991) , and Eichholtz (1997), for the real estate market, and subsequently used by Goetzmann (1993) Pesando (1993) and Mei and Moses (2002) for the art market. In these papers $\pi_{i,t}$ is assumed to be uncorrelated over time and across paintings.

average of the natural logarithm of the returns of all of the assets held in that specific period. Because of the summation, the t in effect drops out of the regression: each observation is the return for a particular asset. However, the errors will be heteroskadastic because of the summation: they will depend upon the number of time periods held.

Theory (by first differencing a hedonic model with fixed effects) suggests that the dummy variables for each pair should equal 1 at the time of sale, -1 at the time of purchase, and 0 in all other periods. In this case, the coefficients on the dummy variables represent a price index. Pesando (1993) uses this methodology. Goetzmann (1992) shows it is more efficient to allow the dummy variables to equal 1 during the periods between purchase and sale, zero otherwise, and then do GLS using weights suggested by Case and Shiller (1987). In this case, the coefficients on the dummy variables represent returns. Goetzmann (1993) and Mei and Moses (2002) let the dummy variable equal 1 for an entire period if the painting was held before the current period and for any part of the current period. Otherwise it equals zero. We modify the construction of the dummy variables first by letting the dummy variable equal 1 if the violin was held for the entire period, letting it equal the proportion of the period held if it was held for less than an entire period ((note that our periods are ten years in length as in Goetzmann (1993)), and letting it equal zero otherwise. This allows us to use data on violins that were held within a ten year period, and also more accurately describes the holding periods.

In the first stage of Case and Shiller's (1987) method, the log of the ratio of the sale price to purchase price is regressed on time dummy variables. In Case and Shiller in the second stage, a regression of the squared residuals from the first stage is run on a

constant term and the number of periods held between sales. The linear specification for the second stage of Case and Shiller results partially from the iid assumption on the errors in the return of the underlying asset i in period t (this is where the term for number of periods held appears) and partly because Case and Shiller put in a constant term to describe the transaction-specific error. The slope coefficient can be directly interpreted as an estimate of the cross-sectional variance in a period and therefore is used to correct for the known bias in the repeat sales estimates as described below.

In the third stage, a generalized least squares (weighted) regressions is run that repeats the stage-one regression after dividing each observation by the square root of the fitted value in the second stage.

The regressions present estimates of the average of the log of the one period return of the portfolio of assets (the geometric mean). However, for the single period returns, we are interested in the arithmetic means across assets (Geotzmann 1992). Thus, resulting from Jenson's inequality, the estimates are downward biased by one-half of the cross-sectional variance. In the Case and Shiller results, we correct for this downward bias by adding 1/2 of the coefficient on the number of periods held terms in the second stage regressions to the estimated μ_t. Thus for a ten year period, our yearly returns are calculated as $(\exp(\mu_t+\sigma^2/2)^{1/10}$.

Data Appendix

Repeat Sales Data

The data on the dealer sales were gathered from *"Violin Iconography of Antonio Stradivari"* (Herbert K. Goodkind, 1972) and *"Antonio Stradivari: His Life and Work"* (W.E. Hill & Sons, 1901). Further sources for the dealer repeat sales include "*Catalog descriptif des instruments de Stradivarius et Guarnerius del Gesu*" (Les Amis de la Musique, Spa, 1994), The Jacques Francais Business Records at the Smithsonian Institution (these also include the business record of Emil Herrmann), and the papers of Gerald Segelman from the Segelman Trust (forthcoming in *Mr. Black's Violins: The Obsession of Gerald Segelman,* Cozio Publishing, Boston, 2009.) Dealer sales data were also gathered from miscellaneous new stories from a variety of publications and the web page, http:://stradivariinvest.com.

The data on repeat sales at auction were gathered from both the original auction catalogues and price sheets from the main auction houses that sell, or have sold, violins and from the secondary sources, *"Violin Iconography of Antonio Stradivari"* (Herbert K. Goodkind, 1972) and *"Antonio Stradivari: His Life and Work"* (W.E. Hill & Sons, 1901). Catalogues from years prior to 1965 were accessed primarily at The British Library and in the archives of Bonhams.

Individual Sales Data

We began putting together the dataset on individual sales by merging data on violin sales published by Donald M. Cohen in "The Red Book: Auction Price Guide of Authentic Stringed Instruments and Bows," sales published by Holfter GmbH in

Stolberg, Germany in "Database: Sales of string instruments 1984-2006," and sales listed on the web site www.cozio.com, published by Cozio Publishing.[10] None of these datasets included all auction houses, so we went back to the original catalogues to fill in the missing sales. We included instruments sold by the major auction houses: Sotheby's, Christie's, Bonhams, Phillips, Tarisio, Bongartz and Skinner as well as other auction venues: Ader Tajan in Paris, Babuino in Rome, Da Salo on the Internet, Dorotheum in Vienna, Etude Tajan in Paris, Gardiner-Houlgate in London, and Vichy in Paris. In addition, we checked the catalogues to ensure that we included only full-size instruments listed as "by" a particular maker and represented in good physical condition.

[10] Previous editions of "The Red Book" were published by Samuel W. Eden.

Appendix Table 1: Old Italian Makers

	obs.	coeff	std. error	Multiples of Lorenzo Ventapane
Stradivari, Antonio	45	3.19	0.11	24.29
Guarneri, Del Gesu	6	3.14	0.21	23.12
Guarneri, Pietro (of Venice)	3	2.41	0.29	11.12
Bergonzi, Carlo	4	2.27	0.25	9.66
Montagnana, Domenico	10	1.92	0.17	6.85
Guadagnini, Joannes Baptista	51	1.85	0.11	6.34
Guarneri, Joseph (fil. Andreae)	13	1.84	0.16	6.27
Guarneri, Pietro (of Mantua)	14	1.70	0.15	5.50
Amati, Nicolo	25	1.44	0.13	4.23
Ruggieri, Francesco	19	1.28	0.14	3.61
Goffriller, Matteo	10	1.26	0.17	3.53
Guarneri, Andrea	22	1.25	0.13	3.49
Bergonzi, Nicola	3	1.24	0.28	3.47
Balestrieri, Tommaso	27	1.08	0.13	2.95
Serafin, Santo	14	1.03	0.15	2.81
Storioni, Lorenzo	22	1.00	0.13	2.73
Gagliano, Alessandro	11	0.92	0.17	2.50
Camilli, Camillo	20	0.90	0.14	2.45
Gobetti, Francesco	7	0.88	0.20	2.41
Mantegazza, Pietro	5	0.87	0.23	2.39
Amati, Antonio & Girolamo	21	0.86	0.13	2.37
Tononi, Carlo	13	0.84	0.16	2.31
Amati, Girolamo (II.)	6	0.78	0.21	2.19
Emiliani, Francesco	6	0.78	0.21	2.17
Gagliano, Gennaro	20	0.77	0.14	2.16
Gagliano, Nicola	68	0.76	0.10	2.13
Cappa, Gioffredo	21	0.73	0.13	2.07
Rogeri, Giovanni Batista	17	0.71	0.14	2.03
Mezzadri, Alessandro	2	0.70	0.34	2.01
Gagliano, Ferdinando	31	0.69	0.12	1.99
Ceruti, Giovanni Battista	12	0.68	0.16	1.97
Grancino, Giovanni	28	0.66	0.12	1.93

Appendix Table 1: Old Italian Makers (continued)

obs.	coeff	std. error	Multiples of Lorenzo	Ventapane
Grancino, Giovanni Battista	5	0.60	0.23	1.82
Landolfi, Pietro Antonio	9	0.59	0.18	1.81
Deconet, Michele	16	0.59	0.15	1.80
Landolfi, Carlo Ferdinando	24	0.53	0.13	1.70
Maggini, Giovanni Paolo	13	0.52	0.16	1.69
Baldantoni, Giuseppe	2	0.52	0.34	1.69
Sorsana, Spirito	10	0.45	0.17	1.56
Gagliano, Giuseppe	36	0.41	0.12	1.51
Goffriller, Francesco	3	0.40	0.28	1.49
Costa, Pietro Antonio Dalla	6	0.34	0.21	1.41
Testore, Carlo Giuseppe	13	0.34	0.16	1.40
Testore, Carlo Antonio	46	0.34	0.11	1.40
Calcagni, Bernardo	14	0.33	0.15	1.40
Tecchler, David	11	0.32	0.17	1.38
Gagliano, Giuseppe & Antonio	17	0.26	0.14	1.29
Gagliano, Giovanni	7	0.25	0.20	1.29
Gragnani, Antonio	24	0.23	0.13	1.25
Tononi, Giovanni	15	0.21	0.15	1.23
Gabrielli, Giovanni Battista	29	0.19	0.12	1.21
Celoniatus, Giovanni Francesco	7	0.10	0.20	1.11
Ventapane, Lorenzo	28	0.00		1.00
Castello, Paolo	23	-0.03	0.13	0.97
Carcassi, Lorenzo & Tommaso	53	-0.04	0.11	0.96
Pallota, Pietro	3	-0.05	0.28	0.95
Eberle, Tomaso	21	-0.07	0.13	0.93
Dall'Aglio, Giuseppe	8	-0.14	0.19	0.87
Testore, Paolo Antonio	7	-0.18	0.20	0.84
Odoardi, Gisueppe	2	-0.18	0.34	0.83
Cordano, Jacopo	3	-0.23	0.28	0.80
Amati, Dom Nicolò	12	-0.23	0.16	0.80
Alberti, Ferdinando	2	-0.38	0.34	0.69
Albani, Matthias	14	-0.54	0.15	0.59

Appendix Table 2: Modern Italian Makers

	obs.	coeff	std. error	Multiples of Ettore Soffritti
Pressenda, Joannes F.	37	2.03	0.12	7.62
Rocca, Giuseppe	43	1.93	0.12	6.91
Ceruti, Giuseppe	2	1.14	0.29	3.14
D'Espine, Alexander	9	1.12	0.17	3.05
Ceruti, Enrico	14	0.95	0.15	2.57
Rocca, Enrico	10	0.93	0.16	2.55
Fagnola, Hannibal	57	0.87	0.12	2.39
Poggi, Ansaldo	9	0.49	0.17	1.64
Scarampella, Stefano	32	0.49	0.13	1.64
Fiorini, Giuseppe	22	0.43	0.14	1.54
Oddone, Carlo Giuseppe	31	0.42	0.13	1.52
Sacconi, Simone Fernando	5	0.40	0.20	1.50
Gagliano, Antonio (II)	2	0.30	0.30	1.35
Bisiach, Leandro	66	0.28	0.12	1.32
Guadagnini, Francesco	9	0.27	0.17	1.31
Ornati, Giuseppe	16	0.24	0.14	1.27
Bisiach, Carlo	13	0.21	0.15	1.23
Sgarabotto, Gaetano	19	0.20	0.14	1.22
Pedrazzini, Giuseppe	67	0.19	0.12	1.21
Praga, Eugenio	2	0.19	0.30	1.21
Postiglione, Vincenzo	34	0.16	0.13	1.17
Genovese, Riccardo	6	0.15	0.19	1.16
Degani, Eugenio	79	0.05	0.12	1.05
Antoniazzi, Riccardo	21	0.04	0.14	1.04
Jorio, Vincenzo	2	0.03	0.29	1.03
Candi, Cesare	18	0.02	0.14	1.02
Farotti, Celeste	14	0.01	0.15	1.01
Soffritti, Ettore	13	0.00		1.00
Pollastri, Gaetano	17	0.00	0.14	1.00
Garimberti, Ferdinando	14	0.00	0.15	1.00
Sannino, Vincenzo	28	-0.04	0.13	0.96
Capicchioni, Marino	28	-0.06	0.13	0.94
Antoniazzi, Romeo	38	-0.07	0.12	0.94
Degani, Giulio	61	-0.09	0.12	0.92
Bisiach, Giacomo & Leandro	23	-0.14	0.13	0.87
Sgarabotto, Pietro	9	-0.15	0.17	0.86
Pistucci, Giovanni	13	-0.17	0.15	0.84
Gadda, Gaetano	48	-0.32	0.12	0.73
Antoniazzi, Gaetano	7	-0.35	0.18	0.70
Gagliano, Raffael & Antonio	2	-0.39	0.29	0.68
Marchetti, Enrico	16	-0.45	0.14	0.64
Contino, Alfredo	35	-0.46	0.13	0.63
Sderci, Igenio	3	-0.55	0.25	0.58
Bignami, Otello	11	-0.95	0.16	0.39

Appendix Table 3: French Makers

	obs.	coeff	std. error	Multiples of Jean Baptiste Vuillaume
Lupot, Nicolas	25	0.21	0.09	1.23
Vuillaume, Jean Baptiste	164	0.00		1.00
Pique, François	16	-0.42	0.11	0.65
Pacherele, Pierre	7	-0.56	0.16	0.57
Bernardel, Auguste Sebastien	42	-0.96	0.07	0.38
Chanot, Georges	37	-1.01	0.08	0.36
Aldric, Jean-Francois	11	-1.08	0.13	0.34
Silvestre, Pierre	2	-1.14	0.31	0.32
Gand, Gand & Bernardel	60	-1.18	0.06	0.31
Bernardel, Gustave	30	-1.26	0.08	0.28