

How Accurate Are Commercial Real Estate Appraisals? *Evidence from 25 Years of NCREIF Sales Data*

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As the commercial real estate industry emerges from the worst downturn since the crash of the early 1990s, the issues of performance measurement and reporting have once again taken center stage. Sales prices plummeted during 2008 and 2009, but what happened to the appraised values upon which investors rely for quarterly valuations? Did they accurately reflect the declines in value so readily observable in sales prices, or did they lag these declines, resulting in overvaluation within their portfolio and the NCREIF Index?

In this study, we provide important new evidence on this issue by examining the accuracy of commercial real estate appraisals that occurred prior to the sale of properties from the portfolios of commercial real estate investors that contribute data to the NCREIF property database. By examining sales over the past 25 years covered by NCREIF, from 1984 to 2010, we are able to determine whether appraised values lag sales prices, and if so, by how much.

We provide new evidence regarding how much confidence an investor can place in the appraisal of a single property, as well as how much confidence an investor can place in the appraisals of a portfolio of properties. We find that, on average, an appraisal is more than 12% above or below the subsequent sales prices that take place two quarters following the appraisal, even after adjusting for capital

appreciation during those two quarters. Even in a portfolio context, allowing for offsetting positive and negative differences, appraisals are off by an average of 4% to 5% of value.

We also provide new evidence on how well appraisals track the cycle of the commercial real estate market. We find that appraisals appear to lag the true sales prices, falling significantly below in hot markets and remaining significantly above in cold markets. The largest deviations are observed during the two peaks and two valleys of the past two cycles in the commercial real estate market. Not surprisingly, the worst performance occurred during the recent financial crisis.

This new evidence provides guidance to investors about how to interpret appraised values, as well as property indices based upon those values, in both a rising and a falling market.

Finally, we develop a model to explain the difference in sales price and appraised value. We find that this "appraisal error" is largely systematic; we can explain more than half of the variation in the signed percentage difference in sales price and appraised value. This is strong evidence that appraisal errors are not due solely to property-specific heterogeneity.

Our study is important because investors, regulators, and others rely upon appraised values to assess returns on the \$11 trillion U.S. commercial real estate market because properties transact infrequently. The most

widely used index of commercial real estate returns—the NCREIF National Property Index (NPI)—is based upon quarterly appraised values.¹

In addition, more than \$200 billion in pension fund investments were held in private commingled real estate funds (CREFs) as of the end of 2009. Many CREFs are so-called open funds in which investors can buy in and sell out based upon the aggregate appraised values of fund properties. If appraised values differ materially from market values, informed investors can, at least in theory, expropriate wealth from uninformed investors by moving in and out of these funds based upon their superior information. The larger the differential in appraised values and market values, the worse this problem becomes.

Finally, to the extent that firms managing the investments of pension funds benchmark their performance against the index, and use that benchmark to determine fees paid to them by investors, the overstatement or understatement of appraised values can lead to distortions in compensation.

There are several studies that have examined the reliability of commercial real estate appraisals, but most are now quite dated and rely upon information from only one cycle of the commercial real estate market. The first of these studies is by Cole, Guilkey, and Miles [1986], who examined 147 properties sold out of the NPI (formerly the Frank Russell Company, or FRC Index) during a period of rising prices from 1978 to 1984. They reported that the average absolute difference in sales price and most recent independent appraisal was almost 9%.

Webb [1994] examined 569 properties sold out of the NPI from 1978 to 1992, including 152 sales prior to 1986 when commercial real estate prices were rising, 115 sales in the 1986–1987 period when prices were flat, and 302 sales from 1988 to 1992 when prices were falling. Webb found that the absolute difference in sales price and most recent independent appraisal averaged 13% prior to 1986, with this average falling to 9%–10% during the 1986–1990 period and declining to only 7% in the years 1991 and 1992. Webb also found that the simple difference in sales price and most recent appraisal was positive and significant during the time of rising prices, but was negative and significant during the time of falling prices—strong evidence of a lag in appraised values relative to market prices.

The most recent study to visit this issue was by Fisher, Miles, and Webb [1999] who examined 2,739

properties sold from the NPI during the index's first 20 years, from 1978 to 1998. They reported that the average absolute percentage error was within a range of 9%–12.5%, reaching the low end of the range in 1986–1987 when the commercial real estate market was transitioning from appreciation to depreciation. They also reported that the average percentage error was 2.64% over the entire period, but was positive during the up market and negative during the down market. The worst performance was in 1991 when appraised values were, on average, 13.4% above sales prices.

DATA

Our data come primarily from the proprietary NCREIF property database. We collect information on quarterly appraised values, capital improvements, and partial sales, as well as information on whether the appraisal was done in house or by an outside third-party appraiser. We collect fixed information on property characteristics, such as property type (office, retail, industrial, apartment, and so on), leverage, type of ownership (open fund, closed fund, or separate account) and location. We collect the net and gross sales prices from the quarter in which the property was sold. We also collect information on cap rates from a survey conducted by the Real Estate Research Corporation (RERC); information on construction costs from the U.S. Census Bureau; and information on several measures of macroeconomic activity including the unemployment rate, level of gross domestic product, and the 10-year Treasury bond rate from the FRED database of the Federal Reserve Bank of St. Louis.

We begin with 9,439 properties where data indicate that the property was sold during the period spanning 1982 Q1 through 2010 Q2. We limit our sample to the 8,281 sold properties that have been included in the NPI at some point during this period. Of these, we identify 7,575 as being a *true sale*, which is defined by NCREIF as a “full sale of the property.” More than half of these sales have taken place since 1998, the last year analyzed by Fisher, Miles, and Webb [1999]. We find that our initial sample includes only three sales in 1982 and five sales in 1983, too few for meaningful analysis, so we drop these properties (one office and seven industrials) from our sample. We also find that our initial sample includes 105 hotel properties, also too few for meaningful analysis on an annual basis, so we also exclude these from our sample. This leaves us with

EXHIBIT 1

Properties Sold from the NPI, 1984 Q1–2010 Q2

Period	Total NPI		Sold from NPI			
	Number	Value (\$ Millions)	Number	Pct.	Value (\$ Millions)	Pct.
12/31/1983	989	9,025.0				
12/31/1984	1,060	11,476.0	37	3.5%	186.5	1.6%
12/31/1985	1,159	15,407.8	41	3.5%	139.8	0.9%
12/31/1986	1,253	17,870.9	90	7.2%	541.8	3.0%
12/31/1987	1,403	22,184.6	86	6.1%	598.1	2.7%
12/31/1988	1,536	28,470.9	118	7.7%	1,324.1	4.7%
12/31/1989	1,660	32,656.1	138	8.3%	1,413.8	4.3%
12/31/1990	1,877	37,970.8	109	5.8%	799.8	2.1%
12/31/1991	2,028	37,009.6	106	5.2%	1,322.7	3.6%
12/31/1992	2,233	39,499.3	87	3.9%	520.8	1.3%
12/31/1993	2,069	40,949.9	140	6.8%	1,289.8	3.1%
12/31/1994	1,970	41,030.8	165	8.4%	1,766.0	4.3%
12/31/1995	2,322	48,278.5	172	7.4%	2,168.0	4.5%
12/31/1996	2,378	54,424.1	307	12.9%	4,147.7	7.6%
12/31/1997	2,560	66,134.9	396	15.5%	7,028.1	10.6%
12/31/1998	2,440	67,352.9	420	17.2%	10,533.5	15.6%
12/31/1999	2,628	81,989.1	342	13.0%	7,176.6	8.8%
12/31/2000	3,028	97,634.8	283	9.3%	8,432.2	8.6%
12/31/2001	3,509	113,708.9	304	8.7%	7,236.3	6.4%
12/31/2002	3,681	122,621.4	372	10.1%	9,179.1	7.5%
12/31/2003	4,060	133,107.2	388	9.6%	10,094.4	7.6%
12/31/2004	4,151	146,535.2	580	14.0%	16,913.7	11.5%
12/31/2005	4,712	189,614.2	737	15.6%	22,639.4	11.9%
12/31/2006	5,332	247,285.3	602	11.3%	18,574.2	7.5%
12/31/2007	5,713	310,068.4	596	10.4%	22,372.7	7.2%
12/31/2008	6,285	305,276.4	230	3.7%	9,384.5	3.1%
12/31/2009	6,209	238,227.5	246	4.0%	6,515.1	2.7%
6/30/2010	6,066	234,484.6	122	2.0%	4,261.8	1.8%

7,462 properties of which 1,517 are apartments, 2,556 are industrial, 2,142 are office, and 1,247 are retail.

We find that 63 properties have no quarterly appraisal data prior to the sale date and are excluded from the analysis, leaving 7,399 properties. When we examine the most recent appraised value prior to sale date, we find that the appraised value is exactly equal to net sales price for 3,450 sold properties—almost half of the sample. This happens when managers substitute the net sales price in place of the value from an actual appraisal, which often occurs when a sale is pending and contract terms are known. Consequently, we focus our attention on the second appraisal prior to sale date. This forces us to delete an additional 185 properties

for which we have appraisal data for only one quarter prior to sale, and leaves us with our final analysis sample of 7,214 sales with data covering at least two quarters prior to sale.²

Exhibit 1 shows the number of properties and appraised value for the total NPI and for our annual samples of properties sold out of the NPI. During the sample period, the percentage of properties sold out of the NPI each year ranges from a low of 3.5% in both 1984 and 1985 to a high of 17.2% in 1998. There are two periods where annual sales exceed 10% of the number of NPI properties—during 1996–1999 and 2002–2007. There also are two periods in which the value of annual sales exceeds 10% of the value of the NPI portfolio—during 1996–1997 and 2004–2005.

As shown in Exhibit 2, our final sample consists of 2,085 office properties, 1,220 retail properties, 1,436 apartment properties, and 2,473 industrial properties. With the exception of 1984 and 1985, each year contains at least 1% of our sample, but this percentage rises dramatically in 1996 to more than 4%, and reaches a peak in 2005 at more than 10% of sales before dropping dramatically in 2008. Similar trends are evident by property type.

The average property in our analysis sample of 7,214 was included in the NPI for only 17.4 quarters, with a median of 14 quarters. This average is shortest for apartments at 14.9 quarters and longest for industrials at 18.8 quarters, with office and retail coming in at 17.2 and 17.4 quarters, respectively.

METHODOLOGY

Many properties report significant capital improvements during the four quarters prior to sale date. It is important to adjust appraisals that occur during these quarters in order to account for subsequent capital improvements, otherwise we will observe large differences in the appraised values and subsequent sales prices, which are attributable to these capital improvements rather than to appraisal error.

A second confounding effect is the capital appreciation that occurs between the date of appraisal and the subsequent date of sale. Without any adjustment,

EXHIBIT 2

Properties Sold from the NPI, 1984 Q1–2010 Q2

Year	Total		Office		Retail		APT		Indus	
1984	37	0.5%	17	0.8%	8	0.7%	0	0.0%	12	0.5%
1985	41	0.6%	7	0.3%	6	0.5%	1	0.1%	27	1.1%
1986	90	1.2%	23	1.1%	23	1.9%	2	0.1%	42	1.7%
1987	86	1.2%	25	1.2%	18	1.5%	1	0.1%	42	1.7%
1988	118	1.6%	24	1.2%	21	1.7%	7	0.5%	66	2.7%
1989	138	1.9%	41	2.0%	22	1.8%	6	0.4%	69	2.8%
1990	109	1.5%	42	2.0%	7	0.6%	3	0.2%	57	2.3%
1991	106	1.5%	40	1.9%	12	1.0%	7	0.5%	47	1.9%
1992	87	1.2%	25	1.2%	16	1.3%	8	0.6%	38	1.5%
1993	140	1.9%	42	2.0%	25	2.0%	33	2.3%	40	1.6%
1994	165	2.3%	40	1.9%	17	1.4%	36	2.5%	72	2.9%
1995	172	2.4%	55	2.6%	33	2.7%	29	2.0%	55	2.2%
1996	307	4.3%	96	4.6%	58	4.8%	51	3.6%	102	4.1%
1997	396	5.5%	93	4.5%	94	7.7%	74	5.2%	135	5.5%
1998	420	5.8%	121	5.8%	99	8.1%	71	4.9%	129	5.2%
1999	342	4.7%	94	4.5%	92	7.5%	59	4.1%	97	3.9%
2000	283	3.9%	93	4.5%	59	4.8%	56	3.9%	75	3.0%
2001	304	4.2%	75	3.6%	58	4.8%	94	6.5%	77	3.1%
2002	372	5.2%	96	4.6%	62	5.1%	89	6.2%	125	5.1%
2003	388	5.4%	115	5.5%	73	6.0%	87	6.1%	113	4.6%
2004	580	8.0%	159	7.6%	94	7.7%	108	7.5%	219	8.9%
2005	735	10.2%	216	10.4%	153	12.5%	161	11.2%	205	8.3%
2006	602	8.3%	183	8.8%	49	4.0%	147	10.2%	223	9.0%
2007	596	8.3%	200	9.6%	60	4.9%	130	9.1%	206	8.3%
2008	232	3.2%	77	3.7%	15	1.2%	65	4.5%	75	3.0%
2009	246	3.4%	57	2.7%	19	1.6%	80	5.6%	90	3.6%
2010	122	1.7%	29	1.4%	27	2.2%	31	2.2%	35	1.4%
Total	7,214	100.0%	2,085	100.0%	1,220	100.0%	1,436	100.0%	2,473	100.0%

we would expect the appraised value to be less than or greater than sales price by the amount of capital appreciation during the period from appraisal date to sales date. This is especially important during quarters such as those in early 2009 when capital depreciation was in excess of 5%. To account for this effect, we calculate an alternative series of sales prices that are “rolled back” from the sales date to the appraisal date using an estimate of capital appreciation for each property type and quarter. More specifically, for each property in each quarter, we calculate

$$\begin{aligned} \text{Capital Appreciation}_{i,t-0} &= [(\text{End Market Value}_{i,t-0} + \text{Partial Sales}_{i,t-0} \\ &\quad - \text{Capital Improvement}_{i,t-0}) \\ &\quad \div (\text{End Market Value}_{i,t-1})] - 1 \end{aligned} \quad (1)$$

where

End Market Value_{*i,t-0*} = the ending market value (appraised values or sale price) reported for property *i* during quarter *t* – 0

Partial Sales = the value of any partial sales reported for property *i* during quarter *t* – 0

Capital Improvement_{*i,t-0*} = the value of any capital improvement reported for property *i* during quarter *t* – 0

We then calculate Capital Appreciation_{*i,t-0*} as the value-weighted average of capital appreciation reported for property type *i* during quarter *t* – 0.

We roll back the sales price by discounting it by one plus the value-weighted average capital appreciation for

that property type and quarter. For the 3,450 properties where the appraisal, one quarter prior to sale, is exactly equal to net sales price, we do not adjust for capital appreciation between the sale date and the one-quarter-prior appraisal, but do adjust for capital appreciation during the previous quarter. So, for comparison with the two-quarters-prior appraisal, we calculate the sales price at time $t + 2$ discounted to time $t - 0$ as

$$\begin{aligned} &\text{Discounted Net Sales Price}_{i,t-0} \\ &= \text{Net Sales Price}_{i,t+2} \\ &\quad \div (1 + \text{Capital Appreciation}_{i,t+1}) \end{aligned} \quad (2)$$

For the remaining 3,943 properties where the one-quarter-prior appraisal differs from net sales price, we adjust capital appreciation during the partial quarter between sale date and the date of the one-quarter-prior appraisal, as well as appreciation during the previous quarter, as

$$\begin{aligned} &\text{Discounted Net Sales Price}_{i,t-0} \\ &= \text{Net Sales Price}_{i,t+2} \\ &\quad \div [(1 + K \times \text{Capital Appreciation}_{i,t+2}) \\ &\quad \times (1 + \text{Capital Appreciation}_{i,t+1})] \end{aligned} \quad (3)$$

where K is the number of days between the sale date and one-quarter-prior appraisal divided by 90 (i.e., the fraction of the quarter during which appreciation took place).

We present results for both the unadjusted and adjusted differences in sales price and appraised value. In most quarters, the median value of capital appreciation is zero, so that the unadjusted differences are better indicators of the accuracy of the appraisal for a single property, and the adjusted differences are better indicators of the accuracy of the appraisal for a property held as part of a portfolio of properties.

Univariate Tests

To measure the accuracy of an appraisal, we calculate the difference in the appraised value and the subsequent transaction price as follows:

$$\begin{aligned} &\text{Percentage Appraisal Error}_{i,t-0} \\ &= \frac{[\text{Transaction Price}_{i,t+2} - \text{Appraised Value}_{i,t-0}]}{\text{Appraised Value}_{i,t-0}} \end{aligned} \quad (4)$$

where

Percentage Appraisal Error _{$i,t-0$} = the percentage difference in the transaction price for property i during quarter $t + 2$ and the appraised value during quarter $t - 0$

Transaction Price _{$i,t+2$} = the transaction price for property i during quarter $t + 2$

Appraised Value _{$i,t-0$} = the appraised value for property i during quarter $t - 0$ preceding the sale of property i during quarter $t + 2$, adjusted for any capital improvements and partial sales recorded during quarter $t + 1$

When we calculate the average percentage appraisal error, positive and negative values cancel out so that this average provides a misleading indicator of accuracy for any single property. An investor in a portfolio of properties, such as a CREF, is interested, however, in the value of the portfolio rather than in the values of individual properties in the portfolio; for such an investor, the average percentage appraisal error is informative. Similarly, investors interested in using an index such as the NPI are more concerned with the accuracy of the portfolio valuation than with the valuation of individual properties.

We also can use the average of this measure to determine if the appraised value is an unbiased predictor of sales price; if such is the case, then the average percentage appraisal error would not be significantly different from zero. Alternatively, if the appraised value is a biased predictor of sales price, as we would expect if appraisals lag true market values, then we would expect that the average percentage error is positive during periods of rising prices and negative during periods of falling prices, but may approximate zero during periods when prices are flat.

To better assess the accuracy of appraisals in predicting *individual* sales prices, we calculate an alternative measure of appraisal error, the absolute percentage appraisal error,

$$\begin{aligned} &\text{Absolute Percentage Appraisal Error} \\ &= \frac{\text{ABS} [\text{Transaction Price}_{i,t+2} - \text{Appraised Value}_{i,t-0}]}{\text{Appraised Value}_{i,t-0}} \end{aligned} \quad (5)$$

where ABS is the absolute-value operator and the other terms are as previously defined.

Webb [1994] reported that the average absolute percentage appraisal error narrowed during the first 15 years of the NPI. In contrast, Fisher, Miles, and Webb [1999] reported that this measure actually widened during the 1990s. We provide new evidence of whether this trend continued or reversed during the most recent 10 years of the NPI.

We also examine the accuracy of "inside" appraisals relative to "outside" appraisals. Many property managers use their own staff to appraise properties in most quarters, only hiring an outside appraiser once a year. The NCREIF database includes a variable that identifies appraisals as being inside or outside, so we are able to distinguish between the two types of appraisals.³

Multivariate Tests

Finally, we investigate determinants of the percentage appraisal error, both at the aggregate level and at the property level. First, we construct quarterly time series of average percentage appraisal errors by averaging the percentage appraisal errors of properties that sell in each quarter. We then estimate an ordinary least squares regression model,

$$\begin{aligned} \text{Average Percentage Appraisal Error}_{t-0} \\ = \sum \beta_j * \text{Explanatory Variables}_{j,t-0} + \varepsilon_{t-0} \quad (6) \end{aligned}$$

where

Average Percentage Appraisal Error_{t-0} = the quarterly average of either the property-level percentage appraisal error or the property-level absolute percentage error as defined in Equation (4) and Equation (5), respectively, for properties that sold during period $t + 2$

Explanatory Variables_{j,t-0} = a vector of explanatory variables measured in period $t - 0$ and thought to explain the average percentage appraisal error in period $t - 0$

β_j = the coefficient on explanatory variable j

ε_{t-0} = a random error term

In order to choose our explanatory variables, we look to the appraisal process for reasons why appraisals would be expected to deviate from subsequent sales prices. In a typical appraisal, there are three approaches to estimating value: the cost approach, income approach,

and sales-comparison approach. In implementing each of these approaches to valuing a commercial property, an appraiser relies upon differing sets of input data.

For the income approach, the appraiser relies on the income from the property being valued and on a cap rate. If rents are changing rapidly, an appraiser relying upon existing rent rolls would be expected to undervalue a property in a rising market and overvalue a property in a falling market. We include the four-quarter change in quarterly NPI Income Return to capture this potential source of error. Similarly, if cap rates are changing rapidly, then an appraiser relying upon stale cap rates would be expected to undervalue a property in a rising market and overvalue a property in a falling market. We include an estimate of the four-quarter change in the quarterly RERC Pre-Tax Yield (IRR) as a proxy for the cap rate to capture this potential source of error.⁴

For the sales-comparison approach, the appraiser relies upon comparable sales. If property values are changing rapidly, then an appraiser relying upon transaction data would be expected to undervalue properties in a rising market and overvalue properties in a falling market. We include the quarterly NPI Appreciation Return to capture this potential source of error. In addition, when properties are transacting more frequently, more timely comparable sales should be available. To capture this, we include the quarterly Number of Sales of NPI Properties as a measure of market liquidity.

For the cost approach, the appraiser relies upon information about the input costs for building a replacement of the property. If input costs are changing rapidly, then an appraiser relying upon stale cost data will undervalue properties when costs are rising and overvalue properties when values are falling. We include the four-quarter change in the U.S. Census Bureau's quarterly Construction Cost Index to capture this potential source of error.⁵

We also investigate the determinants of the percentage appraisal error at the property level. We estimate the ordinary least squares regression model,

$$\begin{aligned} \text{Percentage Appraisal Error}_{i,t-0} \\ = \sum \beta_j * \text{Explanatory Variables}_{i,j,t-0} + \varepsilon_{i,t-0} \quad (7) \end{aligned}$$

where

Percentage Appraisal Error_{i,t-0} = either the difference or absolute difference in sales price and

two-quarters-prior appraised value, adjusted for capital gains, for property i appraised in period $t-0$

Explanatory Variables, $x_{i,j}$ = a vector of explanatory variables measured for property i appraised in period $t-0$ and thought to explain the percentage appraisal error.

β_j = the coefficient on explanatory variable j

$\epsilon_{i,t-0}$ = a random error term

As explanatory variables, in addition to those included in our previous model, we include the following. First, we expect that there is a pecking order in the difficulty of accurately appraising properties such that the office category is most difficult, followed by the retail, apartment, and industrial categories. We include indicators for three of these four types, with industrials being the omitted category.

Second, we expect that appraisals of levered properties would be less accurate because valuations reported to NCREIF are as if the properties are unlevered; if there is favorable or unfavorable financing involved in a transaction, we would expect greater differences in sales prices and appraised values. We include an indicator for levered properties, with unlevered being the omitted category.

Third, we expect external appraisals to be more accurate than internal appraisals, and internal appraisals to be more accurate than no appraisals. Consequently, we include indicator variables for external appraisal and internal appraisal, with no appraisal being the omitted category.

Fourth, we expect type of ownership to influence appraisal accuracy. Accuracy is much more important for open-end funds (including the ODCE funds) in which fund owners can buy in and out on the basis of appraised values than it is for closed-end funds and separate accounts. Consequently, we include an indicator variable for open-end funds, ODCE funds, and closed-end funds, with Separate Accounts being the omitted category. We expect a negative coefficient for Open-End and ODCE, and an insignificant coefficient for Closed-End.

EMPIRICAL RESULTS

In this section we discuss the descriptive statistics based upon each method of calculating the percentage difference between sales price and appraised value.

Descriptive Statistics for the Equal-Weighted Percentage Difference

Exhibit 3 presents descriptive statistics for the equal-weighted percentage differences in sales price and appraised values two quarters prior to the sale date calculated across all property types. Statistics are presented annually by date of appraisal on both an unadjusted and an adjusted basis, where the adjustment rolls back sales price by the percentage capital gain from time of the appraisal until the time of the next quarter. For each year, the exhibit shows the median, mean, and standard error, as well as a t -statistic for the null hypothesis that the mean difference is zero, indicating that the appraisal is an unbiased estimate of the sales price.

For the full sample, the unadjusted median and average percentage differences are 2.8% and 4.9%, respectively, indicating considerable positive skewness in the distribution. The t -statistic is 19.1, indicating with high confidence (significant at better than the 0.001 level) that the true mean is significantly greater than zero, and meaning that the appraised value is a biased predictor of subsequent sales prices.

When we examine the annual differences, we find that the average for the full sample period hides considerable variability because the commercial real estate industry suffered through two massive down cycles: 1988–1993 and 2008–2009. During these down cycles, quarterly capital appreciation on the NPI was negative for at least nine consecutive quarters, cumulating to losses of 38.3% and 37.6%, respectively.⁶ Also during each of these down cycles, the average annual differences in sales price and two-quarters-prior appraisal were significantly negative, indicating that prices were significantly lower than prior appraisals. From 1988 through 1993, these differences were between –2.5% and –8.9%, and each was statistically significant at better than the 0.01 level. In 2008 and 2009, the differences were –12.0% and –8.9%, again statistically significant at better than the 0.01 level. We also see two periods where the average annual differences in sales price and two-quarters-prior appraisal were significantly positive, indicating that sales prices were significantly greater than prior appraisals. From 1996 through 1999, these differences were between 2.9% and 9.8%, and from 2002 through 2007, these differences ranged between 3.4% and 14.7%. Each of these differences is statistically significant at better than the 0.01 level.

EXHIBIT 3

Equal-Weighted Percentage Difference in Sales Price and Appraised Value

Year	Obs.	Unadjusted for Capital Gains				Adjusted for Capital Gains			
		Median	Mean	S.E.	t-Stat	Median	Mean	S.E.	t-Stat
1984	44	-6.7%	-4.4%	1.3%	-3.4***	-8.1%	-6.2%	1.3%	-4.9***
1985	37	0.6%	0.7%	1.7%	0.4	0.1%	0.1%	1.7%	0.0
1986	120	0.3%	0.3%	1.1%	0.2	-0.1%	0.0%	1.1%	0.0
1987	93	-1.4%	-0.9%	1.9%	-0.5	-1.4%	-0.9%	1.9%	-0.5
1988	125	-4.4%	-4.7%	1.6%	-2.9***	-5.1%	-5.2%	1.6%	-3.2***
1989	121	-3.8%	-5.9%	1.5%	-4.0***	-5.0%	-6.1%	1.5%	-4.2***
1990	136	-6.5%	-8.9%	1.1%	-8.2***	-5.9%	-8.3%	1.1%	-7.7***
1991	69	-6.3%	-7.3%	1.5%	-5.0***	-3.8%	-5.4%	1.5%	-3.5***
1992	111	-2.1%	-2.9%	1.6%	-1.8*	-0.3%	-0.7%	1.7%	-0.4
1993	149	0.0%	-2.5%	1.3%	-2.0**	0.4%	-1.4%	1.3%	-1.1
1994	197	0.1%	0.5%	1.5%	0.3	0.4%	0.3%	1.5%	0.2
1995	173	0.3%	1.5%	3.6%	0.4	0.1%	1.1%	3.6%	0.3
1996	393	1.4%	4.1%	1.0%	3.9***	1.0%	3.4%	1.0%	3.3***
1997	403	5.3%	9.8%	1.8%	5.3***	4.4%	8.3%	1.8%	4.7***
1998	409	5.5%	7.6%	0.7%	10.2***	3.7%	5.5%	0.7%	7.5***
1999	268	1.6%	2.9%	0.7%	4.4***	0.7%	2.1%	0.7%	3.2**
2000	317	0.6%	2.5%	1.4%	1.8*	-0.6%	1.3%	1.4%	1.0
2001	310	0.8%	1.7%	0.7%	2.3**	0.9%	1.7%	0.7%	2.3**
2002	383	2.1%	3.4%	0.7%	4.6***	2.0%	3.5%	0.7%	4.7***
2003	456	4.1%	4.8%	0.8%	6.1***	3.7%	4.3%	0.8%	5.5***
2004	717	11.6%	12.0%	0.7%	17.1***	9.7%	10.0%	0.7%	14.6***
2005	697	11.6%	14.7%	0.8%	18.4***	7.7%	10.6%	0.8%	13.7***
2006	606	10.8%	14.5%	0.9%	16.9***	8.1%	11.6%	0.8%	13.8***
2007	397	2.8%	4.9%	0.9%	5.8***	0.8%	2.8%	0.8%	3.3***
2008	174	-9.1%	-12.0%	1.2%	-10.1***	-9.1%	-11.0%	1.1%	-9.6***
2009	305	-7.2%	-8.9%	1.0%	-8.9***	-1.7%	-3.5%	1.0%	-3.3***
Total	7,214	2.8%	4.9%	0.3%	19.1***	1.9%	3.9%	0.2%	15.7***

Note: t-Stat is a t-statistic for testing the null hypothesis that the mean difference is equal to zero.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

The right side of Exhibit 3 presents the results where we adjust for capital gains during the period between the two-periods-prior appraisal and the sales date. As we would expect, this adjustment reduces the magnitudes of the differences between sales price and two-quarters-prior appraisal, but not by much, and the adjustment does not qualitatively affect our findings based upon the unadjusted differences. We still find the same four periods where sales price significantly deviates from appraised values—the two “ups” and two “downs” in the market.

To summarize the results in Exhibit 3, we find strong evidence that the two-quarters-prior appraised value is a biased estimate of sales price, that the direction of bias is

downward in up markets and upward in down markets, and that the magnitude of the bias is greater in hotter and colder markets. This is consistent with the hypothesis that appraisals are lagged indicators of value and that they are not independent of prior appraisals.

Exhibit 4 presents descriptive statistics for the equal-weighted percentage difference in sales price and two-quarters-prior appraised value by property type, with adjustments for capital appreciation. For the full sample, the average percentage difference is largest for retail and apartment properties at 5.3% and is smallest for industrial properties at 2.1%, with office properties in between at 4.2%. Once again, however, the full-sample

EXHIBIT 4

Equal-Weighted Percentage Difference in Sales Price and Appraised Value by Property Type

Year	All Types			Office			Retail			Apartment			Industrial		
	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat
1984	44	-6.2%	-4.9***	19	-7.3%	-5.4***	8	-4.6%	-4.0***	1	10.6%		16	-6.8%	-2.4**
1985	37	0.1%	0.0	8	5.5%	1.2	5	1.5%	1.4	0			24	-2.0%	-1.0
1986	120	0.0%	0.0	30	-3.5%	-1.2	26	0.6%	0.4	3	-5.6%	-2.0**	61	1.8%	1.2
1987	93	-0.9%	-0.5	24	-2.7%	-0.5	21	2.4%	0.7	1	-4.9%		47	-1.3%	-0.7
1988	125	-5.2%	-3.2***	28	-12.6%	-3.6***	25	-3.2%	-0.8	8	-5.1%	-1.5*	64	-2.7%	-1.2
1989	121	-6.1%	-4.2***	47	-8.4%	-3.4***	12	-3.7%	-1.4	5	-7.3%	-2.3**	57	-4.6%	-2.1**
1990	136	-8.3%	-7.7***	45	-8.8%	-3.6***	14	2.0%	1.3	6	-1.8%	-1.5	71	-10.6%	-8.7***
1991	69	-5.4%	-3.5***	24	-2.8%	-0.9	6	-3.7%	-1.7*	4	-1.4%	-0.7	35	-8.0%	-4.1***
1992	111	-0.7%	-0.4	36	2.4%	0.7	21	3.5%	1.2	13	-10.5%	-1.6	41	-2.4%	-1.3
1993	149	-1.4%	-1.1	45	1.5%	0.6	20	0.4%	0.2	40	-1.8%	-0.7	44	-4.7%	-2.3**
1994	197	0.3%	0.2	48	1.4%	0.3	29	-4.9%	-1.1	37	5.2%	3.8***	83	-0.7%	-0.4
1995	173	1.1%	0.3	57	1.5%	0.7	30	17.1%	1.1	31	3.2%	1.9*	55	-9.0%	-1.4
1996	393	3.4%	3.3***	109	6.0%	2.8***	73	1.2%	0.3	71	2.2%	1.7*	140	3.1%	2.5**
1997	403	8.3%	4.7***	105	13.1%	5.4***	117	5.7%	1.1	65	8.0%	6.8***	116	6.7%	5.2***
1998	409	5.5%	7.5***	106	6.7%	4.7***	118	3.9%	2.4**	69	8.2%	6.1***	116	4.4%	3.5***
1999	268	2.1%	3.2***	91	1.5%	1.4	53	4.0%	2.0**	48	4.6%	3.9***	76	0.0%	0.0
2000	317	1.3%	1.0	104	-0.1%	-0.1	55	-3.9%	-1.9*	66	4.4%	3.2***	92	3.8%	0.9
2001	310	1.7%	2.3**	72	-0.8%	-0.5	50	0.5%	0.3	109	5.4%	7.2***	79	-0.5%	-0.3
2002	383	3.5%	4.7***	89	1.9%	1.3	80	9.0%	4.6***	81	5.1%	4.2***	133	0.2%	0.2
2003	456	4.3%	5.5***	129	3.9%	3.5***	83	6.8%	2.8***	106	2.9%	2.6***	138	4.3%	2.6***
2004	717	10.0%	14.6***	188	6.5%	5.3***	170	15.2%	10.3***	110	7.5%	4.6***	249	10.1%	8.7***
2005	697	10.6%	13.7***	220	13.0%	8.6***	60	10.3%	3.2***	163	12.1%	7.5***	254	7.5%	7.2***
2006	606	11.6%	13.8***	205	12.8%	8.1***	50	5.8%	2.4**	148	13.5%	8.2***	203	10.3%	7.4***
2007	397	2.8%	3.3***	134	5.7%	3.8***	39	0.0%	0.0	107	3.0%	1.7*	117	0.2%	0.2
2008	174	-11.0%	-9.6***	46	-13.0%	-4.9***	13	-7.1%	-1.3	57	-10.1%	-5.5***	58	-11.1%	-6.6***
2009	305	-3.5%	-3.3***	76	-4.6%	-2.1**	40	4.5%	2.0**	87	-0.2%	-0.1	102	-8.5%	-4.6***
All	7,214	3.9%	15.7***	2,085	4.2%	9.8***	1,220	5.3%	6.3***	1,436	5.3%	12.5***	2,473	2.1%	5.4***

Note: *t*-Stat is a *t*-statistic for testing the null hypothesis that the mean difference is equal to zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

averages mask considerable variability, not only across years but also across property types. During 2009, for example, the average percentage difference for industrial properties was -8.5%, while for retail properties it was +4.5%. During 2004, the average percentage difference for retail properties was 15.2% while for office properties it was only 6.6%. And during 1997, the average percentage difference for retail properties was 5.7%, while for office properties it was 13.1%. In general, there are large errors across the four property types.

Descriptive Statistics for the Value-Weighted Percentage Difference

Although the results in Exhibits 3 and 4 are valid for the valuations of individual properties, most institutional investors are more concerned with the results for portfolios of properties, where a larger property gets

greater weight than a smaller property. In Exhibits 5 and 6, we recalculate the percentage differences in sales price and two-quarter-prior appraisals, but weight each property by its appraised value.

For the full sample across all property types, the unadjusted median and average percentage differences (shown in Exhibit 5) are 4.2% and 6.7%, respectively, again indicating considerable positive skewness in the distribution. The *t*-statistic is 30.8, indicating with high confidence (significant at better than the 0.001 level) that the true mean is significantly greater than zero, and meaning that the appraised value remains a biased predictor of subsequent sales prices. Moreover, the magnitude of the median and average percentage differences increased by statistically significant amounts. This is evidence that the bias in appraisals is greater for larger properties than for smaller properties.

EXHIBIT 5

Value-Weighted Percentage Difference in Sales Price and Appraised Value

Year	Obs.	Unadjusted for Capital Gains				Adjusted for Capital Gains			
		Median	Mean	S.E.	t-Stat	Median	Mean	S.E.	t-Stat
1984	44	-1.4%	-1.7%	1.0%	-1.8*	-2.2%	-3.3%	0.9%	-3.5***
1985	37	1.7%	3.9%	2.0%	1.9*	1.4%	3.2%	2.0%	1.6
1986	120	0.3%	0.2%	0.9%	0.2	-0.5%	-0.1%	0.9%	-0.1
1987	93	0.4%	2.4%	1.6%	1.5	0.6%	2.2%	1.6%	1.4
1988	125	0.0%	0.0%	1.4%	0.0	-0.1%	-0.3%	1.4%	-0.2
1989	121	0.0%	-1.7%	1.5%	-1.2	-0.1%	-2.1%	1.5%	-1.4
1990	136	-2.9%	-10.1%	1.8%	-5.7***	-2.0%	-9.2%	1.8%	-5.2***
1991	69	-6.3%	-9.0%	1.1%	-8.2***	-3.8%	-7.4%	1.1%	-6.4***
1992	111	-1.9%	-4.3%	1.5%	-3.0***	0.3%	-1.9%	1.5%	-1.3
1993	149	0.0%	-2.8%	1.3%	-2.2**	2.8%	-1.3%	1.3%	-1.0
1994	197	1.2%	-0.2%	1.5%	-0.1	1.8%	-0.1%	1.5%	-0.1
1995	173	0.0%	-0.6%	1.5%	-0.4	-0.2%	-0.9%	1.5%	-0.6
1996	393	1.0%	3.3%	0.7%	4.4***	-0.1%	2.4%	0.7%	3.2***
1997	403	4.4%	8.4%	0.8%	10.7***	3.1%	6.7%	0.8%	8.6***
1998	409	4.9%	6.9%	0.6%	11.7***	2.9%	4.5%	0.6%	7.7***
1999	268	1.1%	2.2%	0.5%	4.0***	0.3%	1.4%	0.5%	2.6**
2000	317	2.8%	3.8%	0.8%	4.6***	1.4%	2.5%	0.8%	3.0***
2001	310	-0.3%	0.2%	0.6%	0.3	-0.1%	0.3%	0.6%	0.4
2002	383	1.5%	3.7%	0.8%	4.8***	2.0%	4.0%	0.8%	5.2***
2003	456	6.4%	6.8%	0.7%	9.8***	6.0%	6.5%	0.7%	9.3***
2004	717	11.0%	11.8%	0.6%	18.9***	9.6%	10.0%	0.6%	16.4***
2005	697	11.9%	15.7%	0.9%	18.2***	7.9%	11.8%	0.8%	13.9***
2006	606	15.1%	16.9%	0.8%	21.2***	12.6%	13.8%	0.8%	17.7***
2007	397	3.9%	7.8%	0.8%	10.0***	1.9%	5.6%	0.8%	7.4***
2008	174	-12.8%	-16.0%	1.3%	-12.3***	-11.9%	-15.2%	1.3%	-12.1***
2009	305	-4.2%	-6.6%	0.8%	-7.7***	1.6%	-1.2%	0.9%	-1.4
Total	7,214	4.2%	6.7%	0.2%	30.8***	3.2%	5.5%	0.2%	26.3***

Note: t-Stat is a t-statistic for testing the null hypothesis that the mean difference is equal to zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

The adjusted median and average percentage differences are 3.2% and 5.5%, respectively, significantly smaller than the unadjusted value-weighted differences, but roughly double the comparable figures for the equal-weighted percentage difference. Again, in Exhibit 5, we see the same four episodes in which sales price differs significantly from two-quarters-prior appraised value: two periods (1990–1993 and 2008–2009) when sales prices were significantly lower than prior appraisals, and two periods (1996–2000 and 2002–2007) when sales prices were significantly greater than prior appraisals.

In summary, the results in Exhibit 5 for the value-weighted percentage difference in sales price and two-quarters-prior appraised value provide even stronger evidence of bias and appraisal lag than do the

results for the equal-weighted percentage difference that appear in Exhibit 3. Sales prices lead appraisals upward in hot markets and downward in cold markets.

Our results for the 1995–1998 period are largely consistent with those reported by Fisher, Miles, and Webb [1999]. Like us, they found that value-weighted percentage differences in sales price and prior appraised value were negative during 1988–1991 and positive during 1996–1998, but they do not provide formal test statistics for ascertaining whether their differences have statistical significance. Our results provide this statistical evidence and show similar findings for the period 1999–2010, but with differences almost double in magnitude.

In Exhibit 6, we break down the value-weighted results by property type as we did in Exhibit 4 for equal-

EXHIBIT 6

Value-Weighted Percentage Difference in Sales Price and Appraised Value

Year	All Types			Office			Retail			Apartment			Industrial		
	Obs.	Mean	t-Stat.	Obs.	Mean	t-Stat.	Obs.	Mean	t-Stat.	Obs.	Mean	t-Stat.	Obs.	Mean	t-Stat.
1984	44	-3.3%	-3.5***	19	-3.6%	-2.7***	8	-2.6%	-2.7***	1	10.6%		16	-5.7%	-1.9*
1985	37	3.2%	1.6	8	12.6%	2.3**	5	1.6%	1.5	0			24	-1.6%	-0.8
1986	120	-0.1%	-0.1	30	-1.0%	-0.5	26	-0.1%	-0.1	3	-5.1%	-1.8*	61	2.3%	1.7*
1987	93	2.2%	1.4	24	-1.2%	-0.4	21	5.2%	1.7*	1	-4.9%		47	4.2%	1.8*
1988	125	-0.3%	-0.2	28	-7.2%	-3.2***	25	5.8%	1.7*	8	-5.1%	-1.6*	64	-1.1%	-0.6
1989	121	-2.1%	-1.4	47	-5.9%	-2.1**	12	4.3%	2.0**	5	-7.5%	-2.6***	57	-0.6%	-0.3
1990	136	-9.2%	-5.2***	45	-14.7%	-3.8***	14	1.9%	1.6	6	-2.0%	-2.1**	71	-7.4%	-5.6***
1991	69	-7.4%	-6.4***	24	-8.9%	-4.9***	6	-2.7%	-1.7*	4	-1.3%	-0.7	35	-8.2%	-3.6***
1992	111	-1.9%	-1.3	36	4.0%	0.9	21	-0.4%	-0.1	13	-6.6%	-1.4	41	-3.2%	-2.2**
1993	149	-1.3%	-1.0	45	2.0%	0.7	20	3.0%	2.8***	40	-2.7%	-1.0	44	-9.1%	-3.8***
1994	197	-0.1%	-0.1	48	-3.0%	-0.7	29	-0.8%	-0.2	37	3.8%	3.4***	83	0.8%	0.5
1995	173	-0.9%	-0.6	57	0.0%	0.0	30	-1.1%	-0.7	31	4.3%	2.6***	55	-7.9%	-1.5
1996	393	2.4%	3.2***	109	4.8%	2.7***	73	-4.2%	-3.2***	71	4.1%	4.1***	140	3.6%	3.5***
1997	403	6.7%	8.6***	105	10.3%	5.4***	117	2.8%	2.4**	65	9.0%	7.2***	116	6.3%	5.0***
1998	409	4.5%	7.7***	106	5.4%	5.1***	118	2.6%	2.2**	69	6.3%	5.1***	116	5.4%	4.8***
1999	268	1.4%	2.6***	91	1.3%	1.6	53	1.3%	1.0	48	5.1%	4.3***	76	-1.3%	-1.2
2000	317	2.5%	3.0***	104	2.7%	2.3**	55	-2.0%	-1.4	66	6.0%	4.5***	92	2.4%	0.9
2001	310	0.3%	0.4	72	-1.9%	-1.4	50	-1.7%	-1.5	109	5.4%	7.3***	79	-2.7%	-1.5
2002	383	4.0%	5.2***	89	-2.1%	-1.1	80	9.7%	6.1***	81	4.8%	4.1***	133	1.1%	1.1
2003	456	6.5%	9.3***	129	6.3%	7.0***	83	11.5%	6.7***	106	4.1%	3.4***	138	2.9%	1.5
2004	717	10.0%	16.4***	188	8.8%	7.9***	170	12.9%	11.5***	110	9.8%	6.5***	249	9.8%	8.0***
2005	697	11.8%	13.9***	220	15.5%	10.5***	60	9.1%	3.1***	163	11.1%	7.4***	254	3.1%	1.8*
2006	606	13.8%	17.7***	205	16.5%	11.4***	50	8.5%	3.2***	148	10.4%	7.6***	203	13.4%	11.1***
2007	397	5.6%	7.4***	134	8.1%	5.7***	39	1.7%	0.8	107	3.7%	3.2***	117	2.3%	1.8*
2008	174	-15.2%	-12.1***	46	-19.0%	-6.7***	13	-9.9%	-3.1***	57	-11.6%	-6.3***	58	-11.5%	-8.2***
2009	305	-1.2%	-1.4	76	-0.6%	-0.3	40	4.9%	2.2**	87	1.0%	0.7**	102	-12.4%	-7.8***
All	7,214	5.5%	26.3***	2,085	6.3%	14.9***	1,220	5.1%	12.0***	1,436	5.8%	14.6***	2,473	3.5%	8.8***

Note: *t*-Stat is a *t*-statistic for testing the null hypothesis that the mean difference is equal to zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

weighted results. As in Exhibit 4, we see considerable variability across property types, especially during the peaks and valleys of the real estate cycles.

Descriptive Statistics for the Equal-Weighted Absolute Percentage Difference

As large as the appraisal errors are that are reported in Exhibits 3–6 regarding the accuracy of commercial real estate appraisals, the results in those four exhibits are based upon the average signed percentage difference, where positives and negatives cancel each other out as they would in a portfolio context. In this subsection and the next, we analyze descriptive statistics for the absolute percentage difference, which provides a much better measure of the accuracy of an appraisal on an individual property. These results show even larger appraisal errors.

Exhibit 7 presents descriptive statistics for the equal-weighted absolute percentage difference in sales price and two-quarters-prior appraised value, both unadjusted and adjusted for capital gains between the appraisal and sale dates and calculated across all property types. For the full sample, the adjusted median and average absolute percentage differences are 8.1% and 12.5%, respectively. Although *t*-statistics are not appropriate for testing the distribution of this variable, which is bounded on the left by zero, they are still instructive. For the full sample, the *t*-statistic is 60.7, indicating that the mean is measured with high precision. The average absolute deviation of 12.5% is relatively close to the 10.8% statistic reported by Fisher, Miles, and Webb [1999] for the 1980–1998 period.

Once again, however, the average over the full sample period masks considerable variability across subperiods. The absolute difference was in single digits during 1984–1986 and again during 1999–2001. The

EXHIBIT 7

Equal-Weighted Absolute Percentage Difference in Sales Price and Appraised Value

Year	Obs.	Unadjusted for Capital Gains				Adjusted for Capital Gains			
		Median	Mean	S.E.	t-Stat	Median	Mean	S.E.	t-Stat
1984	44	6.8%	7.3%	0.9%	7.8***	8.7%	8.6%	0.9%	9.9***
1985	37	5.2%	6.9%	1.2%	5.8***	5.3%	7.0%	1.2%	5.9***
1986	120	5.3%	8.1%	0.8%	10.1***	5.1%	8.0%	0.8%	10.0***
1987	93	8.2%	11.6%	1.4%	8.0***	8.6%	11.8%	1.4%	8.2***
1988	125	9.5%	12.8%	1.2%	10.6***	9.7%	13.0%	1.2%	10.7***
1989	121	8.0%	11.7%	1.1%	10.3***	8.4%	11.9%	1.1%	10.6***
1990	136	8.7%	11.0%	0.9%	11.9***	8.3%	10.8%	0.9%	11.9***
1991	69	6.4%	9.5%	1.2%	7.7***	5.8%	9.0%	1.3%	7.2***
1992	111	6.8%	11.4%	1.3%	9.1***	7.3%	11.8%	1.3%	9.3***
1993	149	5.8%	9.7%	1.0%	9.6***	5.8%	10.1%	1.0%	10.0***
1994	197	6.0%	11.6%	1.2%	9.5***	6.1%	11.6%	1.2%	9.6***
1995	173	5.7%	13.5%	3.4%	3.9***	5.6%	13.6%	3.5%	3.9***
1996	393	6.2%	10.6%	0.9%	11.7***	5.8%	10.6%	0.9%	11.8***
1997	403	8.0%	14.0%	1.8%	7.9***	7.7%	13.4%	1.7%	8.0***
1998	409	8.0%	12.0%	0.6%	20.5***	6.9%	11.1%	0.6%	20.1***
1999	268	5.6%	7.9%	0.5%	15.8***	5.3%	7.8%	0.5%	15.9***
2000	317	5.7%	9.5%	1.3%	7.5***	5.7%	9.5%	1.2%	7.6***
2001	310	5.3%	8.4%	0.6%	14.8***	5.1%	8.5%	0.6%	15.0***
2002	383	7.4%	10.3%	0.5%	19.0***	7.3%	10.5%	0.5%	19.1***
2003	456	8.2%	11.8%	0.6%	20.0***	7.9%	11.7%	0.6%	19.8***
2004	717	14.0%	17.2%	0.5%	32.9***	12.9%	16.0%	0.5%	32.2***
2005	697	14.1%	18.6%	0.7%	27.6***	10.7%	16.1%	0.6%	25.8***
2006	606	13.1%	18.2%	0.7%	24.8***	11.4%	16.5%	0.7%	23.7***
2007	397	7.9%	11.9%	0.7%	17.9***	7.2%	11.3%	0.6%	17.9***
2008	174	11.4%	15.1%	1.0%	15.8***	10.0%	14.2%	0.9%	15.4***
2009	305	11.9%	14.8%	0.7%	19.8***	10.7%	13.4%	0.7%	18.6***
Total	7,214	8.5%	13.2%	0.2%	62.0***	8.1%	12.5%	0.2%	61.0***

Note: t-Stat is a t-statistic for the null hypothesis that the mean difference is zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

absolute difference peaks during the 2004–2006 period, when it is consistently in excess of 16%. There is considerable skew in the distribution, as evidenced by the difference in the mean and median, however, the median absolute difference also reaches double digits during the 2004–2006 bubble years and again during the 2008–2009 crisis years.

Exhibit 8 breaks down the results for the equal-weighted absolute percentage difference by property type, adjusted for capital gains. Over the full sample period, the adjusted average absolute percentage difference is greatest for office properties at 13.5% and smallest for apartment properties at 11.0%. In general, each of the four property types tracks the overall differences for all properties, with correlations ranging from 0.62 for apartment properties to 0.83 for industrial properties.

Descriptive Statistics for the Value-Weighted Absolute Percentage Difference

Exhibit 9 presents descriptive statistics for the value-weighted absolute percentage difference in sales price and two-quarters-prior appraised value, without and with adjustments for capital gains between the appraisal and sale dates. Without adjusting for capital gains, the median and mean differences are 8.6% and 13.3%, respectively, and with adjustments for capital gains, the median and mean differences fall to 7.7% and 12.4%, respectively. The worst results are for 2004–2006 and 2008–2009 when the median reached double digits. In general, the results for the value-weighted absolute percentage difference are very similar to those for the equal-weighted absolute percentage difference, indicating that there is

EXHIBIT 8

Equal-Weighted Absolute Percentage Difference in Sales Price and Appraised Value

Year	All Types			Office			Retail			Apartment			Industrial		
	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat
1984	44	8.6%	9.9***	19	7.6%	6.1***	8	4.6%	4.0***	1	10.6%		16	11.6%	7.8***
1985	37	7.0%	5.9***	8	9.8%	2.9***	5	1.8%	1.9***	0			24	7.2%	5.3***
1986	120	8.0%	10.0***	30	10.5%	4.7***	26	5.3%	6.2***	3	5.6%	2.0***	61	8.0%	7.8***
1987	93	11.8%	8.2***	24	16.5%	3.8***	21	10.6%	4.0***	1	4.9%		47	10.1%	7.7***
1988	125	13.0%	10.7***	28	15.0%	4.7***	25	11.9%	4.0***	8	8.9%	4.9***	64	13.1%	8.6***
1989	121	11.9%	10.6***	47	13.8%	7.3***	12	7.8%	4.3***	5	7.4%	2.4***	57	11.5%	6.7***
1990	136	10.8%	11.9***	45	12.2%	5.9***	14	3.2%	2.3***	6	2.5%	2.8***	71	12.1%	12.1***
1991	69	9.0%	7.2***	24	9.7%	3.7***	6	5.0%	3.2***	4	3.1%	2.7***	35	9.9%	6.0***
1992	111	11.8%	9.3***	36	16.7%	7.2***	21	10.1%	5.0***	13	14.5%	2.4***	41	7.4%	5.1***
1993	149	10.1%	10.0***	45	12.0%	5.6***	20	5.3%	5.2***	40	10.9%	5.0***	44	9.6%	5.8***
1994	197	11.6%	9.6***	48	18.2%	5.2***	29	12.4%	3.3***	37	6.3%	5.2***	83	9.9%	7.6***
1995	173	13.6%	3.9***	57	10.9%	6.8***	30	25.0%	1.6***	31	7.3%	6.5***	55	13.6%	2.1***
1996	393	10.6%	11.8***	109	11.9%	6.2***	73	13.2%	4.0***	71	7.3%	7.3***	140	9.9%	10.5***
1997	403	13.4%	8.0***	105	16.8%	7.6***	117	15.2%	2.9***	65	8.7%	8.0***	116	11.1%	11.2***
1998	409	11.1%	20.1***	106	11.1%	10.0***	118	12.5%	10.3***	69	10.6%	10.0***	116	10.1%	10.8***
1999	268	7.8%	15.9***	91	7.2%	9.9***	53	10.3%	6.8***	48	6.7%	7.1***	76	7.4%	8.8***
2000	317	9.5%	7.6***	104	8.9%	10.7***	55	9.8%	6.2***	66	9.1%	9.7***	92	10.3%	2.5***
2001	310	8.5%	15.0***	72	8.9%	8.5***	50	8.7%	5.1***	109	7.2%	11.9***	79	9.9%	6.7***
2002	383	10.5%	19.1***	89	9.1%	8.0***	80	14.0%	9.0***	81	8.9%	9.8***	133	10.3%	12.4***
2003	456	11.7%	19.8***	129	10.4%	13.7***	83	15.7%	8.5***	106	8.8%	11.4***	138	12.7%	10.0***
2004	717	16.0%	32.2***	188	13.5%	15.3***	170	19.7%	17.7***	110	12.6%	9.6***	249	16.8%	21.3***
2005	697	16.1%	25.8***	220	19.1%	16.1***	60	15.5%	5.4***	163	15.7%	11.2***	254	13.8%	18.4***
2006	606	16.5%	23.7***	205	18.0%	13.8***	50	12.0%	6.4***	148	16.8%	11.8***	203	15.7%	14.1***
2007	397	11.3%	17.9***	134	12.8%	11.2***	39	7.3%	5.6***	107	11.9%	8.4***	117	10.2%	10.5***
2008	174	14.2%	15.4***	46	16.3%	7.5***	13	14.5%	3.5***	57	13.7%	10.0***	58	13.0%	9.1***
2009	305	13.4%	18.6***	76	15.6%	11.5***	40	11.8%	8.7***	87	10.7%	8.1***	102	14.8%	10.5***
All	7,214	12.5%	61.0***	2,085	13.5%	40.6***	1,220	13.3%	17.5***	1,436	11.0%	33.1***	2,473	12.1%	38.5***

Note: t-Stat is a t-statistic for the null hypothesis that the mean difference is zero, indicating that the appraisal is an unbiased estimate of the sales price. *, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

little difference in this measure of appraisal accuracy for large and small properties sold from the NPI.

Exhibit 10 breaks down the results for the value-weighted absolute percentage difference by property type. Over the full sample period, the average absolute percentage difference is greatest for office properties at 13.9% and smallest for retail properties at 10.4%. In general, there are few differences from the equal-weighted results in Exhibit 8. As with the equal-weighted results, each of the four property types tracks the overall differences for all properties, with correlations ranging from 0.58 for apartment properties to 0.84 for office properties.

Descriptive Statistics for Internal versus External Appraisals

One potential (and likely) explanation for the poor appraisal accuracy documented thus far is the simple fact

that most property managers do not pay for an external third-party appraisal each quarter. Most managers perform such an appraisal only once a year, relying upon internal appraisals or no appraisals (where they simply carry forward the most recent appraised value, adjusting for capital improvements and partial sales) during interim quarters.

We investigate this potential explanation in Exhibit 11 where we split our sample of sold properties into these three groups and recalculate the percentage difference in sales price and two-quarters-prior appraised value. As shown in the exhibit, about half of our sold properties had no appraisal two quarters prior to sale, about one quarter of the sold properties had internal appraisals two quarters prior to sale, and one quarter of sold properties had external appraisals two quarters prior to sale.

We expect to find that the adjusted average percentage difference is smaller for external appraisals than for internal appraisals, and smaller for internal appraisals

EXHIBIT 9

Value-Weighted Absolute Percentage Difference in Sales Price and Appraised Value

Year	Obs.	Unadjusted for Capital Gains				Adjusted for Capital Gains			
		Median	Mean	S.E.	t-Stat	Median	Mean	S.E.	t-Stat
1984	44	4.1%	4.5%	0.7%	6.2***	3.2%	5.2%	0.7%	7.2***
1985	37	4.4%	8.0%	1.6%	4.9***	4.4%	7.9%	1.6%	5.0***
1986	120	4.7%	7.1%	0.6%	11.2***	4.7%	7.1%	0.6%	11.1***
1987	93	9.5%	10.5%	1.2%	9.0***	10.1%	10.7%	1.2%	9.2***
1988	125	7.2%	10.6%	1.0%	10.8***	7.0%	10.8%	1.0%	10.9***
1989	121	5.3%	9.9%	1.2%	8.5***	6.2%	9.9%	1.2%	8.5***
1990	136	3.8%	12.4%	1.7%	7.5***	4.3%	12.5%	1.6%	7.6***
1991	69	6.3%	9.3%	1.1%	8.8***	5.6%	8.8%	1.0%	8.9***
1992	111	6.0%	10.0%	1.2%	8.5***	7.0%	10.3%	1.1%	9.1***
1993	149	4.3%	8.6%	1.1%	7.9***	4.9%	9.7%	1.1%	9.1***
1994	197	4.6%	10.8%	1.3%	8.4***	4.9%	10.9%	1.3%	8.6***
1995	173	3.8%	7.9%	1.3%	5.9***	4.0%	7.9%	1.3%	6.0***
1996	393	4.2%	8.1%	0.6%	12.6***	4.5%	8.1%	0.6%	13.0***
1997	403	6.8%	10.9%	0.7%	15.7***	6.5%	10.4%	0.7%	15.7***
1998	409	7.0%	9.8%	0.5%	20.4***	5.8%	8.8%	0.4%	20.0***
1999	268	4.2%	6.4%	0.4%	15.9***	3.9%	6.3%	0.4%	16.1***
2000	317	5.0%	8.6%	0.7%	12.0***	4.7%	8.2%	0.7%	11.7***
2001	310	4.2%	6.9%	0.5%	14.3***	4.5%	7.1%	0.5%	14.7***
2002	383	6.5%	9.9%	0.6%	16.2***	6.1%	10.1%	0.6%	16.3***
2003	456	8.3%	11.5%	0.5%	21.2***	7.9%	11.4%	0.5%	21.0***
2004	717	12.8%	15.8%	0.5%	32.9***	12.4%	14.6%	0.5%	32.3***
2005	697	14.4%	19.9%	0.7%	27.2***	11.3%	17.5%	0.7%	25.3***
2006	606	16.1%	19.3%	0.7%	27.6***	13.8%	17.2%	0.7%	26.1***
2007	397	8.9%	12.0%	0.6%	19.3***	7.3%	11.2%	0.6%	19.4***
2008	174	13.0%	17.8%	1.2%	15.3***	12.5%	16.9%	1.1%	15.0***
2009	305	10.2%	12.2%	0.6%	19.9***	8.8%	11.4%	0.6%	20.6***
Total	7,214	8.6%	13.3%	0.2%	77.3***	7.7%	12.4%	0.2%	76.4***

Note: t-Stat is the t-statistic for the null hypothesis that the mean difference is zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

than for no appraisals. In fact, this is exactly what we find. The median percentage difference rises from 1.6% for external appraisals to 2.1% for internal appraisals and then to 4.7% for no appraisals. The mean percentage difference rises from 2.3% for external appraisals to 3.4% for internal appraisals and then to 8.1% for no appraisals. These results appear on their face to be encouraging; most of the bias documented in Exhibit 3 is attributable to the lag in time between the most recent "real" appraisal and the sale date. When either an internal or external appraisal was conducted, the bias decreases by more than two-thirds. This suggests that, in a portfolio context, appraisals are relatively accurate.

However, when we examine the percentage differences across time, we find that bias remains a serious issue. For appraisals to be accurate in a portfolio context,

pluses and minuses should cancel out across properties at the same point in time, not just across different points in time. What we see is that appraisal errors appear to be highly correlated across time and appear to lag changes in true market values. For example, the average percentage error for external appraisals plummets to -15.6% in 1990 and to -20.2% in 2008, but balloons to 16.2% in 2006.

Next, we look at the equal-weighted absolute percentage difference by appraisal type, shown in Exhibit 12. This gives us our best measure of appraisal accuracy for an individual property. For the full sample period across all property types, we find that the median absolute percentage error for external appraisals is 7.1%, which is slightly better than the 8.6% observed for no appraisals, but slightly worse than the 6.8% observed for inside appraisals. When we look at the mean, external, internal,

EXHIBIT 10

Value-Weighted Absolute Percentage Difference in Sales Price and Appraised Value by Property Type

Year	All Types			Office			Retail			Apartment			Industrial		
	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat	Obs.	Mean	t-Stat
1984	44	5.2%	7.2***	19	5.6%	6.3***	8	2.6%	2.7***	1	10.6%		16	10.7%	5.8***
1985	37	7.9%	5.0***	8	14.6%	3.1***	5	1.9%	2.1**	0			24	5.9%	4.3***
1986	120	7.1%	11.1***	30	8.0%	6.5***	26	5.1%	5.6***	3	5.1%	1.8*	61	6.9%	6.1***
1987	93	10.7%	9.2***	24	11.5%	5.1***	21	9.4%	3.7***	1	4.9%		47	11.3%	6.7***
1988	125	10.8%	10.9***	28	9.6%	5.1***	25	11.4%	4.0***	8	9.1%	5.7***	64	11.6%	11.6***
1989	121	9.9%	8.5***	47	12.3%	5.3***	12	6.3%	3.7***	5	7.5%	2.6**	57	9.8%	6.2***
1990	136	12.5%	7.6***	45	17.8%	5.1***	14	2.9%	2.9***	6	2.4%	3.2***	71	10.1%	9.5***
1991	69	8.8%	8.9***	24	10.1%	6.7***	6	3.8%	3.4***	4	3.0%	3.1***	35	10.2%	5.1***
1992	111	10.3%	9.1***	36	18.7%	6.2***	21	11.3%	5.2***	13	9.1%	2.2**	41	6.9%	6.3***
1993	149	9.7%	9.1***	45	10.6%	4.3***	20	4.7%	6.5***	40	10.8%	5.0***	44	13.0%	6.8***
1994	197	10.9%	8.6***	48	14.1%	3.9***	29	13.5%	3.8***	37	5.1%	5.3***	83	9.9%	9.1***
1995	173	7.9%	6.0***	57	9.5%	5.7***	30	5.3%	3.9***	31	7.9%	6.8***	55	10.8%	2.0**
1996	393	8.1%	13.0***	109	9.5%	5.9***	73	7.4%	6.7***	71	6.4%	7.9***	140	8.1%	9.9***
1997	403	10.4%	15.7***	105	12.9%	7.4***	117	8.4%	9.2***	65	9.7%	8.2***	116	10.4%	10.3***
1998	409	8.8%	20.0***	106	8.8%	10.9***	118	8.6%	9.5***	69	9.1%	9.3***	116	9.6%	11.1***
1999	268	6.3%	16.1***	91	5.5%	8.4***	53	7.0%	8.2***	48	7.1%	7.3***	76	6.8%	9.0***
2000	317	8.2%	11.7***	104	8.5%	9.8***	55	7.3%	7.4***	66	9.4%	9.5***	92	6.6%	2.5**
2001	310	7.1%	14.7***	72	8.3%	8.1***	50	4.5%	5.0***	109	7.1%	12.3***	79	9.2%	6.0***
2002	383	10.1%	16.3***	89	9.8%	5.9***	80	11.4%	8.1***	81	8.6%	10.1***	133	9.3%	13.3***
2003	456	11.4%	21.0***	129	9.6%	15.3***	83	14.5%	10.2***	106	9.6%	10.9***	138	13.3%	8.8***
2004	717	14.6%	32.3***	188	13.6%	16.6***	170	15.4%	16.7***	110	13.5%	11.1***	249	17.3%	20.6***
2005	697	17.5%	25.3***	220	20.2%	16.9***	60	13.5%	5.1***	163	14.3%	10.9***	254	17.5%	13.7***
2006	606	17.2%	26.1***	205	20.5%	17.6***	50	12.0%	5.2***	148	13.4%	11.6***	203	15.6%	14.5***
2007	397	11.2%	19.4***	134	12.7%	11.1***	39	11.0%	8.3***	107	9.0%	10.6***	117	9.7%	10.7***
2008	174	16.9%	15.0***	46	20.2%	7.7***	13	12.0%	4.7***	57	14.5%	10.3***	58	12.2%	9.4***
2009	305	11.4%	20.6***	76	11.9%	11.2***	40	11.8%	8.3***	87	9.0%	10.5***	102	15.4%	11.8***
All	7,214	12.4%	76.4***	2,085	13.9%	43.2***	1,220	10.4%	30.5***	1,436	10.9%	35.2***	2,473	12.7%	41.7***

Note: t-Stat is the t-statistic for the null hypothesis that the mean difference is zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

and no appraisals come in at 11.7%, 10.8%, and 13.5%, respectively. Hence, we find that external appraisals are no more accurate than inside appraisals and only slightly better than no update of the previous appraisal. All three are off by double digits.

Things are even worse when we look year by year. For external appraisals, the median absolute error is 15.2% for 2008, and the average is 20.6%. Both exhibits are appreciably worse than the comparable exhibits for inside or no appraisals. The average absolute error for external appraisals is greater than 10% in each year from 2002 to 2009 with the exception of 2007, when it was 9.1%.

Determinants of the Average and Average Absolute Percentage Appraisal Error

In Exhibit 13, we present the results from two sets of ordinary least squares regressions where the dependent

variables are the quarterly average percentage difference (Panel A) and the quarterly average absolute percentage difference (Panel B) in the sales price and two-quarters-prior appraisal (equal-weighted and adjusted for capital gains). The five explanatory variables are as described earlier: the quarterly NPI Appreciation Return, quarterly number of sales of NPI properties, four-quarter change in the quarterly NPI Income Return, our cap-rate proxy for the four-quarter change in the quarterly RERC Pre-Tax Yield (IRR), and four-quarter change in the quarterly U.S. Census Construction Cost Index.

In Panel A, our dependent variable is the signed percentage difference in sale price and appraised value. First, we sequentially enter each of the five explanatory variables to provide evidence on the explanatory power of each, and then we present a model including all five explanatory variables. We find that the coefficient on the NPI Appreciation Return is positive and significant at better than the 0.01 level, explaining about 7%

EXHIBIT 11

Percentage Difference by Type of Appraisal

Year	External					Internal					No Appraisal				
	Obs.	Median	Mean	S.E.	t-Stat	Obs.	Median	Mean	S.E.	t-Stat	Obs.	Median	Mean	S.E.	t-Stat
1984	8	-2.1%	-3.6%	1.0%	-3.6***						36	-3.2%	-3.1%	1.2%	-2.5**
1985	3	-2.0%	-11.4%	7.8%	-1.5	5	4.7%	13.7%	8.1%	1.7*	29	0.2%	1.5%	1.3%	1.2
1986	18	-2.6%	-1.9%	1.2%	-1.6*	7	0.6%	1.7%	0.8%	2.2**	95	-0.2%	0.0%	1.1%	0.0
1987	11	-11.1%	-6.0%	4.0%	-1.5	4	-5.4%	-3.2%	1.4%	-2.2**	78	1.1%	4.7%	1.8%	2.6***
1988	23	5.7%	9.7%	4.8%	2.0**	7	6.4%	6.7%	3.2%	2.1**	95	-1.1%	-4.2%	1.3%	-3.2***
1989	35	2.4%	1.9%	1.6%	1.2	4	-57.8%	-21.1%	22.7%	-0.9	82	-0.3%	-2.1%	1.5%	-1.4
1990	31	-4.2%	-15.6%	4.7%	-3.3***	16	0.4%	-3.0%	1.4%	-2.1**	89	-0.3%	-3.5%	1.4%	-2.6***
1991	7	-1.5%	-4.3%	3.7%	-1.2	3	-3.8%	-1.9%	2.2%	-0.8	59	-7.5%	-8.1%	1.3%	-6.4***
1992	27	-0.3%	3.7%	3.5%	1.1	3	1.1%	1.2%	1.3%	0.9	81	0.3%	-3.5%	1.7%	-2.1**
1993	36	2.8%	-0.1%	2.1%	0.0	10	-39.5%	-28.6%	10.8%	-2.7***	103	2.8%	0.7%	1.2%	0.6
1994	39	5.5%	4.9%	1.9%	2.6***	17	-0.3%	-25.5%	9.9%	-2.6***	141	1.8%	3.4%	1.0%	3.3***
1995	17	4.0%	1.7%	2.2%	0.8	36	-0.2%	-2.0%	2.6%	-0.8	120	-0.2%	-0.9%	1.9%	-0.5
1996	63	1.0%	0.5%	1.2%	0.4	91	-0.9%	-0.8%	0.9%	-0.9	239	0.7%	4.2%	1.1%	3.7***
1997	46	-0.1%	2.0%	1.2%	1.6*	102	3.4%	8.5%	1.8%	4.6***	255	5.2%	7.9%	1.0%	7.9***
1998	58	2.9%	4.5%	1.2%	3.6***	121	1.4%	1.9%	1.1%	1.7*	230	3.8%	5.7%	0.8%	7.2***
1999	46	0.0%	-0.1%	1.1%	-0.1	91	2.7%	1.9%	0.9%	2.1**	131	-0.6%	1.7%	0.8%	2.0**
2000	46	-2.3%	-1.3%	1.1%	-1.1	89	1.3%	3.1%	2.2%	1.4	182	2.3%	3.2%	0.9%	3.6***
2001	68	0.5%	2.9%	1.1%	2.6***	84	0.3%	1.4%	0.9%	1.6	158	-0.6%	-1.6%	1.0%	-1.6*
2002	84	1.4%	-2.0%	2.5%	-0.8	126	2.4%	7.0%	1.3%	5.2***	173	1.6%	4.2%	0.8%	5.0***
2003	86	4.8%	5.9%	1.6%	3.6***	110	6.6%	5.5%	1.6%	3.5***	260	6.0%	7.0%	0.9%	8.1***
2004	276	4.3%	7.3%	0.9%	8.5***	119	9.5%	7.3%	1.5%	4.9***	322	13.7%	13.0%	1.0%	13.6***
2005	106	4.2%	7.1%	1.2%	5.9***	210	3.5%	6.2%	1.2%	5.2***	381	14.3%	16.2%	1.3%	12.1***
2006	116	12.6%	16.2%	1.9%	8.7***	167	5.2%	7.8%	1.0%	8.1***	323	14.3%	15.3%	1.1%	13.4***
2007	89	1.4%	3.4%	1.3%	2.6***	136	1.6%	4.0%	1.2%	3.4**	172	3.4%	7.7%	1.3%	6.0***
2008	64	-15.2%	-20.2%	1.7%	-11.7***	90	-8.2%	-13.1%	2.0%	-6.7***	20	-5.2%	-7.2%	3.2%	-2.2**
2009	180	-1.8%	-3.8%	1.1%	-3.4***	111	2.7%	2.1%	1.3%	1.6*	14	17.7%	6.3%	4.7%	1.3
All	1,583	1.6%	2.3%	0.4%	5.5***	1,759	2.1%	3.4%	0.4%	8.8***	3,872	4.7%	8.1%	0.3%	27.2***

Note: t-Stat is a t-statistic for the null hypothesis that the mean difference is zero, indicating that the appraisal is an unbiased estimate of the sales price.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

of the variation in the dependent variable. As hypothesized, when property values are changing more rapidly, appraisal errors are larger. Next, we find that the coefficient on the Number of NPI Sales is positive and significant at better than the 0.01 level, and explains more than 37% of the variability in the dependent variable. This is exactly the opposite of what we would expect if the number of sales is a measure of liquidity, indicating the availability of more comparable sales at any point in time. Instead, this is consistent with the number of sales as an indicator of market frothiness, where buyers overpay for properties, bidding up prices beyond what appraisers deem reasonable. Our third variable—the four-quarter change in the NPI Income Return—is negative but not significantly different from zero and by itself has zero explanatory power. We had expected a positive and significant coefficient if this variable were a proxy for unexpected changes in property income. Our fourth variable—our proxy for changes

in cap rates—is negative and significant at better than the 0.01 level. This is consistent with our hypothesis that sales price would exceed appraised values in hot markets where cap rates are falling, and that appraised values would exceed sales prices in cold markets where cap rates are rising. Our final variable—the change in construction costs—is positive and significant at better than the 0.01 level. This is consistent with our hypothesis that sales prices would exceed appraised values in hot markets where construction costs are rising and that appraised values would exceed sales prices in cold markets where prices are falling. In the last column of Panel A are the results from a model that includes all five of our explanatory variables. Each of the variables, except for quarterly NPI Appreciation Return, is statistically significant at better than the 0.05 level, and three are significant at better than the 0.001 level: Number of NPI Sales, Chg. NPI Income Return, and Chg. RERC Cap Rate. The interpretations are the same as for the

EXHIBIT 12

Absolute Percentage Difference by Type of Appraisal

Year	External					Internal					No Appraisal				
	Obs.	Median	Mean	S.E.	t-Stat	Obs.	Median	Mean	S.E.	t-Stat	Obs.	Median	Mean	S.E.	t-Stat
1984	8	2.1%	3.6%	1.0%	3.6***	0					36	3.2%	6.0%	0.9%	6.7***
1985	3	2.0%	11.4%	7.8%	1.5	5	8.6%	16.1%	7.0%	2.3**	29	3.6%	4.9%	0.9%	5.4***
1986	18	2.6%	4.1%	0.8%	4.9***	7	0.6%	1.7%	0.7%	2.3**	95	7.0%	7.8%	0.7%	10.4***
1987	11	11.1%	11.5%	2.5%	4.5***	4	5.4%	3.3%	1.3%	2.5**	78	5.3%	10.9%	1.4%	8.0***
1988	23	12.2%	19.2%	3.3%	5.8***	7	6.4%	9.1%	2.0%	4.5***	95	7.0%	9.2%	1.0%	9.1***
1989	35	7.6%	7.9%	0.9%	8.9***	4	57.8%	38.5%	13.1%	2.9***	82	4.7%	8.3%	1.2%	7.0***
1990	31	6.5%	17.8%	4.4%	4.0***	16	0.5%	3.6%	1.3%	2.7***	89	2.4%	8.2%	1.1%	7.2***
1991	7	2.8%	5.8%	3.3%	1.7*	3	3.8%	3.5%	0.8%	4.1***	59	7.5%	9.5%	1.1%	8.7***
1992	27	5.1%	9.0%	3.1%	2.9***	3	1.1%	1.6%	1.1%	1.5	81	8.2%	11.3%	1.2%	9.3***
1993	36	5.7%	8.3%	1.6%	5.4***	10	39.5%	32.5%	9.5%	3.4***	103	4.0%	8.1%	0.9%	8.7***
1994	39	5.6%	8.6%	1.5%	5.6***	17	7.4%	30.0%	9.1%	3.3***	141	4.3%	7.9%	0.9%	9.2***
1995	17	5.4%	7.4%	1.2%	6.0***	36	2.4%	7.2%	2.3%	3.2***	120	4.0%	8.2%	1.8%	4.7***
1996	63	4.7%	7.0%	0.9%	8.2***	91	6.1%	6.6%	0.6%	11.9***	239	3.6%	9.0%	1.0%	9.1***
1997	46	3.1%	5.1%	1.0%	5.4***	102	8.9%	13.0%	1.5%	8.4***	255	6.9%	11.4%	0.9%	13.3***
1998	58	5.4%	7.1%	1.0%	7.1***	121	5.0%	8.2%	0.8%	10.4***	230	5.9%	9.5%	0.6%	15.5***
1999	46	4.0%	6.1%	0.7%	8.7***	91	4.3%	6.7%	0.6%	10.6***	131	2.8%	6.1%	0.6%	9.7***
2000	46	4.1%	4.9%	0.9%	5.6***	89	5.0%	8.9%	2.0%	4.4***	182	5.4%	8.7%	0.7%	13.3***
2001	68	4.2%	6.6%	0.8%	8.0***	84	4.6%	6.1%	0.6%	10.0***	158	4.6%	7.9%	0.8%	9.6***
2002	84	7.1%	13.2%	2.1%	6.3***	126	6.9%	11.0%	1.1%	10.1***	173	6.0%	8.5%	0.6%	13.5***
2003	86	8.4%	11.9%	1.2%	10.1***	110	6.8%	11.0%	1.3%	8.5***	260	8.2%	11.4%	0.7%	17.0***
2004	276	9.4%	12.0%	0.6%	18.5***	119	12.4%	13.9%	1.0%	14.1***	322	15.4%	17.1%	0.7%	23.3***
2005	106	7.0%	10.7%	0.9%	11.5***	210	7.4%	12.3%	0.9%	13.0***	381	17.7%	22.6%	1.1%	21.1***
2006	116	13.8%	19.0%	1.6%	11.7***	167	7.8%	10.6%	0.8%	13.2***	323	15.5%	19.2%	0.9%	20.3***
2007	89	5.9%	9.1%	1.0%	9.5***	136	7.3%	10.1%	0.8%	12.2***	172	8.0%	13.0%	1.0%	12.8***
2008	64	15.2%	20.6%	1.6%	12.5***	90	8.4%	15.8%	1.7%	9.1***	20	5.2%	9.8%	2.8%	3.5***
2009	180	8.4%	11.6%	0.7%	15.6***	111	6.1%	10.2%	0.9%	11.5***	14	19.2%	16.6%	2.1%	7.9***
All	1,583	7.1%	11.7%	0.3%	37.8***	1,759	6.8%	10.8%	0.3%	35.8***	3,872	8.6%	13.5%	0.2%	56.6***

Note: t-Stat is a t-statistic for the null hypothesis that the mean difference is zero.

*, **, and *** indicate that the mean is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

univariate results. The main difference is that Chg. NPI Income Return becomes positive and highly significant in a multivariate model. This model explains more than 50% of the variability in our dependent variable, indicating that appraisal error is largely systematic rather than random. In other words, by accounting for the variables in this model, appraisers should be able to reduce the difference in sales prices and appraised values by taking these factors into account.

In Panel B, our dependent variable is the average absolute percentage difference in sales price and appraised value. Our explanatory variables are the same as in Panel A except that we have taken the absolute value of each variable, consistent with the construction of our dependent variable. As in Panel A, we sequentially enter each of the five explanatory variables to provide evidence on the explanatory power of each, and then we present a model including all five explanatory variables. We find that the coefficient on the absolute NPI Appreciation

Return is positive and significant at better than the 0.05 level, explaining about 5% of the variation in the dependent variable. As hypothesized, when property values are changing more rapidly, appraisal errors are larger.

Next, we find that the coefficient on the Number of NPI Sales is positive and significant at better than the 0.01 level, and explains more than 11% of the variability in the dependent variable. As in Panel A, this is exactly the opposite of what we would expect if the number of sales is a measure of liquidity; instead, this is consistent with the number of sales as an indicator of market frothiness. Our third variable—the absolute four-quarter change in the NPI Income Return—is positive and significant at the 0.01 level, explaining about 6% of the variability in the dependent variable. Unexpected changes in property income are associated with larger appraisal errors. Our fourth variable—our proxy for changes in cap rates—is positive and significant at better than the 0.01 level, explaining more than 12% of

EXHIBIT 13

Determinants of the Average Percentage Difference in Sales Price and Appraised Value

Panel A: Average Equal-Weighted Quarterly Percentage Difference in Sales Price and Appraised Value

Variable	Parms	Parms	Parms	Parms	Parms	Parms
Intercept	0.0075	-0.042***	0.0071	-0.0012	-0.013	0.0299***
	1.25	-5.26	1.13	-0.21	-1.53	-3.15
NPI Appreciation	0.78***					-0.424
	2.93					-1.30
NPI Number of Sales		0.00072***				0.00061***
		7.9				6.89
Chg. NPI Income			-0.046			0.328***
			-0.55			4.21
Chg. RERC Cap Rate				-0.079***		-0.14***
				-5.08		-4.62
Chg. Constr. Cost					0.657***	-0.568**
					3.33	-2.23
F-Statistic	8.59***	62.36***	0.3	25.84***	11.11***	22.37***
Adj. R ²	0.068	0.371	-0.007	0.193	0.089	0.507
Obs.	106	106	106	106	106	106

Panel B: Average Equal-Weighted Absolute Percentage Difference in Sales Price and Appraised Value

Variable	Parms	Parms	Parms	Parms	Parms	Parms
Intercept	0.1061***	0.0983***	0.1037***	0.1001***	0.0945***	0.0822***
	24.35	19.18	21.40	21.62	13.95	11.02
ABS NPI Appreciation	0.485**					0.197
	2.52					0.84
NPI Number of Sales		0.00022***				0.00014**
		3.75				2.29
ABS Chg. NPI Income			0.174***			0.102
			2.70			1.53
ABS Chg. RERC Cap Rate				0.048***		0.012
				0.012		0.65
ABS Chg. Constr. Cost					0.494***	0.246
					3.17	1.4
F-Statistic	6.34**	14.09***	7.31***	15.36***	10.06***	5.52***
Adj. R ²	0.049	0.111	0.057	0.121	0.080	0.179
Obs.	106	106	106	106	106	106

Note: NPI Appreciation and Chg. NPI Income Return refer to the quarterly appreciation return and four-quarter percentage change in the quarterly income return of the NCREIF National Property Index, respectively. NPI Number of Sales is the quarterly number of properties sold out of the NPI portfolio. Chg. RERC Cap Rate is a proxy for the four-quarter change in the quarterly RERC Internal Rate of Return. Chg. Constr. Cost is the percentage change in the U.S. Census Index of Construction Costs. In Panel B, ABS indicates an absolute value. For each variable, the exhibit presents the coefficient over its associated t-statistic. The sample period covers 106 quarters beginning with 1984 Q1 and ending with 2009 Q4.

*, **, and *** indicate that the coefficient is statistically different from zero at the 0.10, 0.05 and 0.01 levels, respectively.

the variability in the dependent variable. As in Panel A, this is consistent with our hypothesis that appraisal errors are larger when cap rates are changing more rapidly. Our final variable—Chg. Constr. Cost Index—is positive and significant at better than the 0.01 level. Again, this is consistent with our hypothesis that appraisal errors are larger when construction costs are changing more rapidly. In the last column of Panel A are the results from a

model that includes all five of our explanatory variables. Surprisingly, only one of the five variables is statistically significant at even the 0.05 level, whereas each of the five was significant in univariate regressions and four of the five at better than the 0.01 level. This is almost certainly attributable to multicollinearity among the five regressors, as this model explains about 18% of the variability in the dependent variable, far more than any of the

individual variables. While this model has far less explanatory power than our model of the signed appraisal error, it still indicates that there is a large systematic component to the absolute appraisal error that could be reduced by accounting for the variables in this model.

Determinants of the Percentage Appraisal Error

Finally, we investigate determinants of the signed and absolute percentage appraisal error at the property level. In Exhibit 14, we present the results from a series of ordinary least squares regressions where the dependent variable is the signed percentage difference (Panel A) or the absolute percentage difference (Panel B) in sales price and two-quarters-prior appraised value (adjusted for capital gains). The explanatory variables include

the same five macroeconomic variables that appear in Exhibit 13, plus the set of property-level variables discussed earlier.

In Panel A are the results for the signed percentage appraisal error. For the five macroeconomic variables, the results are not qualitatively different from those found for the average signed percentage appraisal error in Panel A of Exhibit 13. Each variable except for the quarterly NPI Appreciation Return is statistically significant, the Number of NPI Sales and change in NPI Income Return are both positive, and Chg. RERC Cap Rate and Chg. Construction Cost Index are negative. In other words, the property-level results confirm our findings for the quarterly average percentage appraisal error.

Among the property-level variables, our results largely confirm our hypotheses. First, we find that signed percentage appraisal errors are smaller for open-end fund

EXHIBIT 14

Determinants of the Percentage Difference in Sales Price and Appraised Value

Panel A: Signed Percentage Difference			Panel B: Absolute Percentage Difference		
Variable	Coef.	t-Stat	Variable	Coef.	t-Stat
Intercept	-0.029	-5.38***	Intercept	0.078	18.48***
NPI Appreciation	-0.180	-1.14	ABS NPI Appreciation	0.407	3.33***
Chg. NPI Income	0.264	6.71***	ABS Chg. NPI Income	0.101	2.88***
NPI Number of Sales	0.00047	12.2***	NPI Number of Sales	0.00012	4.28***
Chg. RERC Cap Rate	-0.100	-6.73***	ABS Chg. RERC Cap Rate	0.014	1.46
Chg. Constr. Cost	-0.362	-3.00***	ABS Chg. Constr. Cost	0.286	3.27***
Open-End	-0.014	-2.22**	Open-End	-0.004	-0.9
ODCE Open-End	-0.026	-2.43**	ODCE Open-End	0.001	0.12
Closed-End	-0.003	-0.41	Closed-End	0.000	0.04
External	-0.016	-3.08***	External	-0.022	-5.69***
Internal	-0.016	-3.35***	Internal	-0.020	-5.39***
Levered	0.021	4.99***	Levered	0.010	2.97***
Office	0.020	4.06***	Office	0.015	3.98***
Retail	0.010	1.78*	Retail	0.004	0.97
Apartment	0.030	5.52***	Apartment	-0.009	-2.13***
F-Statistic	42.00	***	F-Statistic	21.54	***
Adjusted R-Square	0.074		Adjusted R-Square	0.038	
Observations	1,799		Observations	1,799	

Note: NPI Appreciation Return and Chg. NPI Income Return refer to the quarterly appreciation return and four-quarter percentage change in the quarterly income return of the NCREIF National Property Index, respectively. Chg. RERC Cap Rate is a proxy for the four-quarter change in the quarterly RERC Internal Rate of Return. Chg. Constr. Cost is the percentage change in the U.S. Census Index of Construction Costs. Open-End is an indicator variable for Open-End Commingled Real Estate Fund properties, ODCE Open-End is an indicator variable for ODCE Open-End Fund properties, and Closed-End is an indicator for Closed-End Commingled Real Estate Fund properties, with the omitted category being Separate Account Properties. External is an indicator variable for external appraisals, Internal is an indicator for internal appraisals, with the omitted category being No Appraisal Indicated. Levered is an indicator variable for levered properties, with unlevered properties being the omitted category. Office, Retail, and Apartment are indicators for those property types with Industrial being the omitted category. In Panel B, ABS indicates an absolute value. For each variable, the exhibit presents the coefficient next to its associated t-statistic. The sample period covers 106 quarters beginning with 1984 Q1 and ending with 2009 Q4.

*, **, and *** indicate that the coefficient is statistically different from zero at the 0.10, 0.05, and 0.01 levels, respectively.

properties, where accuracy is at a premium because fund participants can trade in and out of the funds based upon appraised values. Signed percentage appraisal errors for closed-end fund properties are not significantly different from those of the omitted category of separate account properties. Second, signed percentage appraisal errors are significantly lower for external and internal appraisals relative to the omitted category of No Appraisal Indicated. We had hypothesized that errors would be smallest for external appraisals, which are done by an independent third party, but this does not appear to be the case. This calls into question the justification for paying for such outside appraisals. Third, the signed percentage appraisal errors are larger for levered properties relative to the omitted category of unlevered properties. The values of levered properties that are reported to NCREIF are as if the property was unlevered, so this “unlevering” calculation appears to magnify any appraisal error. Fourth, signed percentage appraisal errors are largest for apartment properties, followed by office properties, retail properties, and then the omitted category of industrial properties. We had expected a similar pecking order, but with office properties at the top, followed by retail, apartment, and industrial properties. Hence, it appears that appraisals of apartments are the most difficult for appraisers.

In Panel B are the results for the absolute percentage appraisal error. For the five macroeconomic variables, all but Chg. RERC Cap Rate are statistically significant at the 0.01 level or better, and all five are positive. Hence, these results confirm the univariate results reported in Exhibit 13 for the quarterly average absolute appraisal error. Once again, the big surprise is the positive coefficient on the Number of NPI Sales, indicating that it is a proxy for market froth rather than for market liquidity.

Among the property-level variables, our results for external appraisals, internal appraisals, and levered properties are not qualitatively different from those in Panel A. Appraisal errors are smaller for external and internal appraisals relative to the omitted category, No Appraisal Indicated, but not different between External and Internal categories. Appraisal errors are significantly larger for levered properties relative to the omitted category of unlevered properties.

Results for fund type are different from the results in Panel A, in that we find no significant differences in the appraisal accuracy across funds. Results for property

type also are different from those reported in Panel A. Here we find that appraisal errors are largest for office properties, followed by retail and industrial properties, with apartment properties having the smallest absolute errors.

CONCLUSIONS

In this study, we have analyzed the accuracy of commercial real estate appraisals using data from properties sold out of the NCREIF National Property Index during the 1984–2010 period. Our findings are sobering. On average, appraisals are more than 12% above or below subsequent sales prices, and this result holds true for both external and internal appraisals. Even in a portfolio context where errors can cancel out each other, results are not appreciably better; appraisals are off by an average 4%–5% of value because the under- and overvaluations are highly correlated across properties at the same points in time. In other words, errors don’t “average out.” We also find that appraisals appear to lag the true sales prices, falling below in hot markets and remaining above in cold markets. The largest deviations are observed during the two peaks and two valleys of the past two cycles in the commercial real estate market. Not surprisingly, the worst performance occurred during the recent financial crisis.

We also model the difference in the sales price and prior appraisal. We find that this “appraisal error” is largely systematic; we can explain more than half of the variation in the signed percentage difference in sales price and appraised value. This is strong evidence that appraisal errors are not due solely to property-specific heterogeneity. Instead, our results offer guidance to appraisers on what factors to look to in adjusting for fast-changing market conditions.

ENDNOTES

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Meeting of the American Real Estate and Urban Economics Association, for helpful comments.

¹Researchers also have generated indices based upon transactions. See Hoag [1980]; Miles, Cole, and Guilkey [1990]; Webb, Miles, and Guilkey [1992]; and Fisher et al. [2004]. The MIT Center for Real Estate produces a commercial real estate index based upon transactions of NCREIF properties that covers 1984 to the present.

²As we move to three and four quarters prior to sale, we lose an additional 242 and 209 properties, respectively, that have only two or three appraisals available prior to sale date.

³A number of managers do not appraise properties on a quarterly basis. The indicator variable for inside or outside appraisal also includes a third value indicating "no appraisal."

⁴We obtained the Pre-Tax Yield (IRR) for All Property Types from the Real Estate Research Corporation (RERC) for 1993 Q1–2010 Q2. Because our data begin as of 1984 Q1, we developed a model of the Pre-Tax Yield as a function of macroeconomic variables that are available going back to 1984. Our model, which must remain confidential in order for us to comply with the terms of our use of the RERC data, explains more than 90% of the variability in the Pre-Tax Yield over the 1993–2010 period. We then construct a measure of the change in the Pre-Tax Yield that explains more than 50% of the variability in the four-quarter change in the Pre-Tax Yield. We use this measure as our proxy for changes in the cap rate.

⁵We use the Constant Quality (Laspeyres) Price Index of New One-Family Houses under Construction (2005 base year), which we obtained from the website of the U.S. Census, <http://www.census.gov/const/www/constpriceindex.html>.

⁶There also was a mild down cycle in 2001 and 2002 when losses cumulated to only 3.6%. Interestingly, the losses in the 2008–2010 period almost exactly equal the 38.6% cumulative gain in the 2004–2007 period.

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MacKinnon, and Rodrigues examine a sample of OECFs to determine if their underlying portfolios are consistent with common definitions of “core” and to what extent core funds provide beta exposure to the market. Generally, OECFs appear to hold core-type portfolios, but this is not universal. In particular, smaller funds tend to be less diversified and have higher idiosyncratic volatility. Many OECFs have a surprisingly large exposure to development projects. The authors find that leverage also plays a key role in an analysis of OECFs. While most OECF returns are driven by the broad market, OECFs are usually an aggressive play on the market, with each fund’s aggressiveness determined by its leverage. Further, although the authors find evidence of persistence in OECF returns, a closer look reveals that this may be due to funds varying their capital structure over time. Overall, while most OECFs appear driven by similar factors, not all are created equal; investors should conduct careful due diligence on their OECF investments, with special attention to fund size and leverage.

HOW ACCURATE ARE COMMERCIAL REAL ESTATE APPRAISALS? Evidence from 25 Years of NCREIF Sales Data 68

SUSANNE ETHRIDGE CANNON
AND REBEL A. COLE

In this study, Cannon and Cole provide new evidence on the performance measurement and reporting of commercial real estate returns. They do so by examining the accuracy of commercial real estate appraisals that occurred prior to the sale of properties from the NCREIF National Property Index (NPI) from 1984 to 2010, a period that spans two up-and-down market cycles. The authors find that, on average, appraisals are more than 12% above, or below, subsequent sales prices that take place two quarters following the appraisal. Even in a portfolio context, allowing for offsetting positive and negative differences, appraisals are off by an average 4%–5% of value, even after adjusting for capital

appreciation during those two quarters. The authors also provide new evidence regarding how, and by how much, appraised values lag behind sales prices. They find that appraisals appear to lag the true sales prices, falling significantly below in hot markets and remaining significantly above in cold markets. This new evidence provides guidance to investors, regulators, and others about how to interpret real estate indices such as the NPI, which are based on appraised values, in both a rising and a falling market. Finally, the authors find that this “appraisal error” is largely systematic; they can explain more than half of the variation in the signed percentage difference in sales price and appraised value. Hence, appraisal errors are not due solely to property-specific heterogeneity.

HOUSING RISK AND RETURN: Evidence from a Housing Asset-Pricing Model 89

KARL CASE, JOHN COTTER,
AND STUART GABRIEL

Case, Cotter, and Gabriel investigate the risk–return relationship in the determination of housing asset pricing. In so doing, they evaluate the behavioral hypotheses advanced by Case and Shiller in studies of boom and post-boom housing markets. The authors specify a multifactor housing asset-pricing model and evaluate whether the market factor and other measures of risk, including idiosyncratic risk, momentum, and MSA size effects, have explanatory power for metropolitan-specific housing returns. Further, they test the robustness of the asset pricing results to inclusion of controls for socioeconomic variables commonly represented in the house price literature, including changes in employment, affordability, and foreclosure incidence, and find a sizable and statistically significant influence of the market factor on MSA house price returns. Moreover, they show that market betas have varied substantially over time. Results are largely robust to the inclusion of other explanatory variables,