

An Empirical Analysis of the Reliability and Precision of the Cost Approach in Residential Appraisal

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Abstract. Many articles and books have discussed the limitations of the cost approach to estimate market value of real estate. This article is the first to empirically measure the predictive ability of the cost approach to estimate value of single-family houses. Three hypotheses have been tested. The results indicate that the cost approach did not provide unbiased estimates of value, and the sales comparison approach estimated value more precisely. Additionally, cost approach precision was not significantly different for newer or older properties.

Introduction

The validity and usefulness of the cost approach has been questioned for over fifty years. Many articles and books have discussed the limitations of the method to accurately identify market value of real property. However, no empirical evidence has previously been published that actually measured the precision and efficiency of the cost approach to estimate value.

The purpose of this article was to empirically test the hypothesis that the cost approach yields unbiased estimates of market value, and to determine if the precision of the cost approach was affected by the age of the subject properties. In addition, the precision of the cost approach was compared to the sales comparison approach to determine which method was more reliable.

The paper is organized as follows. First, a brief review of previous literature regarding the reliability of the cost approach is presented. This is followed by the model used to quantify residential appraisal error for both the cost approach and the sales comparison approach, a description of the data, and the hypotheses that were tested. Next, the statistical results are presented along with a summary and conclusions.

Literature Review

The cost approach has been identified as being useful for the following appraisal assignments: proposed construction, special-purpose property, property that is in-

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frequently traded, for insurance purposes, and when a lack of comparable sales data exists [1]. Additionally, Entretien and Kapplin have suggested that the cost approach can be useful for construction loan purposes, feasibility, and highest and best analysis, because the cost of construction must be compared to the expected value of the proposed project in these assignments [6]. Derbes theoretically illustrated the interrelationships between the three approaches to value and concluded that the cost approach is useful because it provides information about land values, reproduction costs, and depreciation [5].

Other scholars have described the limitations of the method for estimating market value of improved real estate. Ratcliff noted that as early as 1932, the National Association of Real Estate Boards condemned the cost approach as unsound, inaccurate and misleading [10]. He concluded that the fatal defect in the cost approach is that the value of the whole is not the sum of the parts; and that with few exceptions, the approach is "unrealistic, subjective and unproductive" [10, p. 109]. Harrison said that without sufficient market data to estimate land values, costs and depreciation, significant error is possible; and that extreme caution should be practiced when using the cost approach [8]. Entretien and Kapplin stated that the cost approach is not an indication of market value or most probable selling price, because, in competitive markets, producers have little control over value, although they may have considerable control over cost of production [6]. They suggested that housing producers use cost more as a benchmark to continue production, and that the cost approach is best used as a test or validation of value estimates from other approaches. Rand stated that the validity of the cost approach other than for estimating a range of values is theoretically questionable because the method does not address the risk of the construction process that buyers would assume if they chose to build an exact replica of the subject [9]. In another context, Christensen found that the cost approach is not observed in the market to represent the typical action of buyers when purchasing subsidized income properties, because the value of a subsidized low-income housing project seldom equals the cost of construction [3]. Additionally, these projects often represent a substantial over-improvement to the neighborhood. Although the cost approach has been typically viewed as identifying the upper limit of value, Cutsinger illustrated that under market conditions where there is excessive demand for houses and the supply is restricted by governmental regulation, the cost approach will yield the lowest value estimate [4].

Another indication of the lack of confidence in the cost approach is evident in the corporate relocation industry. The most recent appraisal forms that have been approved by the industry's trade association, Employee Relocation Council, rely exclusively on the sales comparison approach.

Sample Data

To test the hypotheses, a sample of corporate relocation appraisals was gathered from six corporate relocation companies. The appraisals were made by independent fee appraisers for corporate employers to determine the price that they would pay to purchase their transferred employees' houses. The sample included the appraisal reports and the financial information about the subsequent resale of the properties. This information consisted of the sales price, financing terms, date of sale, and remodeling expenditures of the acquired properties. The data was sufficient to compare the a priori appraisal estimates of value with the actual price for which the property subsequently sold.

The sale prices of the properties in the sample ranged from \$27,500 to \$395,000, with a mean sales price of \$90,295. The properties were sold by the relocation companies over a twenty-six-month period from July, 1984 through August, 1986, with an average of 140 days on the market prior to sale. The mean age of the homes was thirteen years, ranging from one year to seventy-nine years. The appraisers rated 28% of the properties as having excellent interior and exterior condition, and rated 1% of the properties as having poor interior and exterior condition. The sample was geographically distributed across thirty-three states, with the heaviest concentration of properties located in Arizona, Indiana, Missouri, Ohio, Oklahoma and Texas. Additional descriptive information about the sample data is provided in the Appendix.

Appraisal Error Defined

To examine the issue of appraisal precision, appraisal error was defined as the difference between the appraised value (from the cost approach and the sales comparison approach) and the adjusted sales price of the property. The appraisal estimate was compared to the actual contract sales price, adjusted for sales concessions made by the seller and any remodeling expenditures made by the seller to improve the property after the house was appraised. Appraisal error for the cost approach (expressed as a percentage of the adjusted sales price) was defined as

$$ERROR_{cost} = \frac{COSTVAL - [SP - PTS - REMOD]}{[SP - PTS - REMOD]} \quad (1)$$

where

COSTVAL = value of the subject estimated by the cost approach,

SP = the contract sales price received for the property,

PTS = sales concessions paid by the seller,

REMOD = remodeling expenditures made after the appraisal.

Similarly, appraisal error for the sales comparison approach was defined as

$$ERROR_{sc} = \frac{SALEVAL - [SP - PTS - REMOD]}{[SP - PTS - REMOD]} \quad (2)$$

where

SALEVAL = value of the subject estimated by the sales comparison approach.

Testing for Estimation Bias in the Cost Approach

To determine whether the cost approach yields unbiased estimates of market value of single-family homes, the following hypothesis was tested.

H_0 : The mean appraisal error from the cost approach is zero.

H_a : Otherwise.

Using a sample of 320 appraisals, the average cost approach appraisal error was found to be 9.76%. This means that the average appraisal estimate was nearly 9.8% above the adjusted sales price for which the property subsequently sold. The results of the t-test, which are presented in Exhibit 1, indicated that the null hypothesis was rejected with a confidence level exceeding 99%. Clearly, the cost approach did not produce unbiased estimates of value for the single-family homes in this sample. These results are consistent with appraisal literature which suggests that, theoretically, the cost approach should represent the top of the value range for the subject property.

Exhibit 1 T - Test for Bias in the Cost Approach

N= 320
Mean Error = 0.0976047
Standard Deviation = 0.124024
T-statistic = 14.078
P-value = 0.0001

Factors That Affect Cost Approach Precision

Current perceptions of residential appraisal methods indicate a lack of confidence in the validity and reliability of the cost approach to estimate market value of houses. The precision of the cost approach is dependent upon the appraiser's ability to estimate the value of the land, the replacement/reproduction cost of the improvements, and the accrued depreciation in the subject property. Land value estimates are most reliable when sales of vacant lots have occurred recently in the immediate neighborhood. In mature, fully developed areas, lack of sales data creates substantial difficulties in accurately establishing land value. However, the chief disadvantage of the cost approach is the difficulty of accurately estimating accrued depreciation [7]. The appraisal reports in the sample used the economic age-life method of estimating depreciation, which requires a highly subjective judgment of the appraiser regarding the effective age of the property. A recent empirical study by Cannaday and Sunderman indicated that the economic age-life method, which assumes a straight-line rate of depreciation, may not be the most appropriate method [2]. Their results indicated that a reverse sum of the years digits method more closely reflects depreciation in single-family houses. Consequently, as a house ages and the amount of depreciation increases in the property, the magnitude of potential estimation errors in the cost approach is expected to increase.

Testing for the Impact of Age on Cost Approach Precision

The following hypothesis was tested to determine if the estimation error of the cost approach increases as the age of the subject property increases.

- H₀: The mean error from the cost approach does not increase as the age of the subject property increases.
- H_a: Otherwise

To test this hypothesis, a one-way analysis of variance model was constructed, such that

$$\text{Cost Approach Error} = f(A)$$

where *A* is a vector of age groups of the subject properties contained in the sample, and cost approach error was defined by equation 1. The sample consisted of 320 appraisals of properties ranging in age from one to seventy-nine years. The properties were grouped by their actual chronological age in three-year increments in the following manner:

Group	Age	<i>N</i>
1	1-3 years	46
2	4-6 years	73
3	7-9 years	59
4	10-12 years	48
5	13-15 years	23
6	over 15 years	71

Properties over fifteen years old were grouped together because additional groupings in three-year increments were not of sufficient size to be statistically useful.

The results of the ANOVA are presented in Exhibit 2. The *F*-statistic of 1.57 revealed that the null hypothesis could not be rejected, indicating that the mean error from the cost approach did not increase as the age of the subject property increased. The coefficient of determination showed that only 2% of the variation in cost approach error was explained by the age of the subject property.

Exhibit 2
Cost Approach Error Grouped by Age of Subject

Source	DF	Sum of Squares	<i>F</i> -Value	<i>R</i> -Square
Model	5	0.1196	1.57	0.0244
Error	314	4.7872	(<i>p</i> = 0.1684)	
Total	319	4.9068		

Age Group	<i>N</i>	Mean Error
1	46	0.0888
2	73	0.1089
3	59	0.1265
4	48	0.0928
5	23	0.0529
6	71	0.0854

Comparing the Precision of the Cost Approach and the Sales Comparison Approach

The American Institute of Real Estate Appraisers suggests that the sales comparison approach is the most reliable and preferred method of residential appraisal, when sufficient comparable sales data are available [1, p. 313]. To empirically measure the relative performance of the two approaches to value, a matched-pairs comparison test was used to determine if the sales comparison approach to residential appraisal was more reliable than the cost approach. The following hypothesis was tested.

H_0 : The mean difference between the appraisal error from the cost approach and the sales comparison approach is zero.

H_a : Otherwise

where:

$$\bar{D} = \text{Mean Appraisal Error difference} = \sum D_i/n$$

$$D_i = \text{ERROR}_{\text{cost}(i)} - \text{ERROR}_{\text{sc}(i)}$$

for the i th property and where cost approach and sales comparison approach appraisal error was defined by equations 1 and 2 respectively, and

n = number of properties simultaneously appraised with the cost approach and the sales comparison approach.

Using a sample of 320 appraisals for which a sales comparison and a cost approach estimate were simultaneously made on the subject property, the results presented in Exhibit 3 indicated that the null hypothesis was rejected. On average, the appraisal error from the cost approach was nearly 3.8% greater than the error from the sales comparison approach on the same property. The F -statistic of 12.34 indicated that the null hypothesis was rejected with 99% confidence, and that the sales comparison approach was a more reliable method of estimating the value of the residential property in the sample. These results are consistent with current thinking in appraisal literature.

Exhibit 3 Matched-Pairs Comparison Sales Comparison Approach versus Cost Approach

\bar{D} = 0.0378
 N = 320
 Standard Error of the Mean = 0.0031
 T -statistic = 12.34
 P -value = 0.001

Mean error from the cost approach	9.76%
Mean error from the sales comparison approach	5.98%

Conclusions

The results of this study confirmed that the cost approach is indeed a less reliable method of estimating value, when compared to the sales comparison approach for estimating the value of residential properties. From the nationally distributed sample of 320 appraisals, three major conclusions can be drawn.

First, the cost approach did not yield unbiased estimates of market value for single-family houses in the sample. Average cost approach error was found to be nearly 9.5% above the adjusted sales price of the appraised property. The cost approach estimates were systematically higher than the actual value of the properties.

Second, the precision of the cost approach was found to be unrelated to the age of the property being appraised, which refutes the notion that the approach is more appropriate and reliable for newer houses with smaller amounts of depreciation. The results indicate that the precision of the cost approach is not significantly different for newer homes or older homes. A practical consequence of this finding may be that placing additional weight on the cost approach in the final reconciliation process of the appraisal of newer houses may not be warranted.

Third, the sales comparison approach was shown to be the superior method of estimating market value. Cost approach appraisal error was found to be over 3.8% greater than the sales comparison approach. Average error from the sales comparison approach was found to be 5.98% over the adjusted sales price of the properties in the sample, significantly lower than the 9.76% error from the cost approach. These results revealed that both appraisal methods systematically overvalued the properties in the sample. Although outside of the scope of this project, future research to identify the market conditions that produced this phenomenon would be interesting and valuable.

In conclusion, the cost approach has been recognized recently as being useful for feasibility studies and highest and best use analysis. Additionally, it provides needed information for lenders making construction loans for new homes and for insurance purposes. However, for the purpose of appraising existing single-family homes, the cost approach appears to provide little incremental information that is not already provided by the sales comparison approach. At best, it can identify the "top end" of the expected range of value for which the subject property will sell, and can be used as a check on the estimate of value from the sales comparison approach.

Appendix

Description of the Sample Data

Mean sales price: \$90,295

Sales price range: \$27,500–395,000

Mean days on the market: 140 days

Mean age: 13 years

Age range: 1–79 years

Mean square footage of house: 1,871 square feet

Range of square footage: 768-5,582 square feet

Houses with basements: 51%

Houses with swimming pools: 8%

Houses rated by appraiser as having excellent interior: 28%

Houses rated by appraiser as having excellent exterior: 28%

Houses rated by appraiser as having poor interior: 1%

Houses rated by appraiser as having poor exterior: 1%

Geographic distribution of appraisals (by State):

Missouri	32	Pennsylvania	6
Ohio	26	Florida	6
Texas	25	Iowa	5
Arizona	24	Louisiana	4
Indiana	23	Montana	4
Oklahoma	20	Alaska	2
Minnesota	19	Alabama	2
Kansas	14	California	2
New York	13	Idaho	2
Michigan	12	Maryland	2
Arkansas	12	Maine	2
Illinois	11	Mississippi	2
Wisconsin	11	New Jersey	2
Nebraska	10	S. Carolina	2
Colorado	10	Tennessee	2
N. Carolina	9	Virginia	2
		Washington	2

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