Measuring Random Appraisal Error in Commercial Real Estate

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Each step of the appraisal process involves an unknown amount of estimation error. The combination of these errors is unlikely to produce a perfect, error-free estimate of value. Thus, appraisal error is virtually unavoidable.

Investors need reasonable estimates of value when buying, selling, or retaining commercial property, so an unknown amount of appraisal error adds uncertainty to the decision-making process. Despite the uncertainty, investors have learned to make allowances for appraisal error in their decision-making processes.

The way in which real estate investors interpret appraisal errors has a material effect upon the decisions that they make. In particular, the predominant belief among real estate professionals is that appraisal error is random. This belief materially influences investor attitudes toward portfolio management and the valuation process itself.

Lack of understanding of the relative magnitudes of random and nonrandom components of total appraisal error has consequences for optimal portfolio strategies. For example, investors who deem the bulk of total appraisal error to be random may reasonably conclude that error in estimates is beyond their control or influence. To minimize total portfolio valuation error, such investors may assemble large, diverse portfolios even though the cost of owning an array of properties of various types and in various locations is expensive.

On the other hand, if the bulk of total appraisal error is nonrandom, investors would do better to pay attention to improving value estimates on each property rather than hoping that the errors in values of a large pool of properties will offset one another. In particular, investors should institute valuation controls and procedures to minimize the errors in each valuation of individual portfolio assets. Such controls might include obtaining multiple simultaneous estimates, changing appraisers for each periodic revaluation, or increasing the frequency of valuations. This conclusion becomes particularly significant in light of studies like Miles et al.[2] that determine that the typical magnitude of total appraisal error is about ten percent of appraised value.

Information in three recent empirical studies provides evidence that previous appraisal research has been mistaken in assuming most appraisal error to be random. The demonstration

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[1] This article is a condensation of a prize-winning manuscript for the best paper presented on real estate valuation at the 1998 Annual Meeting of the American Real Estate Society in Monterey, CA.

[2] Miles, M., D. Guilkey, B. Webb, and K. Hunter, "An Empirical Evaluation of the Reliability of Commercial Appraisals," NCREIF Research Paper, Chicago: National Council of Real Estate Investment Fiduciaries, 1991.

that most appraisal error is nonrandom should encourage real estate investors to focus additional attention on individual asset selection and valuation at the expense of portfolio assembly.

Estimates of Total Appraisal Error

Because most researchers studying the nature of appraisal valuation have not had access to large numbers of commercial real estate appraisals, there have been few empirical investigations of commercial real estate appraisal error and the effect on real estate investment statistics. In one of the few studies of this subject, Cole, Guilkey, and Miles[3] reports the mean absolute difference between a) transaction prices and b) immediately preceding external appraisals for properties in the NCREIF data base to be 9.5% of appraised value. Miles et al. updates the estimate for the mean absolute difference between transaction prices for NCREIF properties and reports appraisal error of 10.7% for the calendar quarter immediately preceding the quarter of each corresponding transaction. However, the reported errors include the combined effects of transaction error, appraisal error, and temporal aggregation error. It was impossible for these researchers to determine whether most of the observed appraisal error was random.

Recent Evidence on Random Appraisal Error

The magnitude of random appraisal error can be determined empirically if one has an appraisal data base for commercial real estate that includes a minimum of two simultaneous independent appraisals whenever a property valuation is updated. In this case one may reasonably assume that the nonrandom components of the appraisal errors in each group of simultaneous appraisals of the same property are virtually identical. Thus, the difference between the nonrandom components of simultaneous appraisals of the same asset is approximately zero. This implies that the sample standard deviation of each group of simultaneous appraisals of the same asset is a sample standard deviation for the random appraisal error component alone.

Three recent studies by Diaz[4], Diaz and Wolverton[5], and Graff and Young[6] contain this kind of information on random appraisal error. The first two studies focus on a controlled appraisal environment for a single test property. The Graff and Young study is an empirical examination of 747 pairs of simultaneous appraisals of commercial property.

Although Diaz and Diaz and Wolverton do not focus on questions of random and nonrandom appraisal error, the data in these studies can be extended to illuminate these questions. In particular, Graff and Young extends the results in these two studies and shows that their controlled experiments support the conclusions of the empirical work of Graff and Young.

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3 Cole, R., D. Guilkey, and M. Miles, "Toward An Assessment of the Reliability of Commercial Appraisals," *The Appraisal Journal*, 1986, 54:3, 422-432.

4 Diaz, J., "An Investigation into the Impact of Previous Expert Value Estimates on Appraisal Judgment," *Journal of Real Estate Research*, 1997, 13:1, 57-66.

5 Diaz, J. and M. Wolverton, "A Longitudinal Examination of the Appraisal Smoothing Hypothesis," *Real Estate Economics*, 1998, forthcoming.

6 Graff, R.A. and M.S. Young, "The Magnitude of Random Appraisal Error in Commercial Real Estate," *Journal of Real Estate Research*, 1998, 16:3, forthcoming.

Diaz, 1997

Diaz presents the results of a controlled experiment that examines thirty expert appraisals of a single parcel of vacant, prepared industrial-zoned land in the Northern Atlanta suburbs. The appraisals are divided into two subsets of fifteen samples. The appraisals in each subset were conducted essentially simultaneously.

Diaz presented data from which Graff and Young computed sample standard deviation statistics of 2.67% for one fifteen-sample subset and 2.61% for the other fifteen-sample subset. These two sample standard deviations virtually coincide, which strongly suggests that the probability distributions for the two appraisal subsets have the same true standard deviation for random appraisal error. Accordingly, the sample standard deviations were combined by root-mean-square summation to produce the following best estimate for relative appraisal error: $s \cong 2.64\%$.

Diaz and Wolverton, 1998

Diaz and Wolverton examines two sets of simultaneous expert appraisals of a Phoenix, Arizona, apartment complex in which the groups of appraisals were conducted eight months apart. The first set contains 16 samples, and the second set contains 15 samples. In each case, appraisers were denied knowledge of previous appraisals of the subject property. These two sets comprise what Diaz and Wolverton refer to as the "unanchored" case.

Graff and Young took data on the sample appraisals in Diaz and Wolverton and derived sample standard deviations for each set of simultaneous appraisals. These sample standard deviations were computed to be 5.36% for the sixteen-sample set and 5.06% for the fifteen-sample set. The proximity of these estimates suggests that the true standard deviations for random relative appraisal error are identical for the two cases. Accordingly, the sample standard deviations can be combined by weighted root-mean-square summation to produce the following best estimate for relative appraisal error in the Diaz and Wolverton unanchored appraisal data set: $s \cong 5.20\%$.

The Diaz and Wolverton study also lists updates of appraisals in the first sample set that were conducted at the same time as the appraisals in the second set. These updates were conducted by appraisers involved in the first group of appraisals and comprise the "anchored" case. The study shows that the first appraisals were a statistically significant psychological "anchor" for near-term valuations that prevented the same appraisers from fully responding to changes in true property value. This confirms the long-standing belief that appraisal anchoring is a substantial problem for recent reappraisals by the same appraisers, and suggests that institutional investors should strongly consider valuation policy controls that limit consecutive appraisals of the same property by one appraiser.

Interestingly, the sample standard deviation of relative appraisal error for appraisal updates in the Diaz and Wolverton study is 6.90%. This is substantially larger than the 5.20% sample standard deviation for relative appraisal error in the case of the 31 original (i.e., unanchored) appraisals, and is on the edge of being statistically distinguishable from the unanchored value.

Random appraisal error estimated from the Diaz and Wolverton data appears significantly larger than appraisal error estimated either from the Diaz data or from data in the Graff and Young study, below. There are at least two possible economic explanations for larger appraisal error in the case of the Diaz and Wolverton study. First, the subject property of the Diaz and

Wolverton study is in Phoenix although the appraisers all practice in Atlanta, whereas appraisers in the cases of Diaz and Graff and Young are active in the markets that contain the subject properties. Second, apartment property may be more difficult to appraise accurately than office, industrial, and retail property, due to shorter average lease maturity and less creditworthy tenants.

Graff and Young, 1998

Graff and Young examines 747 pairs of independent valuations of commercial office, retail, industrial, and apartment properties during the 1989 to 1997 period. Each set of paired valuations consists of one internal valuation conducted by portfolio managers of The RREEF Funds, and one full appraisal conducted by an external third-party fee appraiser hired either directly by the client or by RREEF.

In every case, the appraisers (internal RREEF staffers and outside appraisers) are given the same factual information about property operating expenses, budgets, financial statements, and rent rolls. In order to reduce the possibility of appraisal smoothing, outside appraisers are not informed of prior valuations, either internal or external. However, since outside appraisers sometimes value the same property for several consecutive years, individual outside appraisers may have knowledge of prior appraisals.

Graff and Young also test the hypothesis that the probability distribution for random appraisal error is constant across both time and the universe of real estate properties. More precisely, they test the null hypothesis that appraisal error may be represented as the sum of two components: a random sample from a symmetric distribution with zero mean that is constant across time and the real estate universe, and a nonrandom component that is constant across simultaneous appraisals for individual properties, but that can vary across time and the real estate universe.

The authors note that the 1991-92 period was peculiar in that there few occurrences of commercial property transactions upon which appraisers might test their value estimates. In other words, this two-year period was a time of transaction gridlock in which the distribution of value estimates was substantially wider than more normal, market equilibrated times. In addition, by separating sample standard deviations into subsets of above-median and below-median samples, Graff and Young shows that there is some exceptional agency effect clouding the RREEF data for properties that have greater-than-average investment risk, i.e., properties where there are clear and identifiable differences of opinion of value between the internal and external appraisers. Examination of the property economics associated with the exceptionally large sample standard deviations shows that these values result from properties that are difficult to appraise, are in weak rental markets with tenants having uncertain lease renewal prospects, or are properties in areas suffering regional economic decline.

The test results are consistent with the conclusion that the lower half of the distribution of sample standard deviations for simultaneous appraisal pairs is identical to the lower half of the corresponding distribution for sample standard deviations of random appraisal error. This conclusion, together with the assumption of normality for random appraisal error, can be applied to circumvent the problem that the upper half of the distribution of sample standard deviations for random appraisal error is not observable.

Graff and Young select the aggregate set of appraisal pairs that excludes the 1991-92 data for the median standard deviation estimate, since as discussed above, market gridlock during the

1991-92 period appears to have generated an exceptional amount of valuation uncertainty that violates the time-independence of appraisal error during the rest of the test period. With this adjustment, Graff and Young derives the best estimate for the standard deviation of random appraisal error during periods of normal market liquidity to be 2.00%.

To this determination must be added the qualification that the standard deviation will be slightly larger and possibly also property-dependent during occasional periods of extreme transactional market gridlock, such as occurred during 1991-92 and at the beginning of the 1970s. In particular, Graff and Young estimate the standard deviation of random appraisal error for the 1991-92 period to be 5.42%.

Other Studies

Significantly larger estimates of the magnitude of random appraisal error appear in several other studies, including one conducted in part by the authors of this article. Geltner, Graff, and Young[7] derives an algebraic model that relates variances for three types of unobservable random noise in real estate investment returns, and also suggests values for the unknown parameters in the model including the standard deviation for random appraisal error. Similarly, Geltner and Goetzmann[8] derives an error estimate for the total magnitude of several types of appraisal error and separates random appraisal error from the other appraisal error components. Both studies use NCREIF appraisal-based returns. Geltner[9] also addresses random appraisal error, but relies primarily on Geltner, Graff, and Young for quantitative support.

Geltner, Graff, and Young and Geltner and Goetzmann both require disaggregated NCREIF appraisal-based return series to be serially independent and identically distributed in order to support their conclusions about random appraisal error. Although analyses in these studies could conceivably be robust with respect to small differences in return risk over time, major changes in risk over time (such as result from real estate investment cycles) world invalidate the appraisal error conclusions in both studies. In addition, the analysis in Geltner, Graff, and Young depends upon the restrictive assumption common to early appraisal error studies that all appraisal error is unbiased and random, an assumption that has been eroded by recent empirical research on both United States and Australia commercial property.

Evidence of Nonrandom Appraisal Error

Two recent studies show empirically that nonrandom appraisal error components affect property valuation and investment return, thereby confirming the existence of nonrandom appraisal error. Wolverton and Gallimore[10] examines commercial mortgage lending and demonstrates that client feedback exerts statistically significant material effects on appraisal valuation just prior to sales,

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7 Geltner, D.M., R.A. Graff, and M.S. Young, "Random Disaggregate Appraisal Error in Commercial Property: Evidence from the Russell-NCREIF Data Base," *Journal of Real Estate Research*, 1994, 9:4, 403-419.

8 Geltner, D.M. and W.N. Goetzmann, "Two Decades of Commercial Property Returns: A NCREIF Index Using Independent Appraisals," January 1998, working paper.

9 Geltner, D.M., "How Accurate is the NCREIF Index as a Benchmark, and Who Cares?" *Real Estate Finance*, 1998, 14:4, 25-37.

10 Wolverton, M. and P. Gallimore, "Client Feedback and Perception of the Role of the Appraiser: An International Study of Real Estate Appraisers," paper presented at the American Real Estate Society Annual Meeting, Monterey, CA, April 1998.

and that the effects can become coercive. In an unrelated study, Graff and Webb[11] presents evidence showing how agency costs embedded in transaction prices introduce nonrandom elements into appraisal error that generate statistically significant performance persistence in NCREIF annual appraisal-based investment returns. In addition, the latter study suggests how excessive agency costs can be detected and eliminated by appropriately structured management control systems.

Summary and Conclusion

Interest in understanding appraisal error has recently resurfaced with the recognition that total appraisal error is unlikely to be entirely random. Indeed, several research reports show that random appraisal error constitutes a relatively small share of total appraisal error. It follows that nonrandom appraisal error is relatively large, but controllable by investors if they devote attention to the problem. We argue that the extent to which investors believe that appraisal error is controllable determines their behavior on important decisions like asset selection and pricing, portfolio construction, and valuation practices and procedures.

When there are sufficient transactions in the market to make the appraisal process relatively straightforward and easy, substantially all variance in total appraisal error observed in previous studies is due to nonrandom contributions. When transactions are few or when appraisers are unfamiliar with the property being appraised or the ambient market conditions, we expect the random component of total appraisal error to increase. Nonetheless, it still appears correct to suggest that even in the worst of times, the nonrandom component of total appraisal error dominates the random component.

If total appraisal error appears random, then the magnitude of nonrandom appraisal error is the square root of the difference between the squares of the total sample appraisal error and the random appraisal error. Based on the Miles et al. estimate of total appraisal error as 10.00% and the estimate of typical random appraisal error of 2.00% from the Graff and Young empirical study, it follows that the magnitude of typical nonrandom appraisal error is 9.80%. Thus, in both ordinary and exceptional times, the nonrandom, controllable component of total appraisal error is substantially greater than the random component.

This suggests a basic shortcoming in prevailing top-down real estate portfolio strategies that advocate portfolio assembly over individual property selection. These strategies rely implicitly on the assumption that appraisal error is beyond the control of the appraiser or the investors who purchase appraisal services or use appraisal methodologies to assess values. By creating large, diverse portfolios, investors expect to mitigate the effects of random appraisal error on the portfolio at large. However, this represents a misunderstanding or exaggeration of the impact of truly random appraisal error as a part of total appraisal error.

More realistically, in order to avoid excessive agency costs in an illiquid market like real estate, investors should pay particular attention to property valuation during investment acquisitions and dispositions, or, at the very least, to the establishment of investor-oriented controls on the valuation process.

Moreover, professional appraisal organizations and institutional real estate investment trade organizations with a keen interest in the use of appraisals for valuation, investor reporting, and

[11] Graff, R.A. and J.R. Webb, "Agency Costs and Inefficiency in Commercial Real Estate," *Journal of Real Estate Portfolio Management*, 1997, 3:1, 19-36.

decision-making ought to consider adding management of the appraisal process to their training programs. Appraisers and consumers of appraisal services need to know more about the qualitative factors that influence valuation so that these factors can be incorporated into control of the appraisal process and into the decisions that are influenced by measures of appraisal value.

Exhibit 1
Estimates of Standard Deviation of Random and Total Appraisal Error

Authors (year)	Case	Random Error	Total Error
Diaz (1997) *	(a) appraisers with knowledge of previous appraisal	2.67%	
	(b) appraisers without knowledge of previous appraisal	2.61	
	(c) estimate of combined cases (a) and (b)	2.64	
Diaz and Wolverton (1998) *	(a) estimate of two combined "unanchored" sets	5.20%	
	(b) "anchored" set	6.90	
Graff and Young (1998)	(a) 1989 to 1997 appraisals excluding 1991-92 outliers	2.00%	
	(b) 1991 to 1992 appraisals	5.42	
Cole, Guilkey, and Miles (1998)	NCREIF appraisal vs. transaction price		9.5%
Miles, Guilkey, Webb, and Hunter (1991)	NCREIF appraisal vs. transaction price		10.7%

* The random error figures associated with these studies do not actually appear in the published articles, but were derived in Graff and Young to apply to the current discussion of random appraisal error.