Macrothink Institute™

Business and Economic Research
ISSN 2162-4860
2015, Vol. 5, No. 1

Investing in Diamonds

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Received: March 17, 2015 Accepted: April 4, 2015

doi:10.5296/ber.v5i1.7518 URL: http://dx.doi.org/10.5296/ber.v5i1.7518

Abstract

This paper examines the risk-return characteristics of investment grade gems (white diamonds, colored diamonds and other types of gems including sapphires, rubies, and emeralds). The transactions are coming from gem auctions and span the period 1999-2012. Over our time frame, the annual nominal USD returns for white and colored diamonds amount to 8.1% and 7.4%, respectively, or 5.5% and 4.8% in real terms. For a Euro investor, the returns on white and colored diamonds are about 1.3% lower than for a USD investors but the Euro returns still beat inflation by 3.5% annually. The returns for Other Gem types (rubies, emeralds and sapphires) are more volatile and somewhat lower (4.5% annual nominal returns and 2.1% in annual real terms). Applying the hedonic regression method to the data set of auction transactions of investment grade diamonds, we are able to explain more than 95% of their price variation in white diamonds. Although the diamond returns since 1999 have been below those on gold, both white and colored diamonds have significantly outperformed the US and European stock markets, US and European real estate, US government bonds, as well as European government and corporate bonds. The reward-to-risk (Sharpe ratio) of white diamonds is very close to that of US corporate government bonds. The highest Sharpe ratio (by far) over the past 14 years was the one on gold. Still, in times of crisis investments in diamonds have shown an attractive risk-return tradeoff. In spite of a small positive correlation between the diamond and the equity markets, adding diamonds to an equity portfolio still have some diversification advantages.

Keywords: Auctions; Diamonds; Gems; Hedonic regressions; Luxury goods, Alternative investments.

JEL classification: G11; G12; Q3; Z11.

Acknowledgements: We are grateful to Filip Nys from Rocks International for providing us the data and to Tamas Barko for research assistance.

Executive Summary:

- Over the period 1999-2012, the annual nominal USD returns for white and colored diamonds amount to 8.1% and 7.4%, respectively, or 5.5% and 4.8% in real terms (over and above inflation).

- For a Euro investor, the returns on white and colored diamonds are about 1.3% lower than for a USD investors but the Euro returns still beat inflation by 3.5% annually.
- The returns for Other Gem types (rubies, emeralds and sapphires) are more volatile and somewhat lower (4.5% annual nominal returns and 2.1% in annual real terms).
- The return generating model used to estimate the returns works well: applying the hedonic regression method to the data set of auction transactions of investment grade diamonds, we are able to explain more than 95% of their price variation in white diamonds. The model also performs well for colored diamonds. We confirm that white and colored diamonds are traded based on its physical characteristics as well as details about the transaction (location, auction house).
- Although the diamond returns since 1999 have been below those on gold (a much-used safe haven in the recent financial crisis), both white and colored diamonds have significantly outperformed the US and European stock markets, US and European real estate, US government bonds, as well as European government and corporate bonds. The reward-to-risk (Sharpe ratio) of white diamonds is very close to that of US corporate government bonds. The highest Sharpe ratio (by far) over the past 14 years was the one on gold. Still, in times of crisis investments in diamonds have shown an attractive risk-return tradeoff.
- We have also shown that in spite of a small positive correlation between the diamond and the equity markets, adding diamonds to an equity portfolio still have some diversification advantages.

1. Introduction

In the recent past, impressive sums of money have been spent on diamonds and other gems. In December 2008, a British jewelry dealer paid more than 24 million U.S. dollar (USD) for the 35.56 carat grayish-blue Wittelsbach Diamond at a Christie's auction in London. On 16 November 2010, a rectangular 24.78 carat pink diamond was sold in the auction rooms of Sotheby's Geneva for the record price of 45.75 million USD. In private transactions, the figures have even been higher (Bloomberg, 2008). According to some jewelry experts, the recent financial crisis is partially responsible for the elevated price levels: "nobody knows what they are buying with stocks, but here they are buying something solid and tangible" (Reuters, 2010).

Also in the late 1970s and the early 1980s – when the economic climate was arguably even more uncertain than today – there was an increased investor attention for tangible but easily storable assets, such as gold (Ibottson and Brinson, 1993), stamps (Dimson and Spaenjers, 2011), and gemstones. Two interesting examples of diamond investor manuals that were published around that time were Sutton (1979) and Dohrmann (1981). Both studies elaborated extensively on the advantages of investing in diamonds; the latter publication even claimed in its preface that "diamonds have a track record of thousands of years of value with steady, stable appreciation".

The production side of the gem industry has been dominated by the De Beers cartel since the 1870s. By stockpiling the excess supply of rough diamonds and creating an illusion of scarcity, but also by curbing attempts of speculation, the company cartel has managed to create an "orderly" primary market with prices that have been steadily increasing over time (Spar, 2006). Over the next few years, worldwide jewelry sales are expected to grow strongly, especially in emerging markets. KPMG (2010) foresees a growth in total revenues from 185 billion USD in 2010 to 230 billion USD in 2015. The Indian and Chinese market for gems

will have surpassed the U.S. market in size by 2015.

There are two interesting aspects to the consumer demand for diamonds. First, diamonds may constitute a market for social status (Scott and Yelowitz, 2010).[1] Second, and more relevant when looking at price trends, diamonds are appreciated not only because of their intrinsic consumption effects, but also because they are costly and are a store of value. This may have become even more important since the recent financial crisis. A recent Capgemini (2010) study on passion investments indeed stresses that high-net-worth individuals seek out "more tangible assets expected to hold their long-term value". As a result, 'jewelry, gems, and watches' overtook 'art' as the second most important category of passion investments globally in 2009.

In this paper, we estimate the returns on diamonds and other gems in the secondary market over the period 1999-2012, using a novel data set of auction transactions. We concentrate only on the upper end of the market 'investment-grade' high-quality "white" (colorless or near-colorless) and colored diamonds, and other types of precious gemstones (sapphires, rubies, and emeralds). We also compare and relate the price trends in the secondary market for investment-grade gems to the returns on more traditional asset categories such as equity, corporate and government bonds, treasure bills, gold, and real estate.

This paper proceeds as follows. Section 2 presents the data and methodology. Section 3 illustrates the importance of time-invariant price-determining variables such as carat, color, and clarity. Section 4 outlines our price indices. Section 5 compares the performance of diamonds with that of other assets. Section 6 briefly examines whether higher-quality objects are also better investments. Section 7 concludes and discusses the need for a longer-term perspective.

2. Data and methodology

The data used in this study were provided by H-Ten Diamond Capital, a team of international diamond industry experts. The original database includes information on auction sales of gems at offices of Sotheby's and Christie's worldwide. Although a limited number of transactions are included for the early- and mid-1990s, we start our analysis in 1999, the first year for which there is representative coverage. In total, the database contains information on 4,750 sales. Table 1 shows the distribution of sales per half-year over the three types of stones included in the database: white diamonds, colored diamonds, and other gems. The different sorts of non-diamond gems considered are emeralds from Colombia, rubies from Burma (Myanmar), and sapphires from Burma, 'Ceylon' (Sri Lanka), and Kashmir. The panel shows that a small majority of the transacted gems are white diamonds (2,574 sales). The number of observations for colored diamonds amounts to 1,310 and that for other gemstones is 866.

Table 1 also shows the average transaction price in Euro and USD, and the average price per carat, for each period and for each type of gem. The results indicate that the average transaction value over the past 15 years is highest for colored diamonds at Euro 505,615 (USD 642,689), followed by white diamonds at Euro 400,206 (USD 505,356 USD) and other gem stones at Euro 235,176 (USD 286,996). Also the average price paid per carat is highest for colored diamonds – at Euro 71,785 (USD 90,750). However, there is substantial time-series variation in average prices. For example, the transaction value per carat almost

[1] Scott and Yelowitz (2010) show that the (online) supply of diamonds has distinct discontinuities in the frequency distributions by size. Also, a diamond's price is significantly lower when its size is just below a round carat weight, such as one or two carat. This may be due to a behavioral whole numbers effect or – in the context of engagement and wedding rings – be evidence of conspicuous consumption. We do not study this (retail) segment of the diamonds market.

doubled for colored and white diamonds over the period 1999-2013 (e.g. the price per carat was between Euro 20,000 and 25,000 in 1999-2002 but augmented to Euro 40,000 and 50,000 since 2010).

The increase in the price per carat for white diamonds, colored diamonds, and other gems since the early years of our time frame is further illustrated in Figure 1a (Euro) and Figure 1b (USD).

Business and Economic Research
ISSN 2162-4860
2015, Vol. 5, No. 1

Table 1. Numbers of transactions and average price levels in Euro and USD

	Number				Average price			Avarage price per carat			Average price			Avarage price per carat		
Semester	White	Colored	Other	Total	White	Colored	Other	White	Colored	Other	White	Colored	Other	White	Colored	Other
1999(1)	41	24	10	75	252,548	249,195	248,738	18,715	36,751	20,302	231,753	229,934	229,408	17,130	33,922	18,706
1999(2)	75	51	34	160	347,237	435,426	129,036	23,968	65,195	12,051	330,218	415,354	122,383	22,798	62,005	11,437
2000(1)	87	38	52	177	376,442	358,030	195,420	23,135	56,965	14,341	409,467	390,833	212,379	25,033	62,238	15,539
2000(2)	70	37	37	144	258,058	414,692	239,704	19,983	59,492	15,660	298,504	479,674	277,384	23,111	68,774	18,123
2001(1)	89	43	29	161	321,323	228,779	221,602	21,787	46,633	11,758	362,345	257,049	248,369	24,544	52,458	13,164
2001(2)	120	45	37	202	243,505	235,391	271,767	21,053	41,802	19,796	268,960	260,759	301,038	23,239	46,195	21,861
2002(1)	72	49	28	149	267,137	228,782	161,614	19,666	38,609	14,613	299,324	255,557	181,234	22,066	43,166	16,398
2002(2)	70	46	19	135	212,887	271,755	140,445	22,697	50,074	14,297	213,884	272,591	141,388	22,820	50,276	14,421
2003(1)	49	27	18	94	308,444	237,116	145,530	20,519	20,402	12,935	277,200	211,269	130,446	18,508	18,309	11,587
2003(2)	71	33	22	126	349,074	324,789	353,245	26,485	68,226	21,915	301,527	280,326	306,152	22,862	58,718	18,963
2004(1)	88	57	30	175	375,120	434,951	220,680	27,891	64,022	20,484	310,154	360,147	183,591	23,015	53,068	17,035
2004(2)	53	27	23	103	350,790	440,614	332,264	26,971	80,221	31,621	273,491	341,125	258,489	21,008	62,107	24,585
2005(1)	112	43	48	203	373,339	396,437	320,667	25,798	77,472	27,256	293,367	316,061	250,800	20,346	62,113	21,392
2005(2)	43	22	34	99	322,655	910,639	179,389	24,224	102,130	12,393	271,529	766,311	151,835	20,355	86,127	10,509
2006(1)	101	65	71	237	371,682	547,782	291,371	32,889	64,549	24,211	301,395	447,272	236,449	26,645	52,290	19,688
2006(2)	95	54	49	198	509,626	414,814	217,718	38,192	51,625	21,335	399,640	326,466	170,561	29,903	40,736	16,739
2007(1)	92	60	43	195	415,626	683,877	343,579	36,585	76,489	22,593	309,751	508,876	255,718	27,312	57,027	16,802
2007(2)	133	57	57	247	638,049	696,880	346,385	46,477	115,874	23,978	436,324	479,635	238,713	31,870	79,812	16,536
2008(1)	86	51	41	178	817,855	778,011	316,885	58,728	86,682	25,316	523,934	501,560	203,425	37,669	56,020	16,235
2008(2)	91	49	29	169	670,503	920,661	308,912	52,488	65,426	15,262	507,783	703,094	236,789	39,745	49,385	11,653
2009(1)	111	36	37	184	465,515	676,261	175,948	40,659	92,984	16,103	347,399	499,243	131,479	30,353	68,645	12,066
2009(2)	118	76	34	228	695,173	758,165	415,065	49,932	146,550	33,079	470,415	511,616	280,496	33,817	98,773	22,335
2010(1)	118	75	49	242	653,831	775,850	434,993	53,040	145,689	38,489	503,981	606,330	334,845	40,876	114,358	29,443
2010(2)	71	34	15	120	506,044	1,405,313	298,833	58,362	145,653	29,185	370,214	1,020,315	217,772	42,674	105,403	21,297
2011(1)	115	49	17	181	704,400	1,054,105	975,391	68,422	163,012	46,358	490,198	732,580	678,073	47,695	113,213	32,215
2011(2)	81	32	2	115	888,454	1,532,353	422,539	66,912	237,849	16,070	653,597	1,124,987	315,179	49,215	174,498	11,981
2012(1)	158	67	1	226	746,579	1,076,882	1,142,500	59,042	144,837	56,531	575,045	828,827	873,271	45,422	111,359	43,210
2012(2)	164	63	0	227	709,236	1,038,596		51,999	104,144		553,565	809,663		40,577	81,155	
Total	2,574	1,310	866	4,750	505,356	642,689	286,996	39,792	90,750	21,920	400,206	505,615	235,176	31,408	71,785	17,938

This table shows the number of observed auction transactions, the average price in nominal Euro and USD, and the average price per carat in nominal Euro and USD of white diamonds, colored diamonds, and other gems for each semester over the period 1999-2012.

Figure 1. Average price / carat (nominal)

Figure 1 shows the average price per carat in nominal Euro (Figure 1a) and USD (Figure 1b) of white diamonds, colored diamonds, and other gems for each semester over the period 1999-2012.

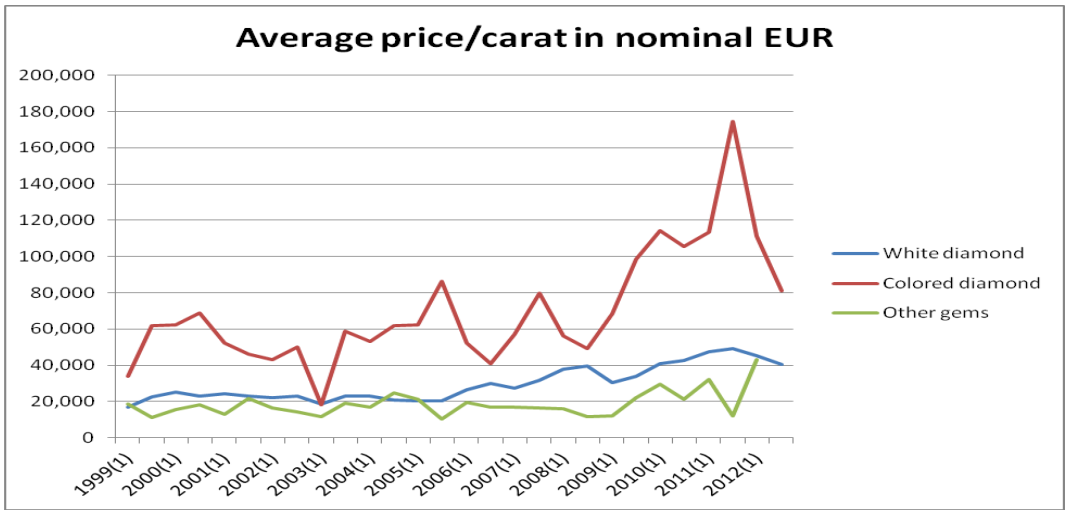

Figure 1a

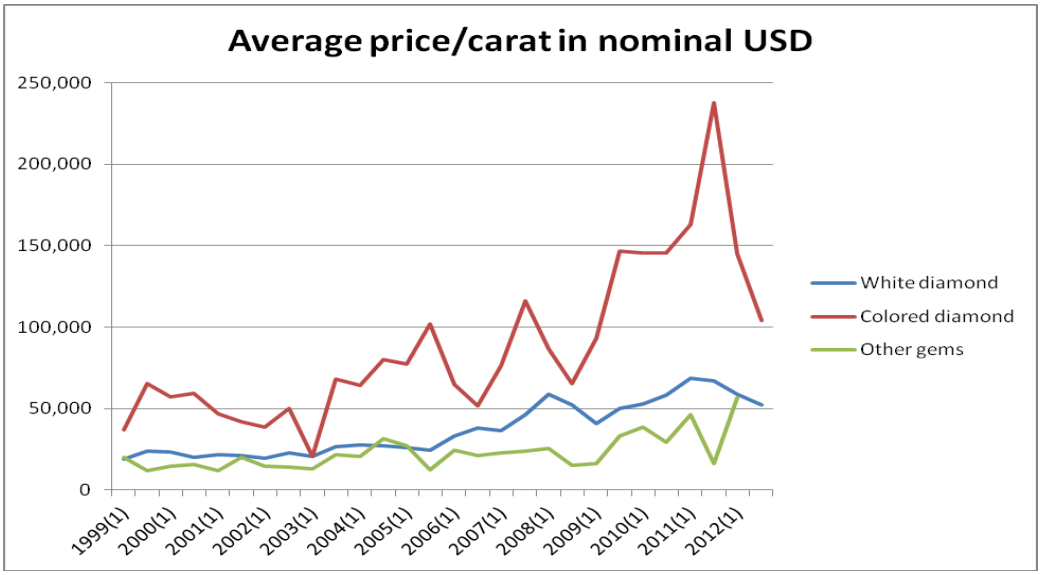

Figure 1b

Calculating average prices is only an initial step, since a price index should also take into account variation in the average quality of the items sold. Indeed, average prices can go up both because of a true increase in the overall price level, or because of a shift in the sales composition towards higher-quality objects. Dohrmann (1981) claims that the uniqueness of

each piece implies that constructing a price index for diamonds is like "trying to have an index for snowflakes". Such a statement is incorrect: building a price index for heterogeneous goods is far from impossible, provided that enough transactions are observed and that detailed sales information is available. Index construction may even be less complicated for diamonds than for other collectible goods, since a relatively limited number of easily quantifiable characteristics capture a lot of the appeal – and hence the price – of each stone (Renneboog and Spaenjers, 2012).

In this study, we estimate the returns on gems by applying a hedonic regression to our database. The hedonic methodology has previously been used to estimate the returns on other heterogeneous and infrequently traded assets, such as real estate (e.g., Meese and Wallace, 1997), wine (e.g., Combris et al, 1997), and art (e.g., Renneboog and Spaenjers, 2013). The idea is to relate the prices of individual sales to a number of price-determining characteristics (e.g., the number of rooms in a house, the region of production of a bottle of wine, or the size of a painting) and a range of time dummies (e.g., years). Under the assumption that the hedonic characteristics capture the quality of the item, the regression coefficients on the time dummies will proxy for the price level in each period. More formally, a hedonic regression model can be represented as in Equation (1):

$$\ln p_{kt} = \alpha + \sum_{m=1}^{M} \beta_m x_{mkt} + \sum_{t=1}^{T} \gamma_t d_{kt} + \varepsilon_{kt} , \quad (1)$$

where p_{kt} represents the price of good k at time t, x_{mkt} is the value of characteristic m of object k at time t, and d_{kt} is a time dummy variable which takes a value of one if good k is sold in period t (and zero otherwise). The coefficients β_m reflect the attribution of a shadow price to each of the M characteristics, while the changes in the antilogs of the coefficients γ_t are used to calculate returns over T time periods.

The choice of the hedonic characteristics is of key importance, since these variables should capture as precisely as possible the time-invariant quality or appeal of each item. Our database contains information on many of the characteristics that can be expected to impact gem prices (see also Renneboog and Spaenjers (2012)). We first focus on 'the four Cs', which are assumed to be the most important factors in setting the value of diamonds (and, to some extent, other gems): carat, color, clarity, and cut. The variable *Ln(carat)* measures the natural log of the carat weight. We have different categories of color for each type of diamonds, indicating different color spectra of light emitted. For white diamonds, our dummy categories are based on the traditional scale which goes from D to Z (If a diamond is indicated to belong to two adjacent categories, we use the greatest letter). Colorless or nearly colorless diamonds have greater brilliance. For colored diamonds, we include separate variables for blue, brown, green, pink, and yellow stones (which are the most frequently observed colors). With respect to the other gems, we create separate variables for emeralds, rubies, and for sapphires from Burma, Ceylon, and Kashmir. For the diamonds in our database, we also consider the clarity of each stone, going from flawless (*FL*), over internally flawless (*IF*), very very small inclusions (*VVS*), very small inclusions (*VS*), and small inclusions (*SI*), to inclusions or

unspecified clarity (*Other / unknown*). The inclusions are scratches, minerals, or other imperfections that have an impact on the diamond's clarity. Diamonds that are completely free from internal flaws are extremely rare. As only one colored diamond is of the "flawless" category; we pool it with the "internally flawless" stones While the color and clarity of a diamond are predetermined by nature, the cut, which affects the brilliance and sparkle, is influenced by human intervention. We take into account the shape of each diamond, by including variables capturing the most popular types of cut: *Round*, *Emerald*, *Marquise*, and *Passion*. We combine less frequently used cuts (such as princess, radiant, oval, pear, asscher) into a benchmark category called *Other*.

Next, in most cases, we observe the location of sale, which can be *Geneva*, *London*, *Hong Kong*, *London*, *New York* or another location (*Other*: Los Angeles, Sankt Moritz,…) in case there are less than 20 sales in a city. Finally, we also include some additional information. *Christie's* equals one if the stone is sold at that auction house, and thus not at Sotheby's (which we use as benchmark). *Brand* equals one if the jewel is from a premium brand, such as Bulgari, Cartier, Graff, or Tiffany. *Certificate* equals one when the database indicates that an authenticity certificate, issued by one of the specialized laboratories, accompanies the stone. (Most of the emeralds, rubies, and sapphires in our sample have a certificate, which makes the presence of a certificate not very informative.) For white diamonds, a dummy variable *Potential* indicates whether the diamond could be upgraded by recutting or polishing. We only use these additional variables if there are at least 20 observations that take the least frequent of the two possible values.

Table 2 shows the descriptive statistics for all variables in our set-up. We show the frequencies of occurrence of the stones' characteristics across all transactions. For the variable *Ln(carat)*, we show the average value. The mean weight is highest in the category of non-diamond gems (12.9 carat) versus 7.4 for white and colored diamonds (compare Panels A-C). In the category of white diamonds (Panel A), we see that the 'colorless' diamonds with color grading D are auctioned most (with 42.5% of the trades). For colored diamonds (Panel B), the most frequently observed color is yellow (57.8%), followed by pink (17.6%) and blue (11.0%). In both diamond categories (Panels A-B), we observe variation with respect to clarity, but stones with very small inclusions are the largest category. Truly flawless diamonds are very rare, even in the top segment of auctioned gems. Over the time period 1999-2012, only 109 flawless white diamonds were auctioned in addition to 594 internally flawless white diamonds (Panel A), and merely two flawless colored diamonds versus 173 internally flawless colored ones (Panel B). About one in four of the white diamonds, and one in eight of the colored diamonds have a round shape (Panels A-B). Panel C shows that sapphires are more frequently traded than both emeralds and rubies. For all three types of gems, a majority of the sales included took place at Christie's (55-60%). Only a minority is from a renowned premium brand. Finally, we see that virtually all diamonds' origin and quality are well-documented and certified (Panels A-B).

Table 2. Descriptive statistics of white and colored diamonds and other gems

Table 2 shows the descriptive statistics of the hedonic variables included in this research. All hedonic

characteristics are defined in Section 2 of this paper. For the dummy variables, we present the number of sales for which the variable takes the values of zero (0) and one (1), and the proportion of ones (% 1). For the caratage, we show the median carat weight. Panels A, B, and C show the statistics for white diamonds, colored diamonds, and other gems, respectively.

Panel A. White diamonds

Variable	*Transactions with these characteristics*	*%*
Size		
Ln (Carat)	[Median is 7.4 carat]	
Color		
D	1,094	42.5%
E	230	8.9%
F	263	10.2%
G	223	8.7%
H	236	9.2%
IJ	281	10.9%
KL	114	4.4%
MZ	125	4.9%
Other	8	0.3%
Clarity		
FL	109	4.2%
IF	594	23.1%
VVS	663	25.8%
VS	928	36.1%
SI	266	10.3%
Other	14	0.5%
Shape		
Emerald cut	744	28.9%
Marquise cut	214	8.3%
Passion cut	418	16.2%
Round cut	639	24.8%
Other	559	21.7%
Location		
Geneva	782	30.4%
Hong Kong	627	24.4%
London	46	1.8%
New York	916	35.6%
Other	203	7.9%
Additional information		
Christie's	1,479	57.5%
Brand	372	14.5%
Certified	2,429	94.4%
Potential	158	6.1%

Panel B. Colored diamonds

Variable	*Transactions with these characteristics*	*%*
Size		
Ln (Carat)	[median is 7.4 carat]	
Color		
Blue	144	11.0%
Brown	89	6.8%
Green	33	2.5%
Pink	230	17.6%
Yellow	757	57.8%
Other	57	4.4%
Clarity		
FL	2	0.2%
IF	173	13.2%
VVS	288	22.0%
VS	549	41.9%
SI	173	13.2%
Other	125	9.5%
Shape		
Cushion cut	155	11.8%
Emerald cut	194	14.8%
Passion cut	192	14.7%
Radiant cut	300	22.9%
Round cut	179	13.7%
Other	290	22.1%
Location		
Geneva	397	30.3%
Hong Kong	352	26.9%
London	11	0.8%
New York	431	32.9%
Other	119	9.1%
Additional information		
Christie's	717	54.7%
Brand	111	8.5%
Certified	1,265	96.6%

Panel C. Other gems

Variable	*Transactions with these characteristics*	%
Size		
Ln (Carat)	[median is 12.9 carat]	
Color		
Emerald	183	21.1%
Ruby	151	17.4%
Sapphire	532	61.4%
Location		
Geneva	362	41.8%
Hong Kong	152	17.6%
London	11	1.3%
New York	255	29.4%
Other	86	9.9%
Additional information		
Christie's	501	57.9%
Brand	199	23.0%

3. The Price Determinants of Gems

The shadow prices of the hedonic characteristics – represented by the vector of coefficients β in Equation (1) – are assumed to stay constant over time. This is a fair assumption given that our estimation time frame is relatively short. We estimate the model of equation (1) for each of the three types of stones four times using ordinary least squares (OLS): for nominal and real prices, both in Euro and USD. Before examining the estimated returns, we focus on the results on the hedonic variables, which are shown in Table 3 for the nominal price model in Euro. The estimated hedonic coefficients hardly differ in the alternative estimations (real prices in Euro or USD or nominal prices in USD). To avoid multicollinearity, we have to leave out one dummy variable for some groups of variables (which then serves as benchmark against which the marginal effects are calculated). For the included variables, we do not only report the coefficient, the standard deviation, and the t-statistic, but also the percentage price impact of the variable, which can be calculated as one minus the exponent of the coefficient. This enables us to focus on the economic significance of the hedonic variables.

Table 3 shows that many of our hedonic variables have a substantial impact on prices. The impact of caratage differs between the different types of stones, but in general there is a very strong relationship between weight and price (Panels A-C). If we omit the squared term from the three models, the coefficients on *Ln(carat)* are all above one, indicating that in general prices increase more than proportionately with carat value (not reported). For white diamonds (Panel A), we see that prices move with the color and clarity scales. For example, a diamond of color category *E* sells on average at a 19.7% discount compared to an otherwise similar diamond of color category *D* (the left-out category); this discount increases to more than 80%

for lower-quality stones. The average premium for a flawless diamond over an internally flawless (*FL*) diamond is 17.9%. Relative to an internally flawless white diamond, a flawless white diamond is sold for a premium of 20%, but a diamond with very very small inclusions (*VVS*) incurs a discount of 27.2%. Also for colored diamonds (Panel B), color and clarity play important roles. The most expensive colored diamonds are blue; they cost in general more than twice as much as green diamonds, more than three times as much as pink ones, more than eight times the value of the common yellow diamonds, and more than twelve times the value of other (brown, orange) diamonds (panel B).

Table 3. Regression results hedonic variables

Table 3 shows the results (coefficients, standard deviations, and t-statistics) of the OLS estimation of hedonic regression equation (1) in nominal Euro. All hedonic characteristics are defined in Section 2 of this paper. For the dummy variables, we also report the price impact, calculated as one minus the exponent of the coefficient. Panels A, B, and C show the results for white diamonds, colored diamonds, and other gems, respectively.

Panel A. White diamonds

Variables	*Coeff.*	*Stan.Dev.*	*t-stat*	*Impact*
Size				
Ln(Carat)	2.209	0.048	45.64	810.7%
Ln(Carat)^2	-0.155	0.010	-15.61	-14.4%
Color				
D	benchmark			
E	-0.219	0.020	-10.71	-19.7%
F	-0.346	0.020	-17.36	-29.2%
G	-0.554	0.021	-26.15	-42.5%
H	-0.745	0.021	-35.66	-52.5%
I-J	-1.038	0.020	-51.38	-64.6%
K-L	-1.418	0.029	-48.44	-75.8%
M-Z	-1.790	0.030	-58.95	-83.3%
Other	-1.628	0.099	-16.53	-80.4%
Clarity				
FL	0.176	0.029	6.01	19.2%
IF	benchmark			
VVS	-0.272	0.017	-16.32	-23.8%
VS	-0.417	0.017	-24.44	-34.1%
SI	-0.751	0.022	-33.64	-52.8%
Other	-1.010	0.074	-13.69	-63.6%
Shape				
Round cut	0.204	0.016	12.52	22.6%
Emerald cut	-0.015	0.016	-0.93	-1.4%
Marquise cut	-0.083	0.022	-3.78	-8.0%
Passion cut	0.006	0.018	0.31	0.6%
Other	benchmark			
Location				
Geneva	benchmark			
London	0.067	0.042	1.58	6.9%
Hong Kong	0.117	0.016	7.23	12.4%
New York	-0.027	0.014	-1.89	-2.6%
Other	-0.038	0.023	-1.69	-3.7%
Additional information				
Christie's	0.023	0.011	2.06	2.4%
Brand	0.064	0.016	4.06	6.6%
Certified	-0.016	0.027	-0.59	-1.6%
Adjusted R-squared	0.94			
N	2,574			

Panel B. Colored diamonds

Variables	*Coeff.*	*Stan. Dev.*	*t-stat*	*Impact*
Size				
Ln(Carat)	0.639	0.098	6.50	89.5%
Ln(Carat)^2	0.060	0.021	2.82	6.2%
Color				
Blue	2.244	0.086	26.05	843.4%
Brown	-0.659	0.098	-6.74	-48.3%
Green	1.444	0.152	9.53	323.7%
Pink	1.340	0.067	19.92	282.0%
Yellow	benchmark			
Other	0.551	0.118	4.65	73.5%
Clarity				
FL	1.220	0.585	2.09	238.8%
IF	benchmark			
VVS	-0.265	0.081	-3.28	-23.3%
VS	-0.297	0.074	-4.03	-25.7%
SI	-0.476	0.092	-5.16	-37.9%
Other	-0.677	0.102	-6.60	-49.2%
Shape				
Round cut	0.117	0.080	1.47	12.5%
Emerald cut	0.331	0.078	4.26	39.2%
Cushion cut	0.191	0.085	2.25	21.0%
Passion cut	0.120	0.079	1.52	12.8%
Radiant cut	-0.102	0.072	-1.43	-9.7%
Other cut	benchmark			
Location				
Geneva	benchmark			
London	-0.111	0.260	-0.43	-10.5%
Hong Kong	0.029	0.066	0.44	3.0%
New York	-0.189	0.062	-3.05	-17.2%
Other	-0.011	0.090	-0.12	-1.1%
Additional information				
Christie's	0.003	0.048	0.06	0.3%
Brand	0.118	0.083	1.43	12.5%
Certified	0.480	0.132	3.62	61.6%
Adjusted R-squared	0.58			
N	1,310			

Panel C. Other gems

Variables	*Coeff.*	*Stan.Dev.*	*t-stat*	*Impact*
Size				
Ln(Carat)	0.865	0.237	3.64	137.5%
Ln(Carat)^2	-0.066	0.041	-1.61	-6.4%
Color/type				
Emerald	Benchmark			
Ruby	0.585	0.094	6.23	79.6%
Sapphire	-0.452	0.075	-6.06	-36.4%
Location				
London	-0.114	0.264	-0.43	-10.8%
Hong Kong	0.290	0.087	3.32	33.7%
New York	-0.035	0.072	-0.48	-3.4%
Other	-0.32	0.105	-3.03	-27.4%
Additional information				
Christies	0.084	0.062	1.35	8.7%
Brand	0.104	0.070	1.49	10.9%
Adjusted R-squared	0.27			
N	866			

Relative to internally flawless (IF) coloured diamonds, diamonds with very small inclusions, very small inclusions, or small inclusions are traded with discounts of relatively 23%, 26% and 38%. We also document in Panel A that there is a significant premium of more than 20% for a round shape in the case of white diamonds. Dundek (2009) argues that "round brilliant diamonds are the only shape to have the perfect proportions defined. This shape has set the standard for all other diamond shapes." But this argument does not hold for colored diamonds (Panel B) of which emerald and cushion cuts seem to be preferred. With respect to the other gem stone types (Panel C), we observe that rubies are clearly more expensive than the other types of stones. Rubies are 80% more expensive than emeralds, which in turn are three times as expensive as sapphires. There is a strong difference in price between the different types of sapphires: the ones coming from Kashmir are significantly more expensive than the ones from Burma or Ceylon (not shown). White diamonds (Panel A) sell at slightly higher prices in London and Hong Kong than in Geneva, New York, and the other locations. Colored diamonds and other types of gems (Panels B and C) are especially expensive in Hong Kong, followed by Geneva. However, it is important to note that the pricing differences between locations may reflect otherwise unobservable differences in average quality, rather than violations of the law of one price. (Moreover, the pricing differences between locations are relatively small such that arbitrage opportunities between locations would not be exploitable.) We find no statistically significant difference in prices that the different auction houses (Christie's and Sotheby's) obtain (Panels A-C). There are only relatively small premia for jewels created by renowned designer houses: 6.6% for white diamonds (Panel A), 12.5% for colored diamonds (Panel B) and 10.9% for other gems (Panel C). Substantially lower prices

are paid for the few colored stones that do not seem to have a certificate (Panel B). Finally, we see a premium of more than 20% for white stones that have the potential to be recut and upgraded (not shown).

At the bottom of each panel, we show the R-squared of each model. We find that our time dummies and hedonic characteristics together explain almost 97% of the variation in prices of white diamonds (Panel A). This implies that investment grade diamonds are large traded on their physical characteristics. The explanatory power is somewhat lower for colored diamonds and for other gems, although still at about 55% or more (Panel B). With regard to the other gems (rubies, sapphires, and emeralds), the hedonic variables only explain 23% of the price variation (Panel C).

In Figure 2, we graphically illustrate the importance of color and clarity for white diamonds. Panel A shows the relative pricing differences between D-grade diamonds and other color grades, all else equal. Panel B shows the premium or discount for different types of clarity in comparison to an otherwise identical internally flawless (*IF*) diamond.

Figure 2. Importance of color and clarity for white diamonds

Figure 2 shows the relative pricing differences between white diamonds of different color grades (Figure 2a) and clarity types (Figure 2b). The percentage premiums or discounts relative to the base categories (color grade *D* in Panel A and clarity type *IF* in Panel B) come from the hedonic regression output shown in Table 3.

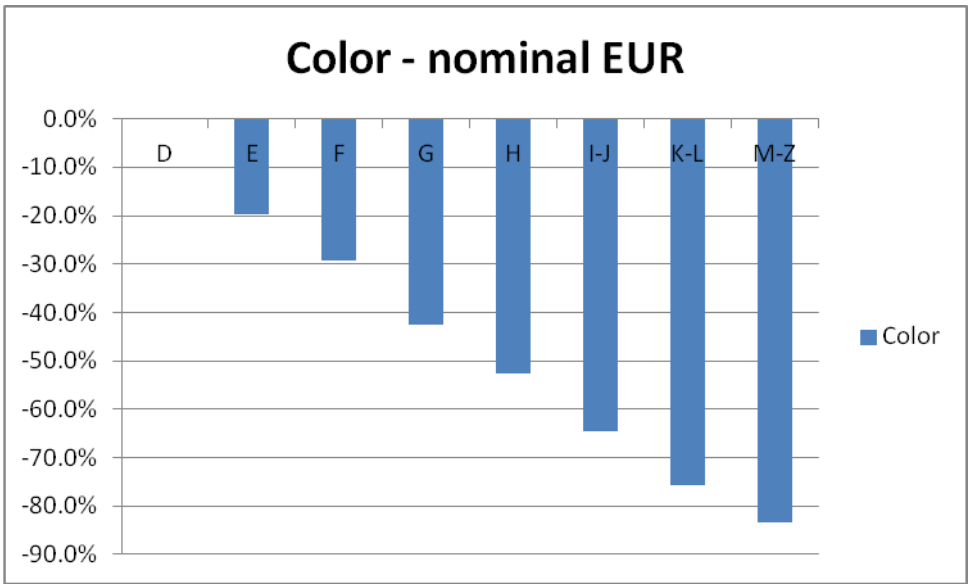

Figure 2a. Color

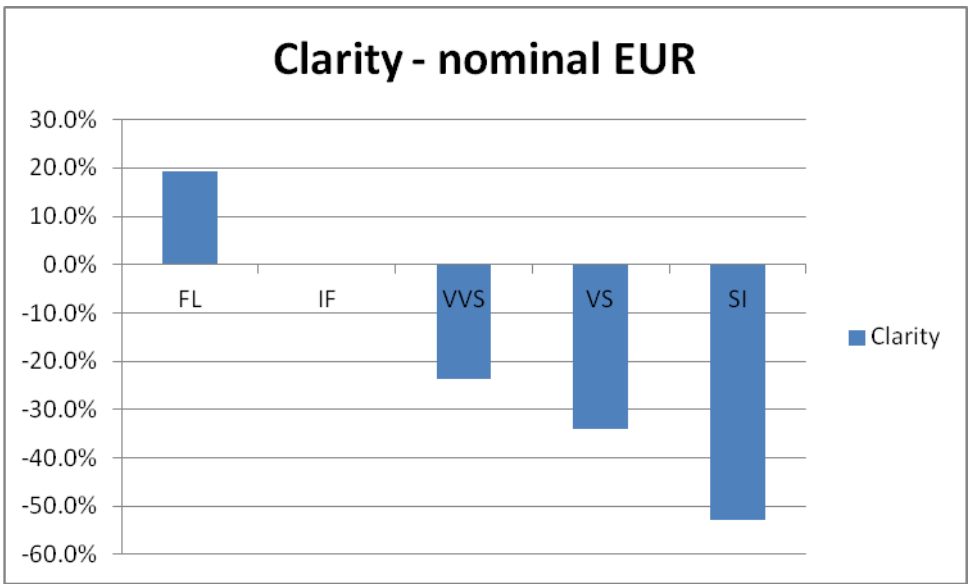

Figure 2b. Clarity

4. The Returns on Diamonds and Gems

In Table 4, we show the nominal returns for each type of gem in Euro (Panel A) and USD (Panel B). At the end of each panel, we also show the real (deflated) returns. These returns are calculated as the exponent of the difference between the coefficients γ on the time dummy variables in two subsequent periods, minus one. A caveat for the Other Gems category is needed: the returns for this category over the period 1999-2002 are based on a small number of observations and should therefore be considered with caution; from the second semester of 2003, a sufficiently large number of transactions yield more representative returns for Other Gems. We also construct a price index for each category, with the relative price level in the first semester of 1999 set equal to 100.

For white diamonds, we observe an annualized nominal return for a Euro investor of 6.9% between the first half of 1999 and the end of 2012 and of 9.7% since 2003 (Panel A). Negative nominal returns were recorded in a number of time periods following the dot-com bust in early 2000 and during the middle of the recent financial crisis. These negative returns were more than compensated, however, by solid price rises subsequent to the crisis periods, namely between end-2003 and early-2008 and since 2009, when also equity markets performed well. The results suggest that changes in the equity market impact the funds available for investment in collectibles markets; we will examine the relationship between equity and diamond prices more thoroughly in the next section. Despite the financial crisis of 2007-2008, the annualized return after inflation on white diamonds equals 4.2% over the last 15 years and 7.1% since the second half of 2003. For a USD investors, the situation looks more favourable (Panel B). His white diamond investments could have yielded 8.1% nominally and 5.5% in real terms (both returns would be 3% higher in case his initial investment was done in 2003).

The performance of colored diamonds is just a little lower. The average nominal returns equal 6.1% since 1999 and 7.6% since 2003 for a Euro investor whose real returns amount to respectively 3.5% and 5.0% (Panel A). As before, a dollar investor would have been able to reach somewhat higher annual returns (Panel B). The returns for Other Gem stones are the lowest but still beats inflation by an annualized 0.4% (since 1999) and 2.3% (since 2003) for investments in Euro and by respectively 2.1% and 4.1% in USD.

Table 4. Real returns and index values

Table 4 shows the nominal and real in Euro (Panel A) and USD (panel B), which follow from the OLS estimation of hedonic regression equation (1), for white diamonds, colored diamonds, and other gems for each semester over the period 1999-2012. The panel also report the index values, where the index is set equal to 100 in the first semester of 1999. The single transaction (representing an extreme outlier) for other gems in 2012 was not included in the returns calculation.

Panel A (in Euro)						
	Nominal returns (Euro)			Index values (Euro)		
Year (semester)	White	Colored	Other Gems	White	Colored	Other Gems
1999(1)				100.0%	100.0%	100.0%
1999(2)	20.5%	53.4%	-15.1%	120.5%	153.4%	84.9%
2000(1)	13.9%	-25.6%	13.3%	137.2%	114.2%	96.2%
2000(2)	1.0%	48.2%	1.0%	138.6%	169.3%	97.2%
2001(1)	4.8%	-14.3%	4.8%	145.3%	145.1%	101.9%
2001(2)	-8.9%	-22.6%	0.0%	132.4%	112.3%	101.9%
2002(1)	1.8%	8.9%	5.7%	134.8%	122.3%	107.7%
2002(2)	-10.7%	-13.2%	-39.7%	120.4%	106.2%	64.9%
2003(1)	-15.6%	-15.3%	19.9%	101.6%	90.0%	77.8%
2003(2)	4.6%	28.1%	27.1%	106.3%	115.3%	98.9%
2004(1)	-2.6%	-8.6%	-13.1%	103.5%	105.4%	85.9%
2004(2)	7.1%	20.4%	15.7%	110.8%	126.9%	99.4%
2005(1)	21.5%	14.3%	-1.9%	134.6%	145.1%	97.5%
2005(2)	10.0%	20.4%	-15.8%	148.1%	174.7%	82.1%
2006(1)	10.7%	-8.8%	14.9%	164.0%	159.3%	94.3%
2006(2)	2.7%	-9.9%	-22.7%	168.5%	143.5%	72.9%
2007(1)	9.9%	12.5%	43.5%	185.2%	161.4%	104.6%
2007(2)	1.7%	7.7%	-8.4%	188.3%	173.9%	95.8%
2008(1)	31.3%	-8.5%	10.3%	247.3%	159.1%	105.7%
2008(2)	-12.0%	-7.7%	-22.2%	217.7%	146.8%	82.2%
2009(1)	-13.5%	0.5%	-17.3%	188.3%	147.5%	68.0%
2009(2)	-4.6%	0.9%	94.6%	179.6%	148.8%	132.3%
2010(1)	27.1%	15.7%	27.5%	228.3%	172.2%	168.7%
2010(2)	-5.4%	2.7%	-47.5%	216.0%	176.9%	88.6%
2011(1)	6.1%	11.2%	145.1%	229.1%	196.7%	217.2%
2011(2)	5.5%	8.3%	-33.8%	241.7%	213.1%	143.7%
2012(1)	8.3%	-12.7%		261.8%	186.1%	
2012(2)	-6.5%	19.9%		244.8%	223.2%	
Nominal average return (geometric) since 1999(1) - Euro				*6.9%*	*6.1%*	*2.9%*
Nominal average return (geometric) since 2003(2) - Euro				*9.7%*	*7.6%*	*4.8%*
Real average return (geometric) since 1999(1) – Euro				*4.2%*	*3.5%*	*0.4%*
Real average return (geometric) since 2003(2)- Euro				*7.1%*	*5.0%*	*2.3%*

Panel B (in USD)						
	Nominal returns			Index values		
Year (semester)	White	Colored	Other Gems	White	Colored	Other Gems
1999(1)				100.0%	100.0%	100.0%
1999(2)	15.5%	47.6%	-18.6%	115.5%	147.6%	81.4%
2000(1)	0.5%	-34.6%	-0.2%	116.1%	96.6%	81.2%
2000(2)	-5.7%	38.8%	-5.7%	109.5%	134.1%	76.6%
2001(1)	7.3%	-11.6%	8.7%	117.5%	118.5%	83.3%
2001(2)	-7.0%	-21.4%	0.6%	109.3%	93.2%	83.8%
2002(1)	0.3%	7.3%	4.5%	109.6%	100.0%	87.6%
2002(2)	-0.1%	-2.9%	-32.6%	109.5%	97.1%	59.0%
2003(1)	-6.8%	-6.2%	32.9%	102.0%	91.1%	78.4%
2003(2)	10.8%	35.3%	33.3%	113.0%	123.3%	104.5%
2004(1)	1.6%	-4.9%	-8.9%	114.8%	117.2%	95.2%
2004(2)	12.8%	28.5%	22.2%	129.5%	150.6%	116.3%
2005(1)	20.5%	11.8%	-2.6%	156.1%	168.4%	113.3%
2005(2)	3.1%	13.2%	-22.0%	161.0%	190.7%	88.4%
2006(1)	14.7%	-5.5%	19.8%	184.6%	180.2%	105.9%
2006(2)	6.8%	-6.7%	-19.9%	197.1%	168.2%	84.8%
2007(1)	14.7%	17.6%	50.7%	226.0%	197.8%	127.8%
2007(2)	10.7%	17.1%	-0.3%	250.2%	231.6%	127.4%
2008(1)	40.3%	-1.9%	17.7%	351.1%	227.2%	149.9%
2008(2)	-25.1%	-21.7%	-34.6%	263.1%	177.8%	98.1%
2009(1)	-12.4%	1.8%	-15.8%	230.4%	181.0%	82.6%
2009(2)	5.0%	11.7%	115.9%	241.9%	202.1%	178.3%
2010(1)	12.1%	0.7%	12.3%	271.1%	203.5%	200.3%
2010(2)	-1.6%	9.6%	-45.3%	266.8%	223.1%	109.6%
2011(1)	11.6%	15.6%	157.8%	297.8%	257.8%	282.6%
2011(2)	0.7%	3.3%	-37.6%	299.8%	266.2%	176.4%
2012(1)	3.6%	-16.8%		310.7%	221.6%	
2012(2)	-7.8%	18.3%		286.5%	262.2%	
Nominal average return (geometric) since 1999(1) – USD				*8.1%*	*7.4%*	*4.7%*
Nominal average return (geometric) since 2003(2) – USD				*10.9%*	*8.7%*	*6.8%*
Real average return (geometric) since 1999(1)- USD				*5.5%*	*4.8%*	*2.1%*
Real average return (geometric) since 2003(2) - USD				*8.2%*	*6.1%*	*4.1%*

5. Comparison with Other Assets

Table 4 is instructive, but it is hard to evaluate the financial attractiveness of diamonds and gems without a proper benchmark. In Figure 3, we depict the index values of white and colored diamonds, other gems, and other types of assets such as US and European stocks (S&P500 and Eurostoxx600), gold (S&P Goldman Sachs Gold Index), European government and corporate bonds (Meryll Lynch), real estate (Case Shiller Composite 10 from the C-S US National Real Estate Index and the S&P EU REIT index) for each semester over the period 1999-2012. All index values are in nominal terms, and each index is set equal to 100 for the first half of 1999. To deflate our nominal returns, we use the US consumer price index (from the Bureau of Labor Statistics) and the Harmonized Index of Consumer Prices (Eurostat).

Figure 3. Index values of various asset classes

Figure 3 shows the index values in nominal Euro for white diamonds, colored diamonds, other gems, US and European stocks (S&P500 and Eurostoxx600), European government and corporate bonds (Meryll Lynch indices ML EU GOV and ML EU CORP), real estate (Case Shiller Composite 10 index) for each semester over the period 1999-2012. The returns for white and colored diamonds are shown in Table 4. In all cases, the index is set equal to 100 in the first semester of 1999.

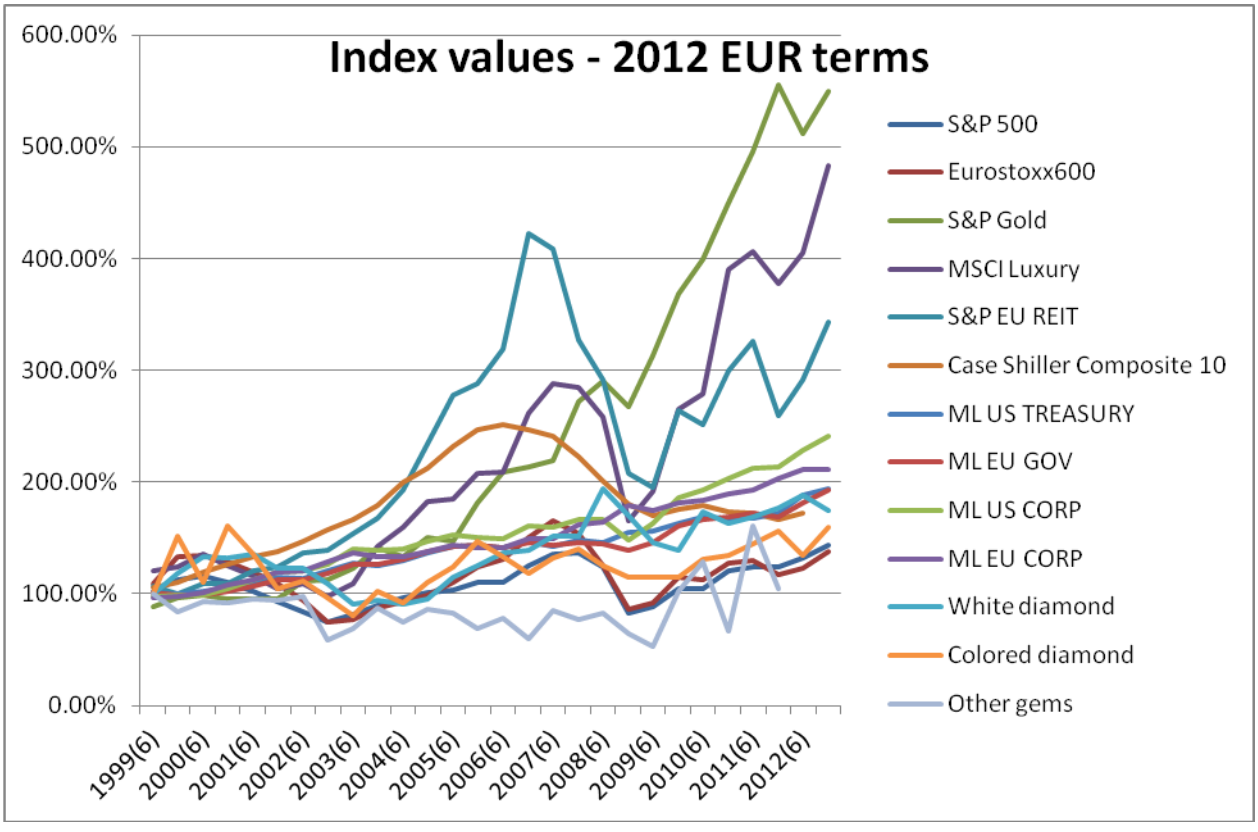

Figure 3 shows that white diamonds outperformed financial assets between early-1999 and late-2012 with exception of US real estate of which the index clearly reflects the bubble (until 2007). Similarly, colored diamonds performed better than stocks and as bonds. Gold appreciated still faster than investment-grade gems. Of course, gold has increased its status of a safe haven since the deep financial crisis that started in 2007.

Figure 3 also further illustrates that shocks in the equity market often precede changes in the gem market. For example, the financial crisis struck in the second half of 2007, but only translated into lower diamond prices in the second semester of 2008.

In Table 5, we more formally compare the performance of white and colored diamonds with that of financial assets, real estate and gold since the first half of 1999. We show the annualized returns, the annualized standard deviation,[2] and an estimate of the Sharpe ratio (i.e., the return in excess of the risk free rate by unit of risk) for each asset.[3] Moreover, we include the correlation of each asset with same-period and previous-period global stock returns.

White diamonds appreciated by an annualized nominal return of 6.9% (in Euro) or 8.11% (in USD) between 1999 and 2012 (Panel A of Table 5), whereas the returns on stocks merely reached 0.6% (Europe) or 1.3% due to the multiple equity market crises (the bursting of the dot.com bubble in 2000 and the succession of crises since 2007 - including the property market, banking, and government debt crises). Over this period, investment in bonds (5%-5.5% for government bonds and 5%-6.5% for corporate bonds) beat stocks but not white or colored diamonds. An investment in short-term government paper turned out not to be a bad investment relative to stocks, and long term government and corporate bonds and even real estate (Panel A). However, the investment that beat even the diamond investment was gold with a nominal annual return of 12.91%. Even when excluding the financial crises since 2007, Panel B does not show a strikingly different picture, save that real estate was an attractive investment (because of its exaggerated growth). Panels C and D of Table 5 give the risk and returns of all asset classes in real terms.

[2] The annualized standard deviation is calculated by multiplying the standard deviation over the half-yearly returns by the square root of two.

[3] We consider returns before transaction costs; these costs are of course higher for gems than for financial assets.

Table 5. Return and risk of investments in diamonds and other assets

Table 5 provides information on the mean nominal and real returns (and their standard deviations) for Euro and USD investors for white and colored diamonds, stocks (S&P500, Eurostoxx600), gold (S&P gold), luxury investments (MSCI Luxury Investment index), real estate (Cash-Shiller Composite 10 index, and real estate investment trusts for Europe (S&P EU REITs)), European and American government and corporate bonds (Meryll Lynch indices), and short-term government bonds (US T-bills on 6 months, German bonds on 6 months). All calculations are based on half-yearly returns over the period 1999-2012. The returns for white and colored diamonds are shown in Table 4. Data on the returns of global stocks, global government bonds, and gold were downloaded from Global Financial data.

Panel A **1999-2012**	**Currency**	**Annual** ***Nominal*** **mean returns**	**Annualized stand. dev.**	**Sharpe ratio**	**Correlation with stock returns**
Diamonds					
White diamond	USD	8.11%	17.39%	0.188	0.307
White diamond	EUR	6.86%	17.04%	0.071	0.128
Colored diamond	USD	7.40%	27.09%	0.094	0.369
Colored diamond	EUR	6.13%	27.56%	0.017	0.362
Stocks					
US (S&P500)	USD	1.30%	16.28%	-0.218	1.000
Europe (Eurostoxx600)	EUR	0.58%	19.28%	-0.263	1.000
Gold					
Gold (S&P)	USD	12.91%	15.38%	0.524	0.491
Luxury and real estate					
Luxury investments (MSCI)	USD	10.40%	24.85%	0.223	0.912
US real estate (Case-Shiller)	USD	3.74%	8.34%	-0.133	0.274
European Real estate (EU REITs)	EUR	3.49%	21.63%	-0.100	0.647
Bonds - long term					
US Gov. Bonds (ML)	USD	5.48%	4.80%	0.131	-0.606
US Corp. Bonds (ML)	USD	6.50%	6.92%	0.238	0.556
EU Gov. Bonds (ML)	EUR	4.96%	4.28%	-0.161	-0.242
EU Corp. Bonds (ML)	EUR	4.86%	4.70%	-0.168	0.289
Risk-free assets					
US T-bills 6 months	USD	4.85%	2.83%	NA	-0.137
German ST Bonds 6 months	EUR	5.65%	1.85%	NA	-0.586

Table 5 continued **Panel B**	**Currency**	**Annual** ***Nominal***	**Annualized stand. dev.**	**Sharpe ratio**	**Correlation with stock**

1999-2007		**mean return**			**returns**
Diamonds					
White diamond	USD	11.39%	11.95%	0.665	0.526
White diamond	EUR	7.73%	14.28%	0.316	0.598
Colored diamond	USD	10.39%	31.30%	0.222	0.249
Colored diamond	EUR	6.73%	33.14%	0.106	0.431
Stocks					
S&P500	USD	2.53%	10.28%	-0.089	1
Eurostoxx600	EUR	3.95%	16.25%	0.045	1
Gold					
S&P Gold	USD	11.38%	14.18%	0.560	0.139
Luxury and real estate					
MSCI Luxury	USD	11.48%	16.95%	0.474	0.797
Case Shiller Composite 10	USD	8.93%	6.59%	0.833	-0.02
S&P EU REIT	EUR	8.43%	17.13%	0.304	0.261
Bonds - long term					
ML US Gov	USD	5.49%	4.71%	0.435	-0.58
ML US Corp	USD	5.89%	5.02%	0.488	-0.396
ML EU Gov	EUR	4.57%	4.20%	0.321	-0.396
ML EU Corp	EUR	4.37%	3.90%	0.295	-0.411
Risk-free assets					
Tbill-6m	USD	3.44%	1.69%	NA	-0.018
GER-6m	EUR	3.22%	0.92%	NA	-0.516

1999-2012	Currency	Annualized *Real* mean return	Annualized std. dev.	Sharpe ratio	Correlation with stock returns
Diamonds					
White diamond	USD	5.51%	16.29%	0.343	0.269
White diamond	EUR	4.21%	16.39%	0.181	0.131
Colored diamond	USD	4.82%	26.63%	0.184	0.359
Colored diamond	EUR	3.50%	27.24%	0.083	0.367
Stocks					
S&P500	USD	-3.87%	17.28%	-0.219	1
Eurostoxx600	EUR	-2.66%	19.89%	-0.197	1
Gold					
S&P Gold	USD	7.58%	16.00%	0.479	0.543
Luxury and real estate					
MSCI Luxury	USD	4.83%	25.96%	0.189	0.923
Case Shiller Composite 10	USD	-1.28%	8.58%	-0.140	0.379
S&P EU REIT	EUR	0.21%	22.07%	-0.047	0.663
Bonds - long term					
ML US Gov	USD	0.45%	4.53%	0.117	-0.393
ML US Corp	USD	1.36%	7.97%	0.181	0.632
ML EU GOV	EUR	1.83%	4.33%	0.134	-0.101
ML EU Corp	EUR	1.71%	5.14%	0.090	0.388
Risk-free assets					
Tbill-6m	USD	-0.08%	1.82%	NA	0.222
GER-6m	EUR	1.25%	1.20%	NA	-0.304

Table 5 continued Panel D 1999-2007	Currency	Annualized mean return	Annualized std. dev.	Sharpe ratio	Correlation with stock returns
Diamonds					
White diamond	USD	8.36%	11.59%	0.656	0.51
White diamond	EUR	4.98%	13.99%	0.232	0.603
Colored diamond	USD	7.39%	30.87%	0.215	0.254
Colored diamond	EUR	4.01%	32.74%	0.069	0.437
Stocks					
S&P500	USD	-2.85%	10.23%	-0.353	1
Eurostoxx600	EUR	0.89%	16.50%	-0.052	1
Gold					
S&P Gold	USD	5.77%	14.15%	0.354	0.132
Luxury and real estate					
MSCI Luxury	USD	5.80%	17.10%	0.295	0.805
Case Shiller Composite 10	USD	3.37%	6.85%	0.381	-0.003
S&P EU REIT	EUR	5.31%	17.21%	0.207	0.274
Bonds - long term					
ML US Gov	USD	0.04%	4.71%	-0.153	-0.594
ML US Corp	USD	0.43%	5.04%	-0.066	-0.406
ML EU GOV	EUR	1.57%	4.19%	-0.041	-0.333
ML EU Corp	EUR	1.37%	3.90%	-0.095	-0.343
Risk-free assets					
Tbill-6m	USD	0.76%	1.45%	NA	-0.097
GER-6m	EUR	1.74%	0.87%	NA	-0.373

Obviously, a performance evaluation needs to be combined with risk. The Sharpe ratio gives the return (over and above the risk free rate) by unit of risk. We learn from Panel A that white diamonds have since 1999 substantially outperformed stocks, US and European real estate, US government bonds, and European government and corporate bonds. Only the reward-to-variability ratio of US corporate bonds and the MSCI index of luxury investments was somewhat better, as was the Sharpe ratio of gold which was by far the outperforming investments because of its safe haven status in times of crisis.[4] If we exclude the recent financial crises since 2007 (Panel B), we find that the Sharpe ratio of white diamonds (in USD) is far superior than that of stocks and bonds and even surpasses that of gold. We conclude that investments in diamonds may also maintain their value in times of crisis and give a fair return relative to its riskiness.

Table 5 also shows that the price changes of diamonds are positively correlated with equity market returns. This confirms the existence of a stock market wealth effect: the acquisition of diamonds is impacted by the evolution of equity wealth. (A similar observation that equity markets have wealth effects on collectibles prices is made by Goetzmann et al. (2011) in the context of the art market.) Our results thus shed doubt on the statement of an auction house jewelry specialist in July 2008 that "when stock markets go down, it's always good for us" (Bloomberg, 2008), which would suggest a negative correlation between the diamond and equity markets. Still, over the whole period 1999-2012, the correlation is between 0.13 (white diamonds) and 0.37 (coloured diamonds) which indicates that in a equity portfolio context, adding an investments in investment-grade diamonds still brings about some diversification advantages.

6. Top Quality Stones

An interesting question is whether the highest-end objects appreciate faster in value than the market as a whole. We therefore repeat the estimation of our hedonic model, first using all white diamonds of color categories D, E, and F, and second using all of those diamonds that weigh at least 10 carat. We illustrate the findings in Figure 4.

[4] It is important to note that the raw standard deviations may slightly underestimate the true riskiness of diamond investments, due to the time aggregation of data. We do not go deeper into this issue here, but refer to Renneboog and Spaenjers (2013).

Figure 4. Top quality diamonds

Figure 4 shows the index values in deflated Euro (Figure 4a) and USD (Figure 4b) for (i) white diamonds, (ii) white diamonds of color categories D, E, and F, and (iii) white diamonds of color categories D, E, and F of at least 10 carat, for each semester over the period 1999-2012. The baseline returns for white diamonds are shown in Table 4. The other returns follow from a re-estimation of hedonic regression equation (1). In all cases, the index is set equal to 100 in the first semester of 1999.

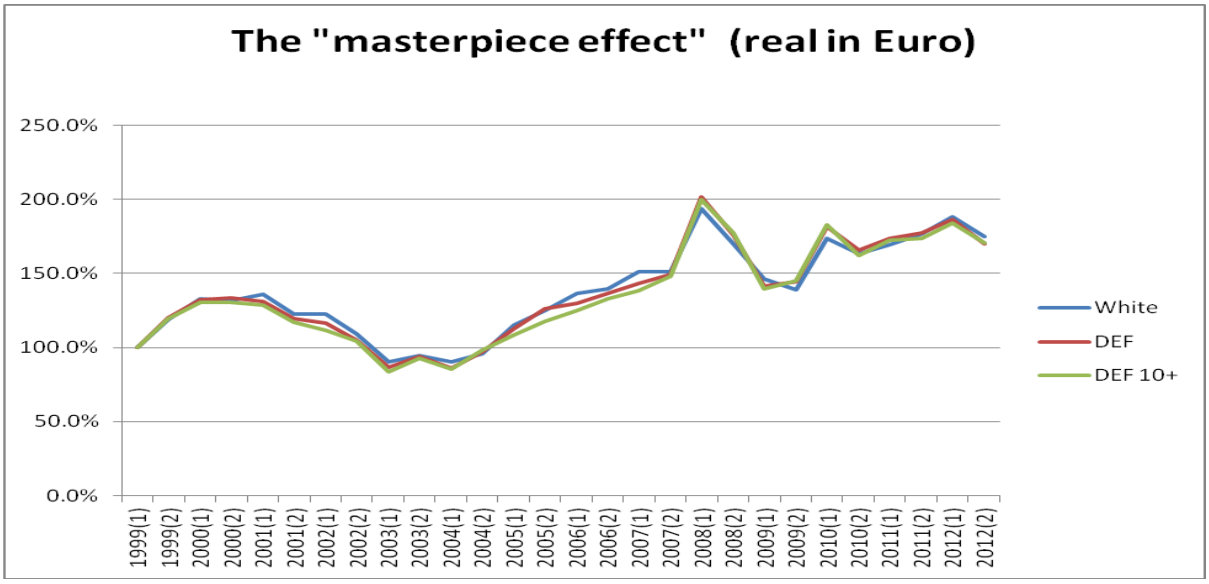

Figure 4a

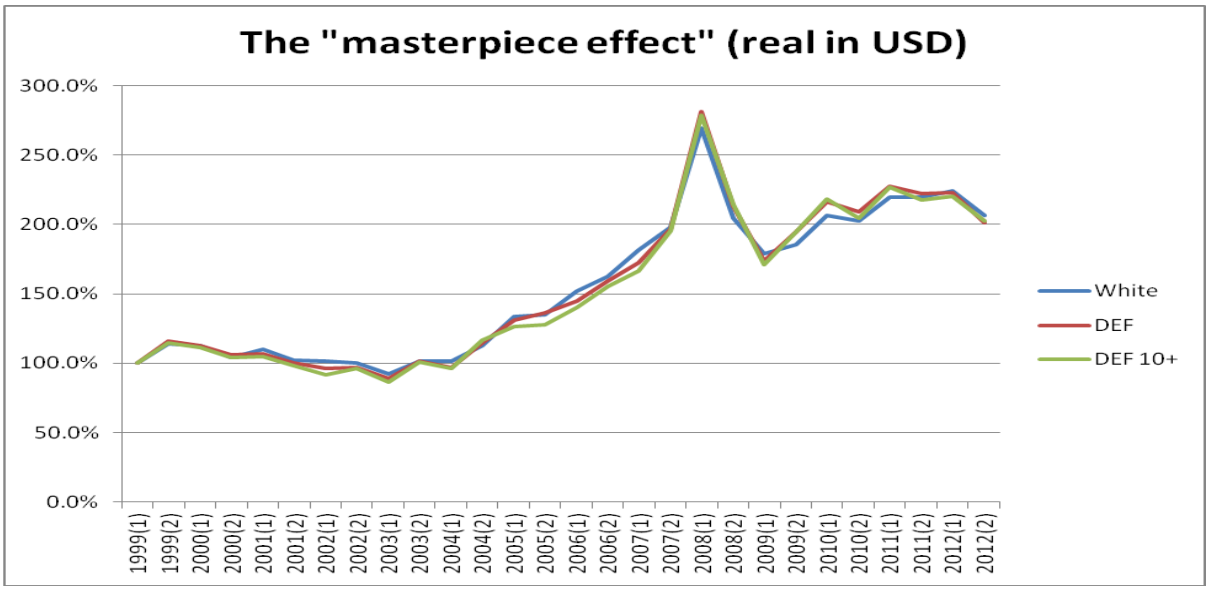

Figure 4b

There seems to be a small return premium for top-quality objects. Over our time frame, we find an annualized return of 5.9% for the larger white diamonds of categories D, E, and F (not reported), compared to 5.2% for our baseline series. This backs up previous evidence on the art market that higher returns can be realized on “masterpieces” (Renneboog and Spaenjers,

2013). Yet, just like high-quality art works, top-end diamonds have slightly more volatile price paths.

7. Conclusion and Discussion

In this paper, we study the market for investment-grade gems between 1999 and 2012. Applying a hedonic regression to a unique data set of auction transactions, we confirm that 'the four Cs' indeed play an important role in setting white diamond prices; overall, we are able to explain more than 95% of their price variation. Our model also performs well for colored diamonds and other gems (sapphires, rubies, and emeralds).

Over the past fourteen years, the annual nominal USD returns for white and colored diamonds amount to 8.1% and 7.4%, respectively, or 5.5% and 4.8% over and above inflation. For a Euro investor, those returns are about 1.3% lower but still beat inflation by 3.5% annually. The returns for Other Gem types (rubies, emeralds and sapphires) are more volatile and somewhat lower (4.5% nominal and 2.1% in real terms).

Although the diamond returns since 1999 have been below those on gold (a much-used safe haven in the recent financial crisis), both white and colored diamonds have significantly outperformed the US and European stock markets, US and European real estate, US government bonds, as well as European government and corporate bonds. The reward-to-risk of white diamonds has been very close to that of US corporate government bonds. The highest Sharpe ratio (by far) over the past 14 years was the one on gold. Still, in times of crisis investments in diamonds have shown an attractive risk-return tradeoff. We have also shown that in spite of a positive correlation between the diamond and the equity market, adding diamonds to an equity portfolio still have some diversification advantages.

One important issue to keep in mind is the low performance and high volatility of financial markets in the period examined in this paper. Ideally, it is important to compare the price trends of diamonds with that of financial assets and real assets over longer time periods. More research is needed to get a truly long-term picture of the realizable investment performance of gems.

References

Bloomberg (2008). Diamonds attract funds as largest gem price surge 76% in a year. 14 July 2008.

Capgemini (2010). *World Wealth Report*. Capgemini and Merrill Lynch Global Wealth Management.

Combris, P., Lecocq, S., & Visser, M. (1997). Estimation for a hedonic price equation for Bordeaux wine: Does quality matter? *Economic Journal.* 170 (390-402). http://dx.doi.org/10.1111/j.0013-0133.1997.165.x

Dimson, E., & Spaenjers, C. (2011). Ex post: The investment performance of collectible stamps. *Journal of Financial Economics.* 100 (443-458). http://dx.doi.org/10.1016/j.jfineco.2010.12.005

Dohrmann, B. (1981). *Grow Rich with Diamonds: Investing in the World's Most Precious Gems*. Harbor Publishing, San Francisco.

Dundek, M. (2009). *Diamonds*. Noble Gems Publications.

Goetzmann, W., Renneboog, L.& Spaenjers, C. (2011). Art and Money, *American Economic Review.* 101(222-226). http://dx.doi.org/10.1257/aer.101.3.222

Ibbotson, R. & Brinson, G. (1993). *Global investing: The Professional's Guide to the World Capital Markets*. McGraw-Hill, New York.

KPMG (2010). *The Global Gems and Jewellery Industry – Vision 2015: Transforming for Growth*.

Meese, R. A., & Wallace, N. E. (1997). The construction of residential housing prices indices: A comparison of repeat-sales, hedonic regression and hybrid approaches. *Journal of Real Estate Finance and Economics.* 14 (51-73). http://dx.doi.org/10.1023/A:1007715917198

National Gemstone (2010). Retail gemstone trends (1975-2009) [http://www.preciousgemstones.com].

Renneboog, L., & Spaenjers, C. (2013). Buying Beauty: On Prices and Returns in the Art Market, *Management Science*. 59 (36-53). http://dx.doi.org/10.1287/mnsc.1120.1580

Renneboog, L., & Spaenjers, C. (2012). Hard Assets: The Returns on Rare Diamonds and Gems, *Finance Research Letters.* 9 (220-230). http://dx.doi.org/10.1016/j.frl.2012.07.003

Reuters (2010). Pink diamond record price shows market strength. 17 November 2010.

Scott, F., & Yelowitz, A. (2010). Pricing anomalies in the market for diamonds: Evidence of conformist behaviour. *Economic Inquiry.* 48 (353-368). http://dx.doi.org/10.1111/j.1465-7295.2009.00237.x

Spar, D. L. (2006). Continuity and change in the international diamond market. *Journal of Economic Perspectives.* 20 (195-208). http://dx.doi.org/10.1257/jep.20.3.195

Sutton, A. C. (1979). *The Diamond Connection: A Manual for Investors*. JD Press.

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