Quantifying Estimation Bias in Residential Appraisal

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Abstract. The purpose of this study was to empirically test the ability of residential appraisers to estimate market value of houses. Using a sample of over 500 appraisals made for corporate relocation firms, the appraisal estimates of market value were compared with the actual price that the houses sold for subsequently. The results indicate that current appraisal methods produce unbiased estimates of market value. Additional empirical results are presented that show that seasonal factors and regional economic conditions significantly explain variation in appraisal error.

Introduction

The real estate appraisal industry currently is receiving severe criticism from many of the entities that demand their services. In 1986, a U.S. House of Representatives Committee on Government Operations reported that more than 800 federally insured savings and loan associations have "significant appraisal deficiencies" and more than 300 of them were declared insolvent or placed in "problem status" by federal regulators. The Committee also reported that 10-15% of the $1.3 billion in losses suffered by private mortgage insurers in 1984-85 could be attributed to inaccurate and fraudulent appraisals, and that 10-40% of the $420 million in loan losses at the Veterans Administration in 1987 was caused by inaccurate or dishonest appraisals or other appraisal–related deficiencies. [7] As a result of these findings, the Committee is calling for increased federal regulation plus the certification or licensing of residential appraisers.

The purpose of this study was to empirically test whether current residential appraisal methods produce unbiased estimates of value. In addition, appraisal errors have been quantified and factors related to appraisal errors identified. A sample of over 500 residential appraisals of properties acquired by corporate relocation companies were compared with the actual prices at which relocation firms were able to sell the properties in the marketplace. Appraisal errors were defined as the difference between the appraiser's a priori estimate of value and the subsequent actual selling price of the property. The empirical results show that current methods are unbiased and that seasonal factors and regional economic conditions significantly explain appraisal errors.

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Previous Empirical Research

Kain and Quigley [5] compared the estimating precision of real estate appraisers with the precision of the owners of properties being appraised. A sample of 113 owner-occupied dwellings (houses and duplexes) were utilized for their research. The appraisers' estimates of value were assumed to be unbiased and free of measurement error. These were used as a basis for evaluating the homeowner's ability to estimate value. Their results indicated that owners tend to underestimate the value of their property by an average of 2% (in comparison with the appraiser's estimate), which statistically was not a significant difference. The focus of Kain and Quigley was to measure the homeowner's ability to estimate value relative to a professional appraiser's value estimate, rather than a direct test of appraisal precision or bias.

In a similar vein Robins and West [6] also compared estimating precision of homeowners and professional appraisers. Using a system of equations to account for the fact that appraiser estimates of value are subject to measurement error, a reduced form regression model was developed to compare the estimating precision of professional appraisers, homeowners, and property tax assessors. Using a sample of 138 single-family dwelling units in a low-income government-sponsored housing project, their results showed that the owner's estimate of value was highest (on average) compared to appraisers and assessors. Appraiser and assessor value estimates were not significantly different. Integral to the Robins and West study is the assumption (also shared with Kain and Quigley) that the appraisers' estimate is an unbiased estimate of market value.

Using data from the corporate relocation industry, Dotzour [3] found that professionally designated appraisers estimate value more precisely than non-designated appraisers. Cole, Guilky and Miles [2] measured the estimating precision of commercial real estate appraisers. Using data from 144 commercial properties such as apartments, hotels, offices, retail, and industrial properties, a comparison of the appraised values and the actual sales prices revealed a mean absolute appraisal error of 7.6%. A nonparametric Wilcoxin signed-rank test revealed that commercial appraisal errors were not significantly different from zero, indicating that commercial appraisal methodology (most often utilizing the income approach) produce unbiased estimates of market value.

As such, previous research regarding the precision of residential appraisers has been limited to comparisons of the value estimates of professional appraisers relative to other individuals such as property owners and tax assessors. Because the properties were not subsequently sold, no transaction prices were available to verify the actual estimating precision of the appraisers. Cole, Guilky and Miles [2] were able to compare commercial appraisal estimates with actual subsequent sales prices, but similar work in residential appraisal has not been previously tested.

Data

A sample of over 500 residential relocation appraisals of houses acquired by six corporate relocation firms was used to test the proposed hypotheses. The appraisals in the sample were relocation appraisals used by the relocation firms to determine the price that they offered to acquire the employee's home. Properties included in the sample were geographically distributed across forty-one states and were sold by the relocation firms between January, 1984 and August, 1986. Prices of houses in the data set ranged from $19,500 to $395,000. In addition to the appraisal information, financial data pertinent to the sales transactions such

as the date the houses were listed and sold, contract sales price, sales concessions made by the corporate seller, the number of days the properties were on the market, and the funds spent remodeling the properties after they were acquired from the employee also was collected.

Quantifying Appraisal Error

Dotzour [3] has defined relocation appraisal error as the difference between the appraiser's estimate of value and the actual subsequent sales price received by the relocation company (net of sales concessions, remodeling expenses, and the impact of holding costs on relocation transaction prices).

As such, relocation appraisal error has been defined as

$$ERROR = \frac{APVAL - [SP - PTS - RECON + (90\text{-}DOM)(.015/30)(APVAL)]}{SP} \qquad (1)$$

for properties with $DOM \leq 90$ days, and

$$ERROR = \frac{APVAL - [SP - PTS - RECON]}{SP} \qquad (2)$$

for properties with DOM > 90 days
where:

ERROR	= appraisal estimation error expressed as a percentage of the actual sales price
APVAL	= the appraiser's estimate of value made before the relocation firm acquired the property from the transferee.
SP	= actual sales price received by the relocation company when the transferee's home is resold
PTS	= sales concessions including discount points and origination fees paid by the relocation firm for the buyer when the house is resold
RECON	= amount spent by the relocation firm to remodel properties after the appraisals were made
DOM	= number of days the property was offered for sale by the relocation company prior to signing a sales contract

Dotzour [3] also pointed out that the adjustment for remodeling expenses may result in measurement error in the calculation of appraisal error. The reason for this is that relocation firms often remodel houses after the appraisals are made in an attempt to reduce DOM and associated holding costs. To the extent that remodeling costs are not fully recaptured in the final sales price, actual appraisal error is overstated. To avoid the potential for measurement error associated with remodeling, the data set contains only properties that had no remodeling expenses.

Testing for Appraisal Bias

If current residential appraisal methods yield unbiased estimates of the value of houses, the expected value of appraisal error for a large random sample of appraisals would be equal to zero. The testable hypotheses were expressed as

Exhibit 1
Testing for Appraisal Bias

Sample Type	N	Mean Error	T–Stat	Std Dev
No remodeling	508	−.00059	−.1347	.1003

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

$$Ho : U(ERROR) = 0$$
$$Ha : U(ERROR) \neq 0$$

where error is defined previously in equations (1) and (2), and

$U(ERROR)$ = the mean appraisal error (expressed as a percentage of the actual sales price) for the population of relocation appraisals.

The sample used for this test consisted of 508 appraisals of properties with no remodeling expenditures. These properties were either in good condition requiring no improvement, or the relocation company marketing policy did not allow for remodeling and required that the properties be sold in "as is" condition. The results in Exhibit 1, which were generated from a SAS statistical program, show that the mean appraisal error for this sample is −.00059 (−.059%) of the actual sales price. The associated t–statistic of −.1347 fails to reject the null hypothesis, supporting the notion that current appraisal methods produce unbiased estimates of market value of single-family housing.

Testing for Seasonal Influences on Appraisal Error

The value of a specific property is determined not only by the physical, legal and locational components of the property, but also by the supply and demand factors present in the market during the period that the property is actively marketed. [1, p. 22]

A sizeable proportion of potential home purchasers are families with children of school age living at home. Many families attempt to time their moves during the summer months, enabling the children to change schools between school terms. Consequently, relative increases in supply and demand in the residential markets are to be expected in the summer months. If the increased level of activity in the summer had an impact on market prices, appraisal error would be significantly associated with the season of the year in which the property was sold. In addition to the seasonal influence on supply and demand relationships due to the schedule of school terms, the weather and climate also can exert an influence on transaction prices. Climatic conditions can influence a buyer's perception of the value of specific components of residential properties. For example, the perceived value of a pool, outdoor amenities and landscaping improvements may be higher in the spring and summer months when the prospective buyer expects to make immediate use of these amenities. These same amenities may have less perceived value in the fall and winter months not only because they will not be used for many months, but also because landscaping is not as attractive when dormant and pools are not as appealing when covered and winterized.

Consequently, seasonal influences would be expected to affect transaction prices through systematic changes in supply and demand for residential properties and through changes in

Exhibit 2
Seasonal Influence on Appraisal Errors

Source	D.F.	Sum Squares	F
Model	3	.2046	6.99*
Error	502	4.9000	
Total	505	5.1046	
QSold	3	.2046	6.99*

Coefficient of determination = .0401
* indicates significance at the .01 level for two-tailed test

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

value perception of housing consumers. However, current appraisal methodology does not attempt to identify or account for seasonal market influences. Current procedures adjust historical sales prices to account for extraordinary financing terms, nonmarket transactions, changing economic conditions, changes in supply or demand factors, and differences in locational and physical characteristics between the historical comparable sales and the subject of the appraisal. [1, p. 314] However, seasonal factors are not specifically addressed. Consequently, if seasonal factors do influence transaction prices, they should significantly explain a portion of the error of appraisal estimates.

The appropriate test for seasonal influences in appraisal error is an analysis of variance {Note 1} utilizing the previous sample, where

$$Appraisal\ error\ =\ f(x),$$

where

x = quarter in which the property was sold {Note 2} and error is previously defined in equations (1) and (2).

The quarters were defined as follows:

Winter = December, January and February
Spring = March, April and May
Summer = June, July and August
Fall = September, October and November

The testable hypotheses were:

$$Ho : U(x1) = U(x2) = U(x3) = U(x4)$$
$$Ha : U(x1) \neq U(\times 2) \neq U(x3) \neq U(x4)$$

where:

$U(x1)$ = mean percentage error of properties sold in the first quarter
$U(x2)$ = mean percentage error of properties sold in the second quarter
$U(x3)$ = mean percentage error of properties sold in the third quarter
$U(x4)$ = mean percentage error of properties sold in the fourth quarter

The results shown in Exhibit 2 indicate that appraisal errors are significantly different according to the quarter the property was sold. The low R-square value of .0401 shows that

Exhibit 3
Mean Appraisal Errors by Quarter Sold

Quarter Sold	N	Mean Error
Winter	109	.0184
Spring	131	.0096
Summer	154	−.0305
Fall	112	.0103

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

even though the quarter sold is significant statistically, the amount of variation in appraisal error explained by seasonal marketing factors is quite small.

The mean appraisal errors for the quarter in which properties were sold are presented in Exhibit 3. Properties which sold in the fall and winter quarters sold on the average of 1% and 1.8%, respectively, less than appraised value. Similarly, properties sold in the spring quarter sold for 1% less than the appraised value. Conversely, properties sold in the summer quarter sold for 3.1% more than the appraised value. A Duncan's multiple range test that tests for significant differences in mean appraisal error according to the quarter in which the property sold, indicated that appraisal error in the summer quarter was significantly different from each of the other three quarters. No statistical differences were found between the other three quarters. These results confirm the hypothesis that seasonal factors systematically influence appraisal errors.

It is possible that seasonal factors may be different across regions due to climatological differences that may influence the residential housing market. To test for regional differences in seasonal factors, the sample data was grouped into regions that experience similar climatological seasons. These groups were tested to see if seasonal influences vary among climatological regions. These regions were defined as:

- Northwest   = Washington, Idaho, Oregon
- Midwest   = Montana, Wyoming, Colorado, South Dakota, Nebraska, Kansas, Missouri, Michigan, Minnesota, Ohio, Iowa, Wisconsin, Illinois, Indiana
- New England   = Pennsylvania, New York, New Hampshire, Massachusetts, Delaware, New Jersey, Connecticut
- Sun Belt   = California, Arizona, Texas, Louisiana, Alabama, Florida, Mississippi

The results presented in Exhibit 4 show that seasonal factors significantly explain appraisal errors in the Midwest region of the country. The New England region, Northwest and Sun Belt regions are not significantly influenced by seasonal factors.

Testing for Regional Economic Influences on Appraisal Error

The sales comparison method of appraisal requires that the appraiser use historical transaction data to estimate current value. [1, p. 309] Consequently, the appraiser must determine if supply and demand conditions remain unchanged since the dates of the comparable sales transactions. If market conditions have changed, then the value estimate must be adjusted

Exhibit 4
Regional Distribution of Seasonal Influences

Region	Sum of Squares		D.F.	F–Stat	R-Square
Midwest	Model	.2459	3	8.12*	.1062
N = 209	Error	2.0696	205		
	Total	2.3155	208		
Sun Belt	Model	.0722	3	2.53	.1019
N = 71	Error	.6361	67		
	Total	.7083	70		
New England	Model	.0022	3	.26	.0231
N = 37	Error	.0926	33		
	Total	.0948	36		
Northwest	Model	.0377	3	2.48	.0733
N = 98	Error	.4772	94		
	Total	.5149	97		

* indicates significance at the .01 level for two-tailed test

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

to reflect such changes. Failure to correctly measure the impact of recent changes in local economic conditions on property values results in appraisal error.

One method of testing for the influence of economic conditions on appraisal error is to group the appraisal data into geographic regions that experience similar economic conditions. The assumption is that properties in the states located within a specified region are subject to similar supply and demand conditions.

Using a grouping procedure similar to that used by Hartzell, Shulman and Wurtzebach [4], the sample was grouped into the following regions with similar economic conditions.

- The Pacific Northwest = Washington, Oregon, Idaho
- The Great Lakes = Ohio, Illinois, Indiana, Michigan, Pennsylvania, Wisconsin
- The Oil Patch = Oklahoma, Texas, Louisiana
- High Tech = California, New York, Delaware, New Jersey, Minnesota, Massachusetts, Connecticut
- Farm Belt = Iowa, Nebraska, Kansas, Missouri, South Dakota, Colorado, Montana, Wyoming

If appraisers are effective in measuring levels of supply and demand and other economic factors that influence residential sales prices, then the mean value of appraisal errors should be constant across all regions. The testable hypotheses were:

$$Ho:U(r1) = U(r2) = U(r3) = U(4) = U(r5)$$
$$Ha:U(r1) \neq U(r2) \neq Ur3) \neq U(r4) \neq U(r5)$$

where:

$U(rj)$ = the mean appraisal error in the jth region for j = 1....5 and error is previously defined in equations (1) and (2).

Rejection of the null hypothesis would indicate that appraisers are not adequately measuring the impact of changing economic conditions on property values.

Exhibit 5
Regional Influences on Error by Region

Source	D.F.	Sum Squares	F
Model	4	.2147	5.28*
Error	434	4.4135	
Total	438	4.6282	
Coefficient of Determination = .0464			
* indicates significance at the .02 level			

Region	Mean Error	N
Pacific Northwest	1.82%	98
Great Lakes	− .80%	137
Oil Patch	2.21%	70
High Tech	−4.33%	73
Farm Belt	.66%	61

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

Using a reduced sample of 413 properties located only in the identified economic regions, an ANOVA test was used to see if a significant difference in appraisal error exists between economic regions. The results presented in Exhibit 5 confirm that regional factors significantly explain a portion of residential appraisal error. The ANOVA model confirmed with 98% confidence that appraisal errors were significantly different across economic regions of the country. Properties were overvalued by an average of approximately 2% of the actual sales price in the Pacific Northwest region and the Oil Patch region. Properties located in the High Tech regions were undervalued on average by 4.3%. Average error in the Great Lakes region and the Farm Belt was less than 1%. The R-square value indicates that regional location explains 4% of the variation in appraisal error. These results indicate that appraisers may have difficulty evaluating the impact of regional economic changes on property values.

A second method of testing for the impact of regional economic influences on appraisal error is to group the appraisals according to the state in which they are located, replicating the previous test on a more disaggregated level (only states that had at least 10 appraisals in the data set were included in this sample). Utilizing a sample of 402 appraisals, the results of the ANOVA test presented in Exhibit 6 show that a significant difference in appraisal errors does exist between different states in the sample. The R-square of .1632 indicates that over 16% of variation in appraisal error is explained by the state in which the property is

Exhibit 6
Regional Influences on Error by State

Source	D.F.	Sum Squares	F
Model	16	.6648	4.73*
Error	396	3.4781	
Total	412	4.1429	
Coefficient of determination = .1604			
* indicates significance at the .01 level			

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

Exhibit 7
Mean Appraisal Errors by State

State	Overapprised mean error	# Appraisals	State	Underapprised mean error	# Appraisals
OK	.063	44	MN	−.078	17
ID	.038	52	TX	−.074	22
CO	.029	12	IL	−.062	19
MI	.024	22	KS	−.050	13
NC	.011	14	NY	−.035	18
OR	.002	16	MO	−.034	17
			CA	−.023	27
			WA	−.008	30
			IN	−.006	35
			WI	−.003	17
			OH	−.002	38

Source: Corporate relocation appraisals and related sales transaction data obtained from six corporate relocation companies.

located. The F–statistic of 4.69 confirms that a significant difference in appraisal error exists with a 99% level of confidence.

Exhibit 7 provides a list of each state used in the ANOVA model and also shows the mean appraisal error (expressed as a percentage of the actual sales prices) for each state. Positive appraisal errors indicate states in which properties were systematically overappraised and conversely, negative appraisal errors indicate a systematic underevaluation of property values.

This research did not attempt to identify specific factors on a state-by-state or regional basis that contribute to systematic mis–estimation of transaction prices in individual states. Rather, further research is required to specifically identify economic events that lead to higher levels of appraisal error.

Summary and Conclusions

The purpose of this article was to present empirical evidence about the quality and precision of residential appraisal information. This study is the first empirical attempt to measure estimation bias in residential appraisal methods and to identify sources that systematically contribute to errors in appraisal estimates.

Corporate relocation appraisal assignments were selected for the sample data because these appraisals represent a pure test of appraisal estimation ability. The relocation appraisal is the only residential appraisal assignment that is consistently followed by an immediate sale of the appraised property. Comparison of the sales price of the property (adjusted for atypical financing and holding costs) with the appraised value yields a true measure of appraisal estimation error.

The empirical results show that current residential appraisal methods produce unbiased estimates of the market value of single-family owner-occupied houses. These results indicate that the market comparison method of appraisal (relied upon heavily in relocation appraisal) is an appropriate technique for estimating the most probable selling price of houses, and that the appraisal industry does not exhibit any systematic tendency to either overvalue or undervalue residential property.

Seasonal factors have been shown to significantly explain variation in appraisal errors. Current appraisal methods do not address seasonality in the appraisal process, but two explanations of seasonal influences have been proposed in this article.

A potential source of seasonal influence on appraisal errors is that changes in supply and demand relationships occur in the summer months because families attempt to relocate during the summer to avoid moving children during the school year. Consequently, demand is likely to be highest in the spring and summer quarters, and lower in the fall and winter quarters. The empirical results confirm this notion because appraisal errors are significantly associated with the quarter the appraised property was sold. The mean appraisal error (expressed as a percentage of the actual sales price) indicated that properties sold in the summer quarter sold for more than the appraised value, while properties sold in the spring, fall and winter quarters sold for less than the appraised value. These results confirm that seasonal factors may influence supply and demand relationships and that appraisers should specifically address this issue in the appraisal process. The results indicate that a seasonal adjustment to comparable sales used in the sales comparison approach may be appropriate. Further research in this area is needed to determine the specific magnitude of the adjustment required.

A second possible source of seasonal variation is that perceived utility of properties may be influenced by the time of year that the property is sold. The influence of climatological conditions on appraisal error was examined by grouping the appraisals into four climatological regions. Seasonal factors have been shown to significantly explain appraisal errors in the Midwest region, but not in the Sun Belt, the Northwest, or New England regions. Consequently, additional research is required to determine on a state–by–state basis whether seasonal adjustments are necessary.

Regional economic conditions have been shown to significantly affect appraisal errors. Because real estate appraisers make use of historical transaction data to estimate market value, appraisal errors can result when the appraiser fails to observe recent changes in the economic environment or incorrectly assesses the influence of observed changes on property values. Empirical results have shown that variation in appraisal error is significantly associated with the economic region in which the property is located. Properties located in the High Tech economic region were systematically undervalued and properties located in the oil-producing region and the Pacific Northwest were systematically overvalued. These results indicate that a lag-period exists between an economic event that influences housing prices and the time that appraisers can correctly assess the impact of the event on current values. Further research is required to identify significant economic events that influence housing prices.

In conclusion, using a national sample of residential appraisals, current methods of appraisal have been shown to produce unbiased estimates of value, when compared to sales prices at which the properties subsequently sold. Regional and seasonal factors have been shown to affect appraisal error. Certain economic regions of the country were systematically overvalued and others undervalued, resulting in an average error not significantly different from zero for the national sample. The evidence shows that current methodology is appropriate, but that appraisal precision can be improved by careful consideration of seasonal factors and the impact of changing regional economic conditions on market prices.

Notes

¹The ANOVA test compares the average appraisal error for appraisals that were grouped according to which quarter of the year the property actually sold, to determine if a significant difference exists.

[2]The date that the purchase contract was signed by both the buyer and the corporate relocation firm was used to define the date that the properties were sold.

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