

Updating Market Values with Adaptive Estimation Procedure

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The New York State Division of Equalization and Assessment conducts market value surveys at least once every three years to establish equalization rates. Between surveys the division uses current sales data to update market values. This paper explains the updating method, which uses the adaptive estimation procedure and which identifies and calibrates time and locational influences. The method can be adapted to other systems. Because this method is responsive to market trends, yet provides rational adjustments to initial market values, it contributes to the credibility of mass appraisal systems with both appraisers and the public.

Background

New York State real property tax law requires the New York State Division of Equalization and Assessment (NYSDEA) to conduct market value surveys at least once every three years in order to establish equalization rates—average ratios of assessed value to full value of taxable property in a municipality. These surveys consist of statistically controlled, small sample

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estimates of the market value of locally assessed property as of a fixed valuation date. Market values are determined at the site level. For these purposes, a site is a parcel, or a subunit of a parcel, that could be sold as a separate entity.

A three-year market value survey cycle resulted in up to a five-year lag between the market value standard and the assessed values used to determine equalization rates. For example, 1985 equalization rates were based on 1985 assessed values and 1980 full values. State aid formulas distribute aid proportional to community need measured by the real property wealth of the community. As the time between the market value standard and its use to determine state aid increased, pressure mounted to increase the currency of equalization rates.

Decreasing the period of time between base market value surveys would increase the currency of the equalization rates. However, under present base survey procedures this could be accomplished only through reduction in sample size or increase in staff. Since neither alternative was viable, NYSDEA decided to conduct one update survey between base surveys. An update survey moves base survey appraised values ahead one year.

NYSDEA uses newly collected sales data to update market values established in a statewide base market value survey conducted to establish equalization rates. The updating method, which uses the adaptive estimation procedure (AEP), identifies and calibrates time and locational influences and can be adapted to other systems. NYSDEA uses this procedure for commercial, farm, vacant, and residential properties.

NYSDEA AEP

The updating method uses the NYSDEA version of AEP patterned after the Carbone and Longini (Carbone 1987) concept. In this version, quantitative and qualitative categories exist for land, building, and other improvements. The qualitative adjustments for each category are multiplied by their corresponding quantitative counterparts. A fourth "general" qualitative category is multiplied by *all* the qualitative categories. The three categories are then summed for a total site estimate of value. The formula is

$$\begin{array}{rcl}
 \text{Land quantitative} \times \text{Land qualitative} \times \text{General qualitative} & = & \text{Land value} \\
 + \text{Building quantitative} \times \text{Building qualitative} & & \\
 \times \text{General qualitative} & = & \text{Building value} \\
 + \text{Other quantitative} \times \text{Other qualitative} \times \text{General qualitative} & = & \text{Other value} \\
 \hline
 & & \text{Total value estimate.}
 \end{array}$$

This program variation is easily incorporated into existing versions of AEP and can be adapted to run on micro-, mini-, or mainframe computers.

Updating Method

The four steps of the updating method are:

1. Base-year model: Create new predictive AEP models using base-year survey, field-reviewed appraisals and their respective final appraised values as input rather than using sales. The model is at a fixed time (market value survey valuation date).
2. Update model: Update the base model with current sales. Alterations in model coefficients reflect market changes over time. Updated individual value predictions are produced.
3. Trend (control) model: Use the base model again as a starting point. Newly introduced time and location variables capture the aggregate trend over time from the current sales input. Aggregate trends are used as a control in correlation and final value determination (step 4).
4. Correlation and final value determination: Compare each appraisal's update model estimate and trended value estimate. Accept one as the final value.

Base-Year Model

New predictive models are created using the known value of the appraisals (for example, assessed value, appraised value) at a fixed time as the dependent variable. The reason for modeling on appraisals is threefold. First, this data base guarantees complete model representativeness of the appraisals to be updated. There is a value with which to model for every type of appraisal in the file. Second, the dependent variable in the modeling process, total appraised value, is the result of an entire appraisal process. The value is supportable and is highly reliable. Third, the model is independent of time because the appraised value for every site is as of the same date.

Figure 1 is a typical residential base model. The 1,391 appraisals are from an upstate New York county with a large metropolitan area and suburbs. The qualitative variables differentiate properties according to descriptors such as excellent, good, normal, fair, and poor condition; expand levels of data-collected variables such as the fourteen types of building style; and stratify data-collected variables such as year built.

Qualitative coefficients are either initialized at constant starting values or are assigned intuitive starting values. Some qualitative variables are quality descriptions and are developed around a reference coefficient of 1.00, which represents average. Thus, coefficients for below-average quality are initialized at values less than 1.00, coefficients for above-average quality, at values greater than 1.00. See such variables as site desirability, view, building grade, interior and exterior condition, and neighborhood rating (figure 1). All remaining qualitative variables are initialized at 1.00

FIGURE 1

Residential Base Model

Land qualitative factors		Sites	Initial value	Final value	General qualitative factors		Sites	Initial value	Final value	Land quantitative factors		Sites	Initial value	Final value
Waterfront type		20	1.0000	1.0008	Neighborhood rating		39	0.9500	0.9260	Square root of water frontage		20	2.300.0000	2.435.0543
Lake					Below average		1,180	1.0000	1.0000	Acres < .25		306	41,500.0000	40,332.8318
Site desirability		31	0.9500	0.9445	Above average		172	1.0500	1.0931	Acres .25-50		557	22,750.0000	21,904.5071
Below average		1,309	1.0000	1.0000	Property class					Acres .5-1		222	15,500.0000	15,134.5680
Average		51	1.0500	1.0448	One-family		1,281	1.0000	1.0000	Acres 1-2.5		96	6,500.0000	6,104.9295
Above average					Two-family		64	1.0000	0.9350	Acres 2-5.5		47	3,500.0000	3,445.8429
View		10	0.9500	0.9420	Three-family		9	1.0000	0.9835	Acres 5-10		36	3,000.0000	2,904.9848
Below average		1,346	1.0000	1.0000	Residence with acreage > 10		30	1.0000	1.0443	Acres > 10		20	650.0000	648.2326
Average		35	1.0500	1.0529	Estate		0	1.0000	1.0000	Building quantitative factors				
Above average					Seasonal		7	1.0000	0.9917	Square feet < 1,000		89	30.0000	29.9608
Building qualitative factors					Neighborhood type					Square feet 1,000-2,000		980	22.5000	22.6003
Square feet of living area		89	1.0000	0.9986	Rural		277	1.0000	1.0709	Square feet 2,001-3,000		268	20.0000	19.7664
< 1,000		980	1.0000	1.0000	Rural crossroads		15	1.0000	1.0311	Square feet 3,001-4,000		44	19.0000	19.0776
1,000-2,000		268	1.0000	0.9902	Suburban		479	1.0000	1.1046	Square feet > 4,000		10	21.5000	21.5179
2,001-3,000		44	1.0000	0.9908	Urban		157	1.0000	1.0484	Number of fireplaces		660	1,950.0000	1,943.6900
3,001-4,000		10	1.0000	0.9982	Residential sub-division		458	1.0000	1.1152	Number of baths		1,390	4,850.0000	4,899.8190
> 4,000					Mixed commercial		5	1.0000	0.9936	Quantitative factors				
Year built (YRBLT)		98	1.0000	0.9652	City/town locational		153	1.0000	1.0428	Total garage square feet		1,149	7.5000	7.2685
Before < 1900		318	1.0000	1.0415	City A		31	1.0000	0.9520	Inground pool		72	2,400.0000	2,092.6304
1900-1939		312	1.0000	1.1316	Town A		128	1.0000	1.1092	Dependent residences		3	14,000.0000	12,531.4256
1940-1959		604	1.0000	1.1694	Town B		42	1.0000	0.9702					
1960-1979		59	1.0000	1.0610	Town C		55	1.0000	1.0246					
1980-present		110	0.9500	0.9437	Town D		46	1.0000	0.9901					
Kitchen and bath quality		106	1.0500	1.0279	Town E		34	1.0000	0.9800					
Below average					Town F		62	1.0000	1.0138					
Above average		1	0.9000	0.8959	Town G		65	1.0000	1.0288					
Building grade					Town H									
Minimum														

Economy	60	0.9500	0.9078	Town I	52	1.0000	0.9747
Average	1,188	1.0000	1.0000	Town J	29	1.0000	0.9772
Good	141	1.0500	1.1552	Town K	30	1.0000	1.0235
Expensive	1	1.1000	1.1043	Town L	31	1.0000	1.0093
Heating system				Town M	79	1.0000	1.0691
No central heat	10	0.9500	0.9369	Town N	33	1.0000	1.0282
Air conditioning				Town O	93	1.0000	1.0195
Central	168	1.0500	1.0533	Town P	74	1.0000	1.0526
Interior condition				Town Q	33	1.0000	1.0092
Poor	4	0.9000	0.8968	Town R	122	1.0000	1.0482
Fair	48	0.9500	0.9405	Town S	72	1.0000	1.0126
Normal	1,261	1.0000	1.0000	Town T	127	1.0000	1.0286
Good	75	1.0500	1.0569	Town clusters			
Excellent	3	1.1000	1.1023	Cluster 1	153	1.0000	1.0428
Exterior condition				Cluster 2	336	1.0000	1.0150
Poor	4	0.9000	0.8938	Cluster 3	269	1.0000	1.0239
Fair	55	0.9500	0.9186	Cluster 4	312	1.0000	1.1892
Normal	1,193	1.0000	1.0000	Cluster 5	321	1.0000	1.0908
Good	137	1.0500	1.0664				
Excellent	2	1.1000	1.1020				
Building style							
Ranch	319	1.0000	1.1693				
Raised ranch	56	1.0000	1.0155				
Split level	152	1.0000	1.0529				
Cape Cod	141	1.0000	1.0099				
Colonial	273	1.0000	1.0545				
Contemporary	23	1.0000	1.0332				
Old style	404	1.0000	1.0237				
Cottage	9	1.0000	0.9922				
Duplex	8	1.0000	1.0004				
Bungalow	4	1.0000	0.9950				
Other style	2	1.0000	1.0159				
<u>Other qualitative factors</u>							
Driveway	27	0.9500	0.9014				
None							

because the relationships among them are unknown. These variables include a binary variable for each city and town within the county, and cluster variables—homogeneous groups of towns—that further refine the model for locational differences.

The quantitative variables are those that refer to measurable features, such as square feet of living area (SFLA), acreage, and number of baths. Acreage and SFLA variables are stratified into size ranges, creating separate data levels for each variable. The initial value of quantitative variables, such as appraised building value per square foot or appraised land value per acre, are derived from analysis of appraisal data or from previous modeling experience.

Figure 2 is a typical commercial base model. It represents thirty-nine apartment appraisals from an upstate New York county with a metropolitan area and suburbs. This model contains only building qualitative and quantitative variables and general qualitative variables. For apartments in this county, as with most commercial properties, the best predictor of value with the market approach is total value per unit (square foot, apartment, and so on). This commercial base model predicts values using total value per square foot as the only quantitative factor. Appraisers value property and investors purchase property on this basis.

As in the residential base model, all qualitative coefficients are initialized at constant starting values of 1.00 when relationships are unknown and at intuitive starting values when relationships can be determined through analysis of the data or from modeling experience. Starting values for the building quantitative variables were determined through analysis.

Modeling Statistics. During the base modeling process, coefficients move in the direction that the data indicate. The iterative process does not try to correct the total error all at once on each parcel. The rate of correction depends on the size of the error and the damping factor (mu). The mu controls the rate of adaption, or magnitude of the adjustment, for each coefficient in the model. Faster adaption is not necessarily better. At times it could cause large fluctuations in predictions, because the coefficients change every time a new site is introduced into the formula and thus diverge from an optimal solution to track each new site. The rate of adaption can be either internally generated based on frequency of data occurrences (automatic mu), or manually input based on the model builder's judgment.

In the residential base model a mu of .020 was used on all qualitative coefficients. A mu of .050 was used for all quantitative coefficients, allowing them to adapt at a higher rate. Thus, the larger portion of value is explained by the quantitative variables, with the qualitative variables acting as value refinements.

The commercial base model used the automatic mu . The fewer the occurrences, the larger the mu assigned. Less frequently occurring variables

need a larger adaption to allow their coefficients to fit the model, especially for smaller data files such as the one used in the apartment model example.

Certain properties may have physical inventory that deviates significantly from the norm. Furthermore, these properties may possess characteristics that cause a large unexplained error prediction in the adaption process. Rather than allow these properties to influence the formula, by causing adaption to a nonglobal solution, the program automatically rejects them as outliers. Whereas damping factors attempt to control these properties, the reject factor completely removes their influence rather than correcting for their existence. When a site's absolute mean percent error (MPE) is greater than that specified by the modeler (reject factor), that site is prevented from altering the model coefficients on that particular pass. A reject factor of 50 percent was used for the residential base model. Of 1,391 sites, 81 were rejected. The commercial base model used a reject factor of 100 percent, with no sites rejected.

Generally, repredictive accuracy for residential, vacant, farm, and mobile home base models has been at least equivalent to that achieved during base survey modeling. Because NYSDEA has not used mechanical modeling before in a production mode for commercial properties, the results were better than expected.

The statistical measure of accuracy of the AEP model is the absolute MPE. The MPE is determined by comparing the predicted value estimate to the actual value for each site. MPE is a measure of the overall accuracy of the predictions. The MPE of the residential base model's 1,310 appraisals (1,391 less 81 rejects) was 8.919 percent. The base model MPE of all 1,391 residential appraisals was 11.9992 percent. The MPE of the commercial base model's thirty-nine appraisals was 9.3296 percent.

Modeling Refinements. This computer-assisted valuation updating method was designed to repredict property values accurately, to retain reasonable stability from prior predictions, and to eliminate all field review of updated values. The method includes a systematic compensation to capture nonquantifiable, indiscernible, or economic influences outside the site. The compensation is an adjustment for model regressivity and site variance within the modeling process.

One common modeling problem in value prediction is regressivity—lower-valued properties are overestimated and higher-valued properties are underestimated (figure 3).

During updating, the market value for all of the subject properties in the previous year is known. If regressivity is evident in the predictive accuracy of the base model, it can be measured and compensation made. The NYSDEA's AEP program uses value ranges to stratify the file into quartiles (four value ranges containing equal numbers of sites). The program compiles statistics on the predictive accuracy of the model for each

FIGURE 2

Commercial Base Model

Building qualitative factors	Sites	Initial value	Final value	General qualitative factors	Sites	Initial value	Final value	Building quantitative factors	Sites	Initial value	Final value
Parking				Site desirability				Total square feet			
None	0	1.0000	1.0000	Poor	0	0.0900	0.9000	0-3K	4	20.0000	18.3931
Inadequate	13	1.0000	1.2222	Fair	9	0.9500	0.9434	3-4K	11	20.0000	17.3166
Inadequate onsite/adequate offsite	3	1.0000	0.7897	Normal	17	1.0000	1.0000	4-7K	7	20.0000	18.5510
Adequate on site/inadequate offsite	19	1.0000	0.9685	Good	13	1.1000	1.1198	7-14K	5	20.0000	19.9455
Adequate	4	1.0000	0.9833	Excellent	0	1.2000	1.3000	14-50K	4	20.0000	16.8059
Land rating				Condition	1	0.8000	0.7452	50-900K	8	20.0000	14.7324
Below average	1	0.9000	0.7452	Poor	8	0.9000	0.8453				
Average	36	1.0000	1.0000	Fair	24	1.0000	1.0000				
Above average	2	1.1000	1.0536	Normal	5	1.0500	1.0500				
Total land size				Good	1	1.1000	1.0729				
0-.29 acres	16	0.8500	0.9298	Excellent							
.3-.75 acres	8	0.9500	0.9021	Neighborhood type							
.76-4.99 acres	6	1.0000	1.0000	Central business	2	1.0000	0.9386				
5-14.99 acres	6	1.0500	1.0096	Major strip	1	1.0000	1.2200				
15-49.99 acres	2	1.1000	1.0408	Secondary strip	2	1.0000	0.8372				
50-200 acres	1	2.0000	2.3078	Mixed	28	1.0000	1.1365				
Apartment type				Industrial park	0	1.0000	1.0000				
Walk-up	7	1.0000	0.7582	Major industry	0	1.0000	1.0000				
				Rural	6	1.0000	0.8579				

	Converted	14	1.0000	0.6817	Planned unit development	0	1.0000	1.0000
Garden	16	1.0000	1.2029	Neighborhood rating	4	0.9500	0.9428	
Townhouse	0	1.0000	1.0000	Below average	29	1.0000	1.0000	
High rise	1	1.0000	1.5193	Average	6	1.0500	1.1000	
Row	1	1.0000	0.4034	Above average				
Multiple use				Zoning				
Yes	8	1.0000	1.0343	Residential 1	4	1.0000	0.9192	
Total number apartments	20	1.1000	1.1892	Residential 2	6	1.0000	0.7478	
0-5	7	1.0500	1.0692	Farm	0	1.0000	1.0000	
6-15	4	1.0000	1.0000	Commercial	17	1.0000	1.3192	
16-50	4	0.9500	0.8765	Industrial	0	1.0000	1.0000	
51-150	4	0.9000	0.9000	Mixed	9	1.0000	1.1429	
151-750	4	1.1000	1.2000	None	3	1.0000	1.0287	
Age	4	1.0500	1.1434	Nonforthcoming	0	1.0000	1.0000	
0-12	12	1.0000	1.0000	Government	0	1.0000	1.0000	
13-25	13	0.9500	0.9500	Clusters				
26-40	5	0.9000	0.9364	Cluster 1	4	1.0000	0.9750	
41-60	5	0.9000	0.9364	Cluster 2	15	1.0000	0.9630	
61-100	5	0.9000	0.9364	Cluster 3	20	1.0000	1.1678	
Total rentable square feet								
0-3K	4	1.1500	1.2319					
3-4K	11	1.1000	1.1239					
4-5K	7	1.0500	1.0379					
5-14K	5	1.0000	1.0000					
14-50K	4	0.9500	0.9294					
50-400K	7	0.9000	0.8500					
400-900K	1	0.8500	0.6895					

FIGURE 3

Model Regressivity

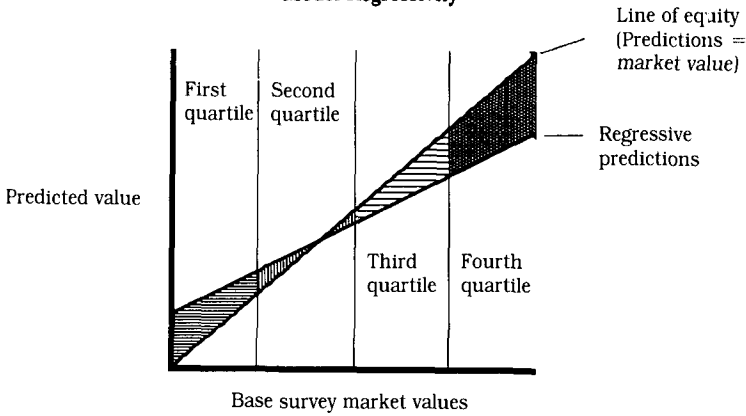
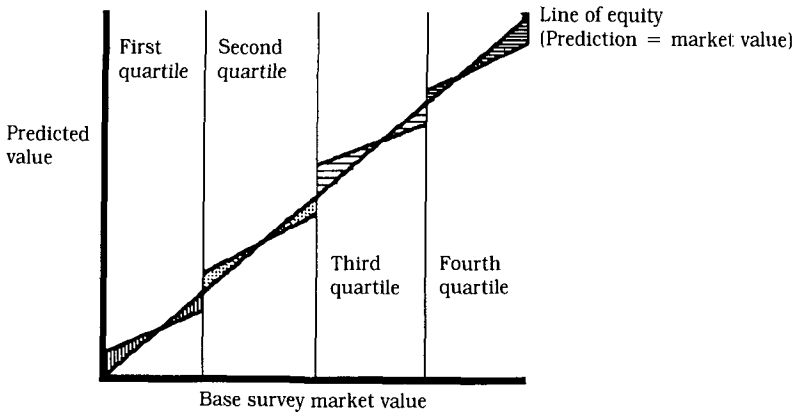


FIGURE 4

Quartile Adjustment for Regressivity



quartile, in addition to global statistics. Analysis of these statistics shows that the most difficulty in value prediction lies in the first (lowest values) and last (highest values) quartiles. To eliminate any undesirable effect on other coefficients in the model, binary quartile variables are created and introduced into the modeling process while not allowing previously established base model coefficients to adapt. This prevents a dominant correlation of a quartile variable with the appraised value, allows model predictions to achieve a more normal distribution around the mean, and improves central tendency by minimizing regressivity (figure 4).

After making quartile variable adjustments, the prediction model becomes a series of disjointed line segments. The shaded areas may have

decreased prediction accuracy, but modeling bias is minimized. Regressivity becomes distributed by quartiles, but individual prediction regressivity is diminished overall.

The quartile coefficients, which are developed to compensate for regressivity in the residential base model, and a comparison of model statistics are shown in tables 1 and 2.

With base modeling completed, the percent deviation between actual and repredicted values is computed for each site. The distribution of this deviation for the *final* residential and commercial base models is illustrated in figures 5 and 6.

Another common modeling problem is site variance adjustment. By their very nature, most modeling techniques tend to predict a model around the average properties with predicted values ranging from lower than to higher than actual values. Since base model coefficients are developed around actual, and sound, appraised values, the percent deviation, or site variance, between actual and predicted value must be due to factors that cannot be easily measured, such as a home that is closer to a noisy highway than other residences in the neighborhood. Once the best possible base model is derived, the percent deviation between the computer-generated prediction and the appraised value for each site is stored on an AEP output file for use as the site variance term in the update model formula.

Update Model

Current sales are used to update the base model. Variable coefficients from the base model are used as starting points for the update cycle. No qualitative variable coefficients developed in the base model are allowed to

TABLE 1
Residential Base Model Quartile Coefficients

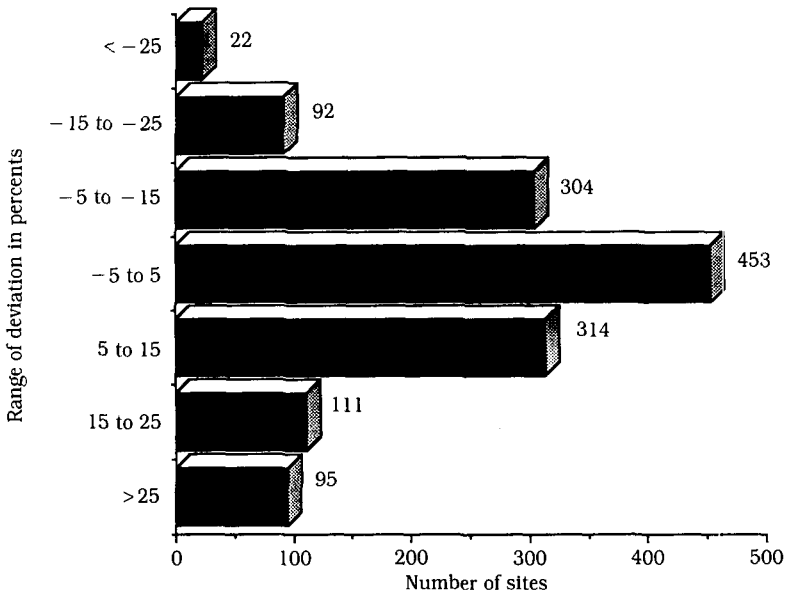
	Initial value	Final value
Quartile 1	1.0000	0.9808
Quartile 2	1.0000	1.0244
Quartile 3	1.0000	1.0181
Quartile 4	1.0000	1.0410

TABLE 2
Residential Base Model Mean Percent Errors

	Before quartiles	After quartiles
Quartile 1	19.9576%	19.3033%
Quartile 2	8.7125%	8.8005%
Quartile 3	8.2274%	8.5398%
Quartile 4	10.8025%	10.5199%
Global	11.9992%	11.8616%

FIGURE 5

Residential Base Model Distribution of Percent Deviation



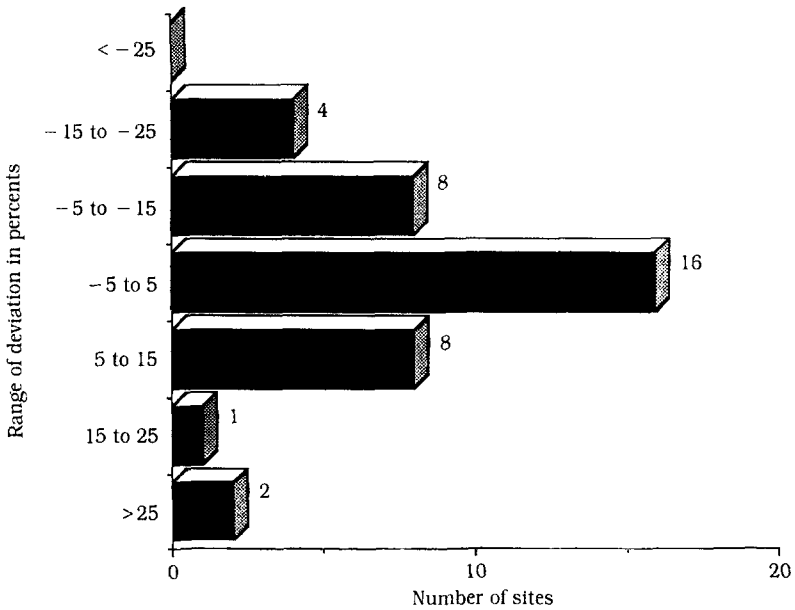
adapt during update passes. With the introduction of time-ordered (oldest to newest) sales in the update run, only the coefficients of controlled property characteristics (quantitative variables and reintroduced time- or location-dependent qualitative variables) adapt to fit, or track, the new market data. The number of iterations through the data is limited. This eliminates the development of a new coefficient set based on sales data, yet allows the coefficients to respond to the market. Thus, a relationship to the previous appraised values is maintained, providing stability and responsiveness to the market.

Depending on the data base, some coefficients may move up, but others may move down, or not at all. Thus, the difference in the variable coefficients of the controlled property characteristics from the base model to the update model reflects market changes over time. When this model is applied to the inventory of each appraisal, an individual updated value prediction is produced.

Figures 7 and 8 illustrate the residential and commercial update models. Note that the initial and final values of these variables are the same. All qualitative coefficients developed in the final base model become the initial values in the update model and are not allowed to adapt. In the base model, these coefficients are calibrated to reflect as well as possible the data of the field-reviewed appraised value and are developed around a

FIGURE 6

Commercial Base Model Distribution of Percent of Deviation



reference of 1.00. Varying these coefficients in the update model based on limited number of sales would change the model relationships. Therefore, one may assume that these qualitative relationships remain relatively constant during annual updates.

Change in time is captured mainly in the adjustments made in the quantitative coefficients—land, building, and other quantitative factors for the residential model, and building quantitative factors for the commercial model. These variables are initialized at their base model level and are calibrated as the time-ordered sales are input.

Certain global qualitative variables that vary with time (for example, location and property type) are reentered in the model and initialized at 1.00. In the residential update model, town cluster variables are reintroduced, which, in combination with the frozen base model coefficients and the adaptable quantitative factors, allows the update model to reflect varying rates of appreciation, or possibly depreciation, for different properties, based on actual market activity and without technically changing the variables in the model.

For example, using the residential model, an average 2,100-square-foot colonial home on .45 acres with two baths, and a 500-square-foot garage, located in the suburb of Town P, in cluster three, which had an actual

Average	1,188	1,000	1,000	Town H	65	1,0288	1,0288
Good	141	1,1552	1,1552	Town I	52	0,9747	0,9747
Expensive	1	1,1043	1,1043	Town J	29	0,9772	0,9772
Heating system				Town K	30	1,0235	1,0235
No central heat	10	0,9369	0,9369	Town L	31	1,0093	1,0093
Air conditioning				Town M	79	1,0691	1,0691
Central	168	1,0533	1,0533	Town N	33	1,0282	1,0282
Interior condition				Town O	93	1,0195	1,0195
Poor	4	0,8968	0,8968	Town P	74	1,0526	1,0526
Fair	48	0,9405	0,9405	Town Q	33	1,0092	1,0092
Normal	1,261	1,0000	1,0000	Town R	122	1,0482	1,0482
Good	75	1,0569	1,0569	Town S	72	1,0126	1,0126
Excellent	3	1,1023	1,1023	Town T	127	1,0286	1,0286
Exterior condition				Town clusters			
Poor	4	0,8938	0,8938	Cluster 1	153	1,0428	1,0428
Fair	55	0,9186	0,9186	Cluster 2	336	1,0150	1,0150
Normal	1,193	1,0000	1,0000	Cluster 3	269	1,0239	1,0239
Good	137	1,0664	1,0664	Cluster 4	312	1,1892	1,1892
Excellent	2	1,1020	1,1020	Cluster 5	321	1,0908	1,0908
Building style				Quartiles			
Ranch	319	1,1693	1,1693	Quartile 1	358	0,9808	0,9808
Raised ranch	56	1,0155	1,0155	Quartile 2	338	1,0244	1,0244
Split level	152	1,0529	1,0529	Quartile 3	352	1,0181	1,0181
Cape Cod	141	1,0099	1,0099	Quartile 4	343	1,0410	1,0410
Colonial	273	1,0545	1,0545	<u>Reintroduced general</u>			
Contemporary	23	1,0332	1,0332	<u>qualitative factors</u>			
Old style	404	1,0237	1,0237	Town clusters			
Cottage	9	0,9922	0,9922	Cluster 1	153	1,0000	1,0049
Duplex	8	1,0004	1,0004	Cluster 2	336	1,0000	1,0249
Bungalow	4	0,9950	0,9950	Cluster 3	269	1,0000	1,0212
Other style	2	1,0159	1,0159	Cluster 4	312	1,0000	1,0136
<u>Other qualitative factors</u>				Cluster 5	321	1,0000	1,0356
Driveway							
None	27	0,9014	0,9014				

FIGURE 8

Commercial Update Model

Building qualitative factors	Sites	Initial value	Final value	General qualitative factors	Sites	Initial value	Final value	Building quantitative factors	Sites	Initial value	Final value
Parking				Site desirability				Total square feet			
None	0	1.0000	1.0000	Poor	0	0.9000	0.9000	0-3K	4	18.3931	19.8953
Inadequate	13	1.2222	1.2222	Fair	9	0.9434	0.9434	3-4K	11	17.3166	18.5380
Inadequate onsite/adequate offsite	3	0.7897	0.7897	Normal	17	1.0000	1.0000	4-7K	7	18.5510	22.2277
Adequate onsite/inadequate offsite	19	0.9685	0.9685	Good	13	1.1198	1.1198	7-14K	5	19.9455	18.7289
Adequate	4	0.9833	0.9833	Excellent	0	1.3000	1.3000	14-50K	4	16.8059	16.6819
Land rating				Condition				50-900K	8	14.7324	15.3305
Below average	1	0.7452	0.7452	Poor	1	0.7452	0.7452				
Average	36	1.0000	1.0000	Fair	8	0.8453	0.8453				
Above average	2	1.0536	1.0536	Normal	24	1.0000	1.0000				
Total land size				Good	5	1.0500	1.0500				
0-.29 acres	16	0.9298	0.9298	Excellent	1	1.0729	1.0729				
.3-.75 acres	8	0.9021	0.9021	Neighborhood type							
.76-4.99 acres	6	1.0000	1.0000	Central business	2	0.9386	0.9386				
5-14.99 acres	6	1.0096	1.0096	Major strip	1	1.2200	1.2200				
15-49.99 acres	2	1.0408	1.0408	Secondary strip	2	0.8372	0.8372				
50-200 acres	1	2.3078	2.3078	Mixed	28	1.1365	1.1365				
Apartment type				Industrial park	0	1.0000	1.0000				
Walk-up	7	0.7582	0.7582	Major industry	0	1.0000	1.0000				
Converted	14	0.6817	0.6817	Rural	6	0.8579	0.8579				
				Planned unit development	0	1.0000	1.0000				

Garden	16	1.2029	1.2029	1.2029	Neighborhood rating			
Townhouse	0	1.0000	1.0000	1.0000	Below average	4	0.9428	0.9428
High rise	1	1.5193	1.5193	1.5193	Average	29	1.0000	1.0000
Row	1	0.4034	0.4034	0.4034	Above average	6	1.1000	1.1000
Multiple use					Zoning			
Yes	8	1.0343	1.0343	1.0343	Residential 1	4	0.9192	0.9192
Total number apartments					Residential 2	6	0.7478	0.7478
0-5	20	1.1892	1.1892	1.1892	Farm	0	1.0000	1.0000
6-15	7	1.0692	1.0692	1.0692	Commercial	17	1.3192	1.3192
16-50	4	1.0000	1.0000	1.0000	Industrial	0	1.0000	1.0000
51-150	4	0.8765	0.8765	0.8765	Mixed	9	1.1429	1.1429
151-750	4	0.9000	0.9000	0.9000	None	3	1.0287	1.0287
Age					Nonconforming	0	1.0000	1.0000
0-12	4	1.2000	1.2000	1.2000	Government	0	1.0000	1.0000
13-25	12	1.1434	1.1434	1.1434	Clusters			
26-40	13	1.0000	1.0000	1.0000	Cluster 1	4	0.9750	0.9750
41-60	5	0.9500	0.9500	0.9500	Cluster 2	15	0.9630	0.9630
61-100	5	0.9364	0.9364	0.9364	Cluster 3	20	1.1678	1.1678
Total rentable square feet								
0-3K	4	1.2319	1.2319	1.2319				
3-4K	11	1.1239	1.1239	1.1239				
4-5K	7	1.0379	1.0379	1.0379				
5-14K	5	1.0000	1.0000	1.0000				
14-50K	4	0.9294	0.9294	0.9294				
50-400K	7	0.8500	0.8500	0.8500				
400-900K	1	0.6895	0.6895	0.6895				

appraised value of \$90,000 (putting it in the third quartile), would receive a base model estimate of \$92,281 (figure 9).

The percent deviation between the base model estimate and the original appraised value of \$90,000 is 2.535 percent.

In the update model, all the quantitative coefficients are updated. In addition, the town cluster variables are reintroduced and allowed to adapt. The updated value estimate for this example uses an updated general qualitative factor (a result of reintroduced cluster variables) and the updated quantitative variable coefficients (figure 10).

Once the coefficients of the final update model are extended to produce an estimate for each site, the site variance term stored on the file from base modeling is accessed. It is assumed that if the base model were underpredicting or overpredicting a property's value, then an update model using the same variables would do the same. Figure 11 shows the distribution of percent change in value between the original appraised value and the update model predictions calculated *without* the site variance term for the residential update model.

In order to allow nonquantifiable factors to enter the update equation, each update model estimate is adjusted by the reverse of its base model site variance. For example, if the base model predicted 110 percent of the site's appraised value (overprediction), then the update model when applied to the appraisal will do the same. Therefore, 10 percent will be subtracted from the update model value prediction to account for the site variance.

In the preceding example, the base model overpredicted the original appraised value, creating a site variance of 2.535 percent. The update model estimate of \$100,251.76 must be adjusted downward by 2.535 per-

FIGURE 9

Computing a Base Model Estimate

	Qualitative		Quantitative		General qualitative	Value				
Land	1.0	×	.45 acres	×	\$21,904.5071	×	1.212	=	\$11,946.72	
Building	1.221	×	2,100 square feet	×	\$19.7664	×	1.212	=	61,427.83	
Building	1.221	×	2 baths	×	\$4,899.819	×	1.212	=	14,502.01	
Other	1.0	×	500 square feet	×	\$7.2685	×	1.212	=	4,404.71	
									Base model estimate =	\$92,281.27

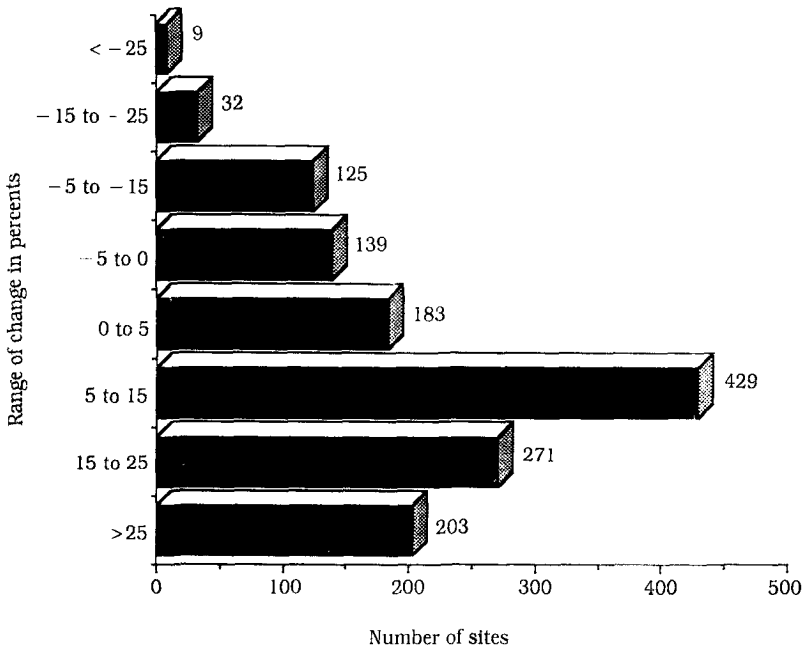
FIGURE 10

Computing an Update Model Estimate

	Qualitative		Quantitative		General qualitative	Value				
Land	1.0	×	.45 acres	×	\$21,208.7147	×	1.2377	=	\$11,812.51	
Building	1.221	×	2,100 square feet	×	\$21.0374	×	1.2377	=	66,764.01	
Building	1.221	×	2 baths	×	\$5,716.7536	×	1.2377	=	17,278.68	
Other	1.0	×	500 square feet	×	\$7.1044	×	1.2377	=	4,396.56	
									Update model estimate	= \$100,251.76

FIGURE 11

Residential Update Model Without Site Variance



cent. Thus, the final update model estimate is

$$\$100,251.76 \times .97465 = \$97,710.38,$$

representing an 8.57 percent increase from the original appraised value of \$90,000.

Figure 12 shows the distribution of percent change in value between the original appraised value and the update model predictions calculated *with* the site variance term for the residential update model. Using the site variance term significantly improves the stability between original valuations and update predictions by compensating for nonquantifiable factors.

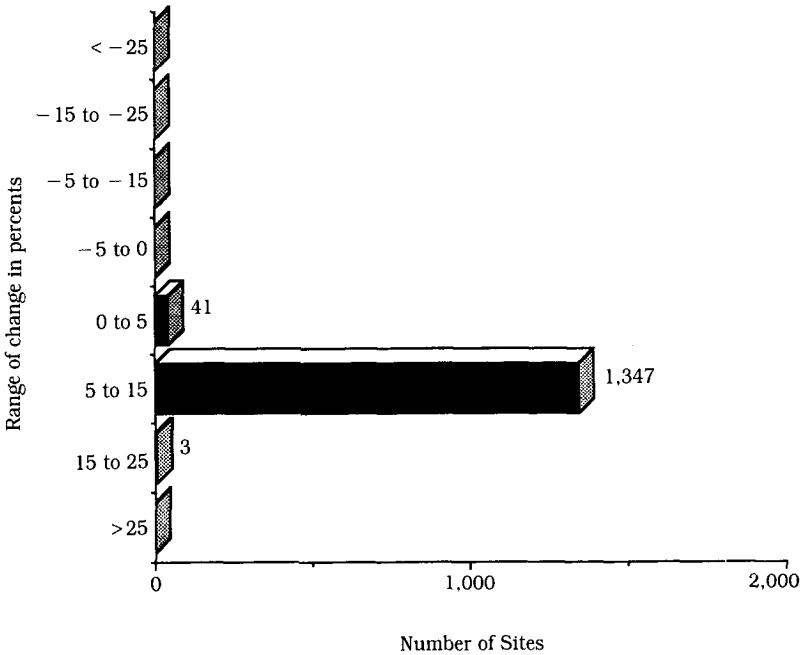
Figures 13 and 14 show the distributions of percent change in value between the original appraised value and the commercial update model predictions, calculated without and with the site variance term.

Trend (Control) Model

Base model coefficients are used as starting points and time-ordered sales are introduced in the same way as in the update model process. No base model coefficients are allowed to adapt. Only newly introduced time and

FIGURE 12

Residential Update Model With Site Variance

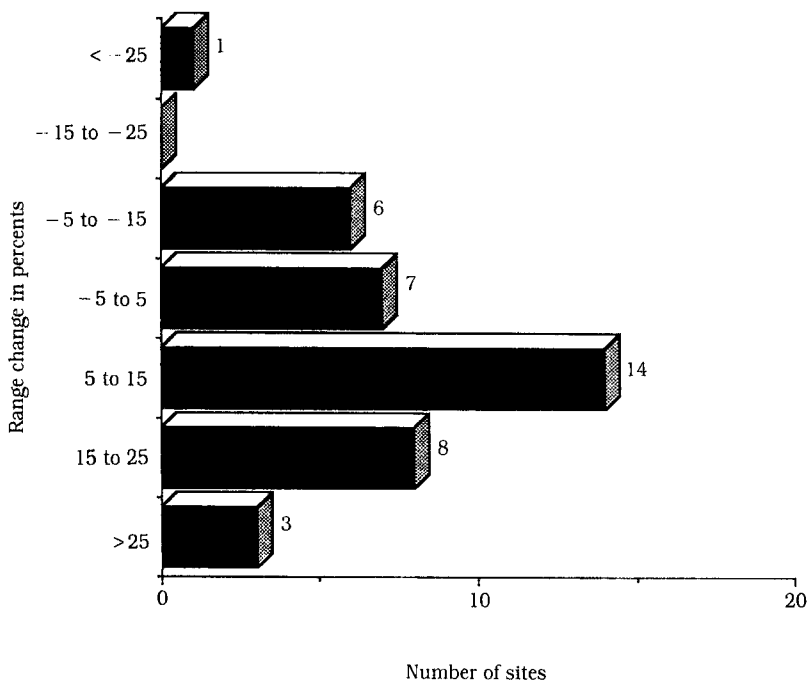


location variables are allowed to adapt to the sales data. These factors, which are initialized at 1.00, absorb the total contribution for broad market changes when the new model is calibrated with current sales. The change in these coefficients is an aggregate trend (time adjustment). The model coefficients are not used to predict an individual value estimate. The trend is applied to the original appraised value. Depending on the number of sales available for trend derivation, trends may be developed at the following aggregate levels: town level, village level, school district, location cluster, property class or use, countywide within property class grouping or use, and countywide with no distinction for use. Binary variables can be created for one or all of these levels depending on the size and representativeness of the sales data base and the requirements of the user.

Aggregate trends are developed on as specific a level as possible, but generally NYSDEA's data base limits trend derivation to county within property class grouping, property class or use, or locational cluster levels. In the sample county, town cluster trends were deemed more appropriate for residential properties due to the nature of the sales data. A countywide trend for apartments was developed. These trends are used as a control

FIGURE 13

Residential Update Model With Site Variance



in the correlation and final value determination phase of the updating method.

Sales collected for the updating process are representative of the appraisals with respect to location, physical characteristics, and other amenities. It is important that this sales base be used as the primary source for aggregate trend development. In order to gauge the reasonableness of aggregate trends developed from the trend model, a comparison to the update model range of value change is made. Residential update model value predictions generally ranged from 4 percent to 14 percent over the original appraised values, whereas commercial update model value predictions ranged from 4 percent to 19 percent over original appraised values. The trends used in the value correlation phase fell within these ranges (table 3).

Correlation and Final Value Determination

The individual update model estimate and the trended value estimate for each site are compared systematically, and one estimate is accepted as the final value. As a result, final updated values are a blend of the indi-

FIGURE 14

Commercial Update Model With Site Variance

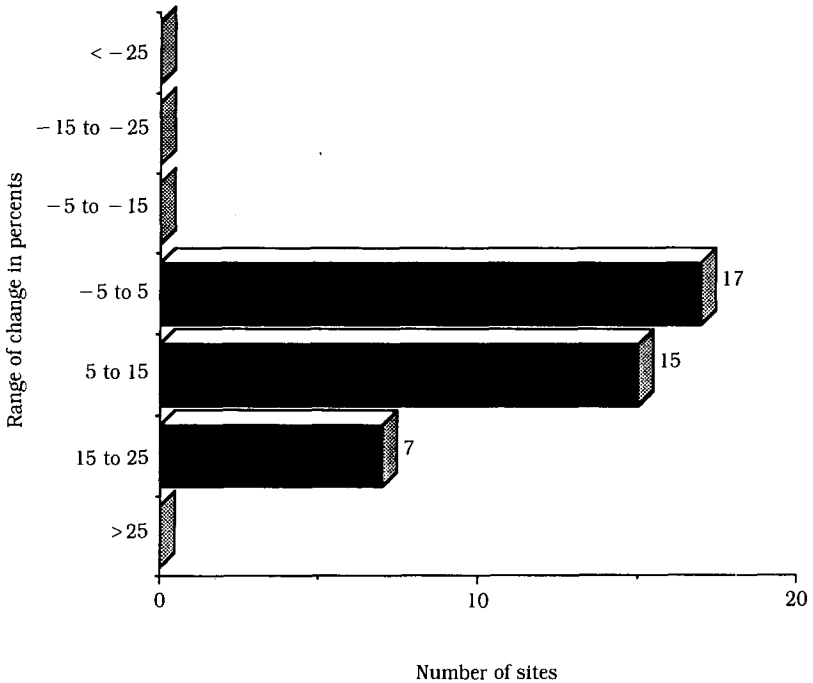


TABLE 3

Aggregate Trends

Model	Trend type	Trend
Residential	Town cluster 1	5.5%
Residential	Town cluster 2	7.5%
Residential	Town cluster 3	6.5%
Residential	Town cluster 4	7.0%
Residential	Town cluster 5	9.0%
Commercial	Apartment (countywide)	9.0%

vidual accuracy of the update model predictions and the stable value changes derived from an aggregate trending process.

Limits, set around the trended value estimate as a control, are used programmatically to determine the final value. NYSDEA limits established for acceptance of individual update model estimates have been set as shown in table 4. If a site's individual update model estimate falls within the limits, then this update model estimate becomes the final value. Otherwise the trended value estimate becomes the final value.

For example, in the sample county the original appraised value for a

TABLE 4

Limits for Acceptance of Individual Update Model Estimates

Trend	Low	High
≤ 10%	5% below trended value estimate	5% above trended value estimate
> 10% ≤ 20%	7.5% below trended value estimate	7.5% above trended value estimate
> 20%	10% below trended value estimate	10% above trended value estimate

site in town cluster 5 is \$75,000 and the trend is 9 percent. Therefore, the trended value estimate is \$81,750 ($\$75,000 \times 1.09$). The lower limit value is \$77,663 ($\$81,750 \times .95$) and the upper, \$85,838 ($\$81,750 \times 1.05$). Thus, if the update model individual estimate falls between \$77,663 and \$85,838, it is used as the final value; otherwise the trended value estimate of \$81,750 is accepted as the final value.

When these limits were used in the value correlation process for the two sample models, 1,362 residential and 23 commercial individual update model estimates were accepted as final values; 29 residential and 16 commercial trended value estimates were accepted as final values using the trends developed from the trend (control) models. The average percent change in original appraised value to final updated value was 8.48 percent for residential properties and 7.16 percent for commercial properties.

Conclusions

NYSDEA selected AEP as the modeling technique for its update market value survey because of its suitability to model updating. AEP allows the user to describe the model form by decomposing total values into land, building, and other components. AEP's flexibility lets all variables input by the user remain in the update model. The modeler can monitor the interaction of variables, producing a model that is more readily understood than others. AEP allows updating with a limited number of sales and will use them to track, rather than fit, the market.

This method produces reliable values. In the base model process the dependent variable is appraised value—the result of an entire appraisal process. The site variance term developed in this model captures the intangible factors, such as economic influences outside the site, that can never be fully quantified in a data-collected variable. These factors are accounted for when the appraiser determines the base survey appraised value of each site.

The update model allows coefficients developed in the base model to

respond to the market, yet eliminates development of a new coefficient set. Thus, the premise behind the update model is that it produces an individually accurate updated value estimate that compensates for non-quantifiable factors affecting value. However, because a normal distribution of values is produced by any statistical model, individual update model estimates may show disparities in value change from site to site, even within the most homogeneous neighborhoods.

Trending original appraised values with an aggregate factor derived from the trend model provides stable value changes across a broad spectrum of property types. Unfortunately, all properties do not change in value at the same rate over the same period of time.

The value correlation and final value determination process of this updating method provides the happy medium between the need for stability and the desire for accuracy. The use of limits around an aggregate trend value estimate as a control for the acceptance of individual update estimates ensures individual accuracy within a stable window of value change.

Reference

- Carbone, Robert. 1987. Notes on the Carbone-Longini feedback system. *Property Tax Journal* 6(3):161-172.