

The Concept and Market Extraction of Effective Age for Residential Properties

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Abstract. This paper presents a theoretical and algebraic technique for the estimation of effective age on a residential property. This estimate for the subject property is a number that is calculated relative to the aging of the comparables. The owner's rate of aging can be compared to the rate exhibited by the comparables to determine if the subject's economic life should be equal or different to the economic life of the comparables. The analysis and technique shown should be of use to every residential appraiser.

Introduction

The extraction of effective age of the subject is critical to the appraiser for three reasons. First, it serves as one important element of comparison in the subsequent selection of the appropriate comparable properties in the sales comparison approach. Second, this estimate is important to clients such as FNMA whose guidelines [9, p. 25] require that the remaining economic life cannot be less than one-half of the maturity of a new loan.¹ Third, the appraiser may have market-observed reasons to want an effective age to use in lieu of actual age in an age/life calculation.

Surprisingly, the literature is almost void of a theory and procedure for extracting this figure from the market. The purpose of this paper is to present a theoretical concept of effective age and to illustrate a procedure that can be used by appraisers to estimate it by utilizing the information in comparable sales.

The Literature

The literature on aging appears to be divided into two groups. The first involves a highly statistical approach that attempts to estimate the rate of depreciation of the housing stock. One purpose has been to identify and test statistical techniques in order that more accurate estimates can be derived of the rate of aging and its impact on housing stock [4, 11, 12, 15, 16, 18, 19, 20, 22]. Economists want to use this information to estimate national income and wealth [15] and to suggest future housing policy that is based on demand and the existing stock. A closely related purpose has been to relate the aging estimate to the current tax policy that uses a depreciation deduction and a capital gains tax [5, 17, 21, 24].

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The second is composed of attempts to determine the impact of property age on sales price [2, 3, 6, 7]. Corgel and Smith [6, 7] examined theoretically and statistically the importance of remaining economic life to market value.² They concluded that the aging estimate does have an important impact on price [6, p. 2], the proper linear or nonlinear specification of the variables has not been accurately tested [6, p. 34], and that the aggregation of the data at different market levels can produce different results [6, p. 34]. They concluded that remaining economic life was the most important aging variable since it incorporated the ability to rehabilitate the property [6, p. 81].

Another recent paper by Cannaday and Sunderman [2] estimated the rate of depreciation for a subdivision using a log linear equation that incorporated the age-life method. Their conclusions supported a path of depreciation that was initially less rapid than straight line [2, p. 270].

No previous studies have presented a theory-based procedure for the estimation of effective age for a single-family structure. The recommendation by Corgel and Smith [6, 7] that the appraiser use remaining economic life did not estimate effective age directly. It was built around a statistical survivorship table for the properties in the communities.

The procedure recommended in this paper is based on this recommendation of Corgel and Smith, but requires that appraisers use only the comparables for the current assignment. It recommends that the appraiser concentrate first on an accurate economic life estimate of the subject and the comparables. Second, the effective age estimate for the subject can be extracted relative to the economic life estimates of the comparables. Thus, effective age for the subject is a *relative* concept that relates the aging of the subject to the aging of the comparables.

The paper is constructed as follows. Section three presents the typical procedure for estimating effective age with an illustration. Section four covers the correct concept with an illustration and also, discusses incorrect methods. Section five contains the conclusions.

Economic Life

Effective age should be derived from economic life. The most commonly taught method [1, p. VI-2; p. CS-8-1] for extracting economic life involves a sequence of detailed steps that is shown below:

Sequence of Steps for Estimation of EL

$$AD = RCN - ASP \quad (1)$$

where

- AD = total accrued depreciation from all sources
- RCN = reproduction cost new
- ASP = adjusted sales price found by gross sales price adjusted for sales and financing concessions and time less the site value and depreciated site improvements

$$ADRCN = (AD/RCN) \times 100 \quad (2)$$

where

$ADRCN$ = accrued depreciation as a percent of the RCN

given AA

where

AA = actual age of the property which is known

$$ADRCNAA = ADRCN/AA \tag{3}$$

where

$ADRCNAA$ = accrued depreciation as a percent of the RCN per year of the actual age which is found by $[(AD/RCN) \times 100]/AA$

$$EL = 100/ADRCNAA \tag{4}$$

where

EL = extracted economic life which is found by $100/[(AD/RCN \times 100)/AA]$

Simplified Equation

The steps above may be rewritten into *one simplified equation* for the extraction of economic life that is shown below:

$$EL = 100/[(1-ASP/RCN)100/AA] \tag{5}$$

where

$(1-ASP/RCN)100 = AD$ as a percent of the RCN per year

The longer sequence of steps that is shown above in equations 1-4 and the shorter, simplified equation 5 give the same answer.

Example

As an example, consider the following information for a subject.

Sales price adjusted for financing and time	= \$67,762
Estimate site value	= 16,000
Depreciated site improvements	= 2,000
Reproduction cost new	= 70,300
Actual age	= 19 yrs.

Extracting EL using equations 1–4 gives the following results:

$$\begin{aligned}
 AD &= RCN - ASP \\
 &= 70,300 - (67,762 - 16,000 - 2,000) \\
 &= 20,538 \\
 ADRCN &= AD/RCN \\
 &= 20,538/70,300 \\
 ADRCNAA &= ADRCN/AA \\
 ADRCNAA &= 29.1\%/19 \text{ yrs.} \\
 &= 1.54\% \\
 EL &= 100/ADRCNAA \\
 &= 100/1.54\% \\
 &= 65 \text{ yrs.}
 \end{aligned}$$

Extracting EL using equation 5 gives the following results:

$$EL = 100 / [(1 - ASP/RCN)100/AA]$$

where

$$\begin{aligned}
 ASP &= 67,762 - 16,000 - 2,000 \\
 EL &= 100 / [(1 - 49,762/70,300)100/19] \\
 &= 65 \text{ yrs.}
 \end{aligned}$$

Rapidly Changing Markets

Traditional thinking is that either equations 1 or 2 produce accurate estimates if (a) good comparable properties exist, (b) market conditions are in balance such that demand is somewhat equal to supply, and (c) reproduction cost new estimates are current and reliable. This produces a value in equation 2 where,

$$ASP/RCN \leq 1 \text{ because } ASP \leq RCN.$$

An important issue for the appraiser is the correct estimation and interpretation of EL in a rapidly rising market where demand is greater than supply which causes,

$$ASP/RCN > 1 \text{ because } ASP > RCN.$$

In this market situation, ASP is increasing faster than the accrued depreciation is occurring. The public is increasing its offer price at a faster rate than the AD rate.

The correct interpretation is that this fraction, ASP/RCN will be ≤ 1 in ALL MARKETS. In any market, the typical homebuyer is buying what the family budget can afford at a specific location with a minimum transportation cost for commuting. In essence, the property owner is buying principally the site or location. If the ratio ASP/RCN becomes > 1 , the appraiser needs to reexamine the site values again by direct sales comparison or abstraction to determine if the reverse sign has been caused by rapidly rising site values.

The essential point here is that all properties have a physical deterioration and functional obsolescence that causes the structure to be worn out. Expecting the ASP/RCN ratio to always be ≤ 1 , the appraiser should constantly reexamine the site/total value ratio of the subject and compare it to a similar figure for each comparable to assure that it has not recently changed. Unless the cost of construction has changed significantly, this ratio typically remains constant for the short run in a typical neighborhood. Thus, it should be very similar in all of the correctly selected comparables.

In sum, under *all market conditions*, the above simplified equation 5 correctly estimates EL , and $RCN-ASP$ produces a correct value for AD if (a) the cost of construction has remained relatively stable, (b) the site/total value ratio remains relatively consistent for all comparables, (c) the amenities are similar, and (d) the short-lived items have similar conditions. If the total values of the comparables increase rapidly and significantly, most likely the site values have increased and the site/total value ratios have remained stable.

All Accrued Depreciation is Included EL

Physical, Functional and External Factors

An argument can be made [21, p. 3–6] that the level of accrued depreciation that exists in the subject at a moment in time is directly dependent on the strength of the pride-of-ownership of the owner. Since this level can vary significantly among owners, the true economic life should be estimated after the physical deterioration has been corrected (added) and the physical obsolescence that is short-lived has been subtracted. Once this has been done, the EL can be estimated only on the long-lived items. This estimate should not be as subject to individual desires and more stable.

The methodology presented in this paper argues that all types of accrued depreciation should be included in the EL and effective age estimates. These two represent the “riskiness” that exists in the total value when it is read by the client.

The EL should be viewed as cross-sectional view on the date of the appraisal of the homeowner’s level of maintenance, neighborhood conditions that influence functional design acceptability, and external conditions such as unemployment. It is a variable that can be at different levels on different dates in time.

This view is consistent with the sales comparison analysis that permits the appraiser to submit photos on the sales date of the comps that show a property that may not match the physical condition of the same property on the date of the appraisal. The owner and market conditions may have changed between the two dates. The point is that the EL estimate on the date of the sale will not necessarily be identical to the estimate on the date of the appraisal.

Straight-line vs Curvilinear Path of Effective Age

With relatively stable comparables, the path of EL and effective age can be estimated within reason for a subject. While this information is useful to evaluate trends, this paper argues that the issue of a straight-line or a curvilinear path of effective age is less important than the actual estimate.

The estimate of both *EL* and effective age are cross-sectional views at one moment in time as a measure of risk, especially when contrasted to the known actual age of the subject and neighborhood. The path becomes important when the user of the information wants to evaluate *the magnitude of future estimates of EL and effective age which becomes a future estimate of risk.*

Effective Age Concept and Definition

The effective age of the subject is a *relative concept* that reflects the market condition of the subject in comparison to the market condition of the comparables selected. An appropriate definition of effective age follows:

$$EA \text{ of subject} = (AD/RCN \text{ of subject}) \times (\text{avg. } EL \text{ for the comparables}) \quad (6)$$

This may be rewritten into the following,

$$EA \text{ of subject} = (AD/RCN \text{ of subject}) \times (AA \times RCN)/AD \text{ for the comps}$$

This result is the amount of the comparable *RCN* that has been used by *AD* that belongs to the subject.

Effective age and actual age are different when the *AD* for the subject and the *AD* for all comparables are different. This concept can be expressed in terms from the formulas above as,

$$(1-ASP/RCN)/100 \text{ for subject } < \text{ or } > (1-ASP/RCN)/100 \text{ for all comparables}$$

EA represents an excess or deficiency in repair, remodeling, functional design, and location or economic obsolescence of the subject relative to the level of the same variables in the comparables. The wearing out of the subject is larger or smaller than the identical feature in the comparables.

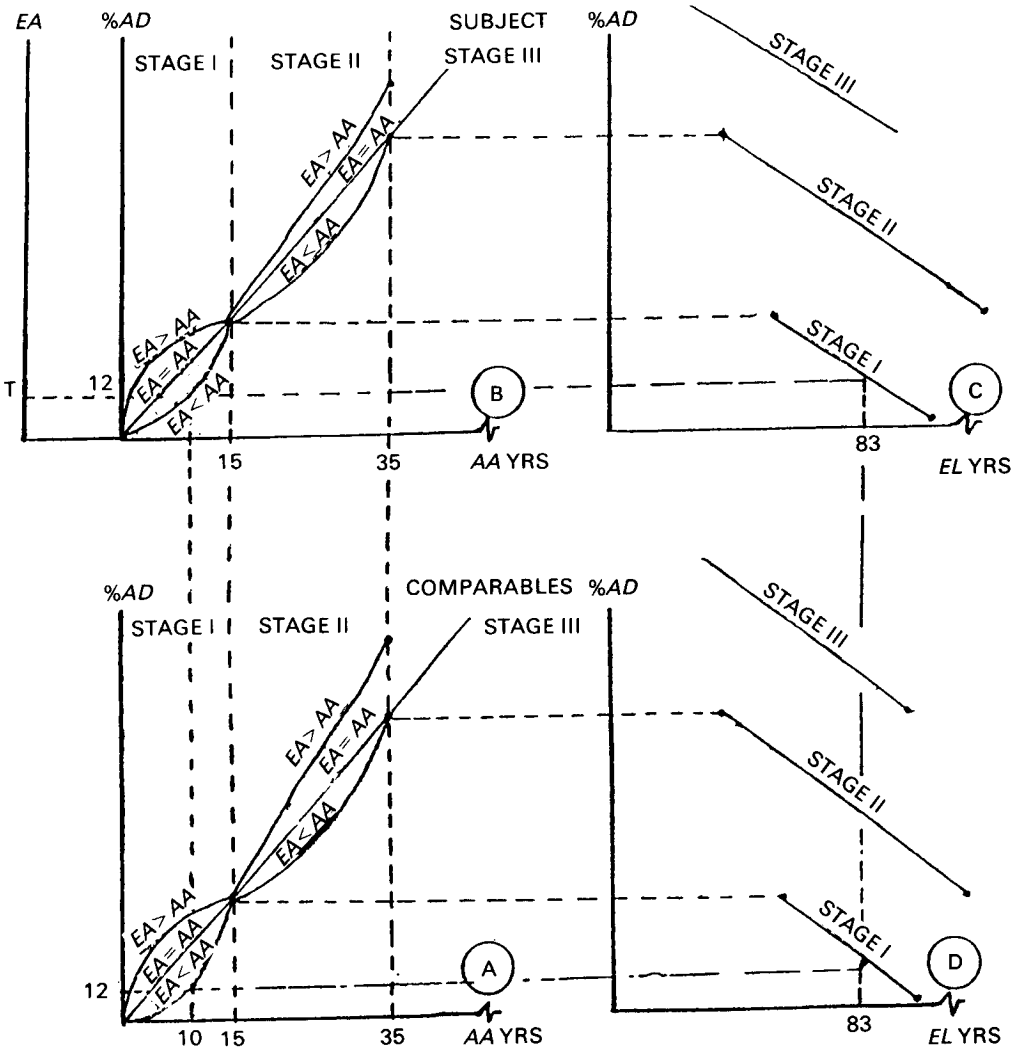
Comparison of Accrued Depreciation and Economic Life

Exhibit 1 illustrates the first three stages of every residential property that may be repeated as long as the property has an economic life. This four-graph model illustrates the various paths of accrued depreciation that a group of comparables may take, the corresponding *EL* of the comparables, and the corresponding accrued depreciation, *EA*, and *EL* for the subject.

The correct extraction of an *EA* for the subject correctly begins with Chart A for the comparable properties. Consider an example where the subject is located in a relatively new neighborhood and the comparables reveal an average actual age of ten years. The level of maintenance and other market conditions produce a level of accrued depreciation equal to 12% that gives an *EL* for the comparables of eighty-three years³ shown in Chart D.

The question for the appraiser to answer is whether the level of accrued depreciation for the subject is *<*, *>*, or *=* the 12% estimate for the comparables. If it is equal as shown in Chart B, the estimate for *EL* is the same as the neighborhood and the estimate

Exhibit 1
Three Stages of Economic Life and Effective Age



of EA is at point T in Chart B. If the subject should exhibit a level of accrued depreciation that is < or > the 12% in the comparables, the estimate of EL for the subject in Chart C will not be the same as the comparables in Chart D.

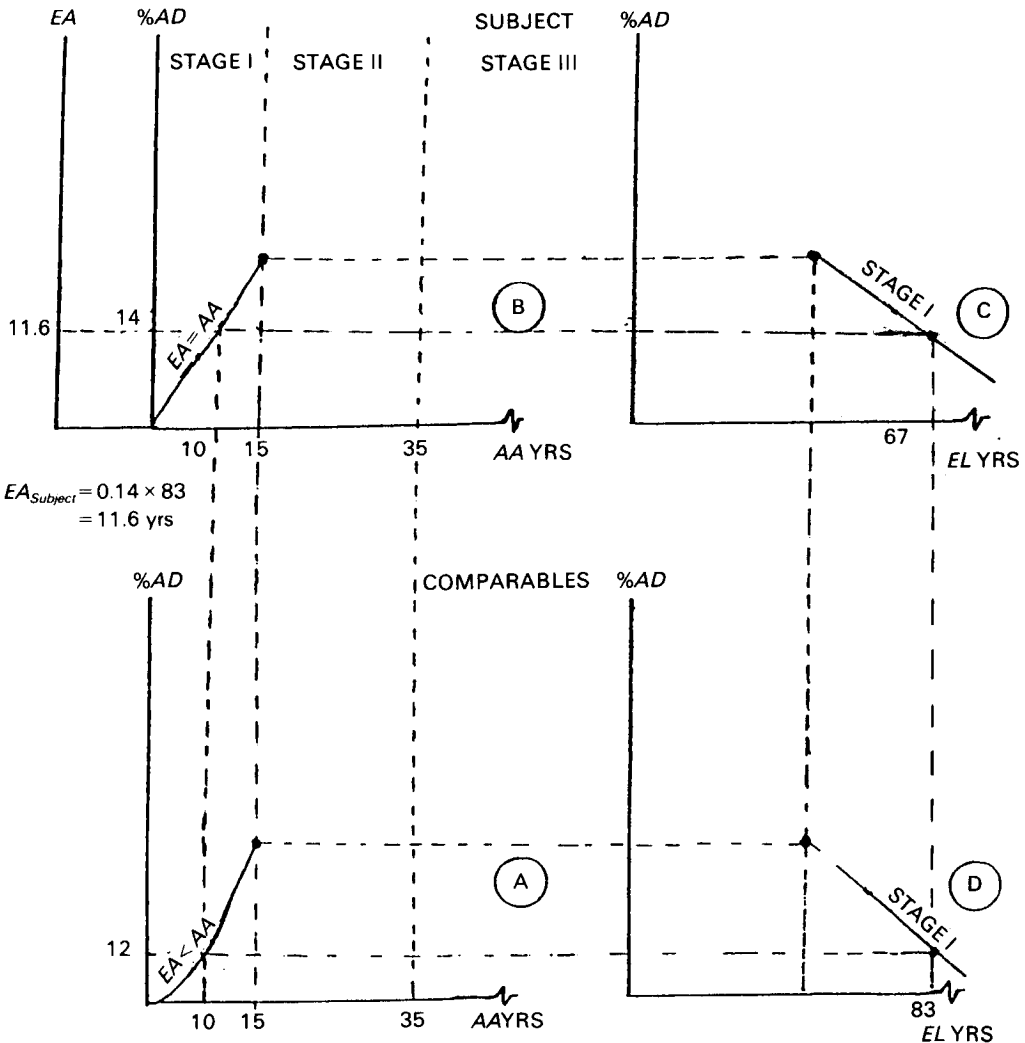
Stages of Accrued Depreciation

All properties will proceed along one of three possible paths of accrued depreciation to a point in time that is approximately fifteen years of actual age. At this point, the items that were classified as incurable physical deterioration must be replaced. Typically, these are the appliances, carpets, roof, and heating-air conditioning units.

Once the new items are in the property, the total economic life most likely in many neighborhoods will increase but certainly not to the level that was estimated for a new property. Thus, the *ELs* in Charts C and D will be negatively sloped and move generally from right to left and upward, depending on the neighborhood.

A homeowner who elects not to replace these incurable short-lived items will cause the property to experience an increasing rate of *AD* in Stage II. In contrast, the owner can elect to replace a few selected items annually and maintain a steady aging of the property along the average line where the *EA* = *AA*. The third alternative is where the subject

Exhibit 2
Three Stages of Economic Life and Effective Age



$EA > AA$ that most likely is caused by extreme hard use of the property in its early years that is accompanied by little maintenance.

These stages will repeat themselves since the incurable physical items will need be replaced in lumpy expenditures at somewhat predictable times. These items, such as new roof and heating/air conditioning systems, are replaced when they expire rather than in annual continuous increments. As each set of items is replaced, a new EL line will emerge. The total AD most likely will not decrease significantly and the EL estimate will most likely decline depending on the neighborhood.

During the life of any subject, hard use with a slow rate of repair or no repair relative to the comparables can cause $EA > AA$. Instantaneous repairs at a rate faster than those exhibited in the comparables will cause $EA < AA$. These cases will be seen in the difference between EL for the subject in Chart C and the EL for the comparables in Chart D.

Exhibit 2 shows a situation where the average EA for the comparables is $<$ the average AA , and the EA for the subject equals the AA . The average AD for the comparables is 12.0% in Chart A that gives an average EL of 83 years in Chart D. The AD for the subject is 14.0% in Chart B that is multiplied by 83 which produces an EA of the subject equal to 11.6 years in Chart B and an economic life of 83 years in Chart C. Thus, a homeowner who maintains the house at an average straight-line rate that is consistent with the actual age rate of obsolescence will be given a lower rate of EA if the property is located in a neighborhood where the rate of maintenance is less than straight line.⁴

EA for the Subject

EA for the subject can be estimated easily from the data that all appraisal offices maintain on the comparables. Every office should maintain a file similar to the one below for each neighborhood or set of comparables. The task should not be difficult with the use of the PC.

Comparable Properties						
(A)	(B)	(C)	(D)	(E)	(F)	
Actual age (yrs)	% AD is of RCN	AA (yrs)	B/C (yrs)	Median of (D)	Extracted EL from comps ($100/E = yrs.$)	
15-19.99	}	35.2	18	1.94	2.0	50
		39.0	19	2.05		
		38.0	19	2.0		
		37.5	18	2.08		
		35.3	18	1.96		

Using the definition of EA above and the table, the EA of the subject property is the (AD/RCN) for the subject times the average EL from the table for the comparable

properties. For example, if the subject has an actual age of 19 years and the (AD/RCN) for the subject equals 36.0, then the EA for the subject is,

$$36.0 \times 50 \text{ yrs. from the table} = 18 \text{ yrs.}$$

The resulting *remaining economic life* for the subject is,

$$\begin{aligned} REL &= EL - EA \\ &= 50 - 18 \\ &= 32 \text{ yrs.} \end{aligned}$$

Thus, the appraiser uses the (AD/RCN) for the subject and the *average economic life for the appropriate comparables*.

Incorrect EA

One appraisal technique estimates the EA for the subject by the following:

$$EA = (AD/RCN) \text{ for the subject} \times EL \text{ for the subject}$$

Conceptually, this is incorrect since it involves circular reasoning.

From equation 5 above,

$$EL \text{ for the subject} = 100 / [(1 - ASP/RCN)100/AA]$$

It is easily seen that (AD/RCN) is a part of the estimate for EL . Therefore, multiplying the AD/RCN for the subject by the EL for the subject gives the AA of the subject which can be shown algebraically. The correct EL must be an average for the comparables.

Market Situations

The next step is to examine the relative rates of change in the AD for the subject and the rate for the comparables. Specifically, what is the expected result if one rate is not equal to the other?

The chart below outlines the possible scenarios. Case A shows that the rate of AD in the subject is equal to the rate shown in the comparables at a low level. Case C shows the same equality at a high level. In both cases, the effective age equals the actual age.

Cases B and D show that the effective age and actual age part when the rate of AD in the subject is $>$ or $<$ the rate of AD shown in the comparables. The conclusion here for the homeowner is to maintain a level of maintenance in the subject that is at least equal to the level shown in the comparables.

	subject		comparables
Case A:	low %AD		low %AD
	or		or
	rate of AD	=	rate of AD
	RESULT:EA	=	AA

Case B:	low %AD or rate of AD	<	high %AD or rate of AD
	RESULT: EA	<	AA
Case C:	high %AD or rate of AD	=	high %AD or rate of AD
	RESULT: EA	=	AA
Case D:	high %AD or rate of AD	>	low %AD or rate of AD
	RESULT: EA	>	AA

Conclusion

The argument presented in this paper is that the effective age of a subject property should be an estimate that is *relative* to the economic life of the neighborhood. The percent that accrued depreciation represents of *RCN* for the subject should be multiplied by the economic life of the comparables. Thus, the resulting effective age of the subject should be correctly interpreted as the relative percent of the neighborhood economic life that is used up by the subject.

This relative measurement should be the appropriate risk variable that a client wants to review in addition to the actual age. The actual age presents a picture of average straight-line wear-and-tear. The relative effective age measure tells the client if the level of maintenance that is shown in the subject is comparable to the neighborhood. Neighborhood characteristics are reported and judged in other locations in the valuation.

The relative measurement of effective age will most likely penalize a subject that possesses a higher level of maintenance than the neighborhood, and will most likely enhance a subject's effective age that has a lower level of maintenance than the neighborhood. This concept of effective age increases the importance of the neighborhood influence on the economic characteristics of the subject.

A business decision-maker who uses this information should desire this type of risk measure. A well-maintained property in a neighborhood that is not maintained at the same level most likely would not exhibit the same level of value that the same property with the same level of maintenance would exhibit in a neighborhood that illustrates a higher level of care.

Notes

¹Since remaining economic life(*REL*)=economic life(*EL*)–effective age(*EA*), the latter two variables must be estimated first.

²See note 1.

³Using equation 5, $EL = 100 / [(1 - ASP/RCN)100/AA]$ or $EL = 100 / [(.12)100/10] = 83$ years.

⁴Conceptually, all comparables originate in the subject's neighborhood. The subject should not have an *EL* longer than the neighborhood. Thus, $REL_{subject} = EL_{neighborhood} - EA_{subject}$ or $REL_{subject} = 71$ years.

References

- [1] Appraisers, Society of Real Estate. *Applied Residential Property Valuation: Course 102*. Chicago: SREA, 1984.
- [2] R. E. Cannaday and M. A. Sunderman. Estimation of Depreciation for Single-Family Appraisals. *AREUEA Journal* 14:1, 255-73.
- [3] P. T. Chinloy. The Effect of Maintenance Expenditures on the Measurement of Depreciation in Housing. *Journal of Urban Economics* 8 (1980), 86-107.
- [4] ———. The Estimation of Net Depreciation Rates on Housing. *Journal of Urban Economics* 6 (1979), 432-43.
- [5] R. M. Coen. Investment Behavior, The Measurement of Depreciation, and Tax Policy. *American Economic Review* 65 (1975), 59-74.
- [6] J. B. Corgel and H. C. Smith. *The Concept and Estimation of Economic Life in the Residential Appraisal Process*. Chicago: Society of Real Estate Appraisers, 1981.
- [7] ———. The Concept and Estimation of Economic Life in the Residential Appraisal Process: A Summary of Findings. *The Real Estate Appraiser and Analyst* 48 (Winter 1982), 4-11.
- [8] M. J. Derbes. Economic Life Concepts. *The Appraisal Journal* 55 (April 1987), 216-24.
- [9] Federal National Mortgage Association. Focus: Appraisal Guide: Underwriting Guidelines. Washington: FNMA, 1988.
- [10] T. Holderness. A New Look at Accrued Depreciation. *The Real Estate Appraiser and Analyst* 54 (Fall 1988), 12-14.
- [11] H. S. Hotelling. A General Mathematical Theory of Depreciation. *Journal of the American Statistical Society* 20 (September 1925), 340-53.
- [12] W. H. Jones, M. G. Ferri and L. R. McGee. A Competitive Testing Approach to Models of Depreciation in Housing. *Journal of Economics and Business* 33 (1981), 202-11.
- [13] D. Keifer. Housing Deterioration, Housing Codes, and Rent Control. *Urban Studies* 14 (February 1980), 59-71.
- [14] W. N. Kinnard and G. L. Beron. *The Challenge of Measuring Economic Obsolescence*. Chicago: Society of Real Estate Appraisers, 1986.
- [15] W. A. Leigh. Economic Depreciation of the Residential Stock of the U.S. 1950-1970. *The Review of Economics and Statistics* 62(1), 200-206.
- [16] ———. The Estimation of Tenure-Specific Depreciation/Replacement Rates Using Housing Quantity Measures for the U.S., 1950-1970. *Quarterly Review of Economics and Business* 19 (Autumn 1979), 49-59.
- [17] C. C. McGuire. Housing Depreciation and Optimal Tax Policy. *National Tax Journal* 32 (1979), 471-79.
- [18] R. McHugh and J. Lane. The Age of Capital, The Age of Utilized Capital, and Tests of the Embodiment Hypothesis. *The Review of Economics and Statistics* 69 (May 1987), 362-67.
- [19] E. O. Olsen. A Competitive Theory of the Housing Market. *American Economic Review* 59 (September 1969), 612-22.
- [20] R. B. Palmquist. Hedonic Price and Depreciation Indexes for Residential Housing: A Comment. *Journal of Urban Economics* 6:1, 267-71.
- [21] R. Reilly. Identification and Quantification of Economic Obsolescence. *Journal of Property Taxation* 1 (Winter 1988), 45-62.
- [22] P. K. Robbins and R. W. West. Measurement Errors in the Estimation of Home Value. *Journal of the American Statistical Association* 72 (June 1977), 290-94.
- [23] D. R. Stevenson. Financing and Time in Multiple Regression Applications to the Assessment of Single Family Residential Properties. *Assessors Journal* 12 (September 1977), 171-205.
- [24] P. Taubman and R. Rasche. Economic and Tax Depreciation of Office Buildings. *National Tax Journal* 22 (September 1969), 334-46.