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# Industrials: The Baseline Method

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**The use of multiple regression analysis and the valuation models it allows appraisers to create have largely been confined to residential property. This article sets forth a methodology for a valuation model for single-user industrial buildings. It describes the results of the application of the model to sales data in and around Boston. One byproduct of the method is a GIS map depicting the value change for a standard "baseline" building at the various industrial locations across the region. The article weighs the advantages and disadvantages of the use of a valuation model versus traditional analysis through the sales comparison approach. It suggests other avenues for applying similar techniques.**

Regression analysis and the more standard method of analysis through the sales comparison approach come at valuation from different perspectives. Standard analysis stresses the uniqueness of individual properties, moving the majority of market data to the background in favor of the use of perhaps a half dozen sales with characteristics most similar to a subject property worthy of inclusion in an adjustment chart for direct comparison. Regression analysis says that, within a market of similar-use buildings, though one may be clad in brick and another in block, one partitioned into many rooms and another into few, one large and one small, they all are buildings and so are comparable as expressions of a larger pattern of value. Neither is necessarily the "better" method. Whether one is superior to the other for the usual purpose of an appraiser depends on its usefulness in describing the value of a particular property.

Regression analysis as applied to appraisal has been most successful to date in the valuation of the property type for which the largest volume of sales data is available, single-family dwellings. The purpose of this article is to set forth a method for the extension of regression analysis to industrial property in the environs of a large city, Boston, during a period of several years of relative price stability and considerable market activity, during which sufficient sales data have accumulated to form the raw material for a meaningful application. The name given the model is the baseline method, after its distinguishing characteristic, an informational map that depicts the variation in the value of a standard, or "baseline," industrial building at different locations.

## THEORY

When a building sells in an arm's length transaction under terms that conform to the definition of market value, we have a snapshot of the value of that building or of any building roughly similar to it near that location.

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If the face of the earth were developed with identical buildings spaced at, say, quarter-mile intervals and all those buildings sold frequently-say, once a year-we could use those once-a-year transaction prices to construct a map that would display the highs and lows of value in the manner of a typographical map, with contour lines joining points of equal value.

If we know the value of one building, we also know with only somewhat less certainty the value of another building that differs from it in a fixed, measurable way. This is the principle behind the adjustments in an adjustment chart. If the value of one building is this much per square foot, then the value per square foot for one twice its size is somewhat less and for one half its size somewhat more, because price per square foot typically declines with increasing size. If we have reason to believe that a relationship of this kind applies, we make an adjustment for differing building size in an adjustment chart. The same is true for differences in land-to-building ratio, the quality of a building, and its age and condition. We anticipate that variation conforming to fixed principles exists and in standard analysis through the sales comparison approach attempt to measure it through paired sales analysis, isolating two properties that have sold and that differ only in terms of one significant variable, then translating their price difference into a measure of the effect of that variable on price. Multiple regression analysis performs the same task, but through the use of a larger database.

Creating a map is unnecessary for property types for which location is not a significant determinant of value (for instance, houses within a relatively uniform subdivision in which no lots benefit from superior views, proximity to water, or other such features) or for types at which locational variation can be adequately described as a single attribute (inside or outside a planned industrial park; a distance of so and so many tenths of a mile to a highway interchange). The adage "location, location, location," however, seems apt for most property types. Locational variations are complex, and an accounting of them for valuation purposes is not easily gained by any means other than a map. For industrial property in Greater Boston, differences in value that are produced by differing location are so great and the variations so complex that a map is a necessary component of the valuation model presented here.

In theory, with a map that depicts the variation in the value of a standard, "baseline" building as that building is moved from place to place and with a valuation model that describes the change in price that results from other value determinants, we are able to estimate the value of any industrial building that falls within the parameters of the model we have created within its geographic range.

## APPLICATION

A study group tested this theory against a target market of mid-sized industrial buildings in Greater Boston. Industrial buildings appeared the most suitable nonresidential group because of their relative similarity and because, during the period in question (19921995), the market of buyers for them was uniformly owner-occupants (rather than rental income investors), and their valuation was thus best accomplished through sales comparison. The industrial market in the Northeast declined in price dramatically in the period 1990-1991; since 1992, evidence in the form of average selling prices has indicated stability. More than 500 one-story, single-occupant industrial buildings changed hands in the period after 1991 in the region from Boston to the cities and towns along its outer beltway, Interstate Route 495. These appeared to provide an adequate body of data for the development of a valuation model.

To allow the use of the maximum number of data points, we arbitrarily established the characteristics of the baseline building at the midpoints of the range for the target group. In terms of size, most buildings ranged from 8,000-100,000 square feet, with a preponderance at 10,000-30,000. We chose 20,000 square feet as the baseline building size. Doubling this size twice results in a building area of 80,000 square feet. Halving it twice results in a size of 5,000 square feet. The model could thus incorporate all data within a building size range of 5,000-80,000 square feet with a maximum of two size transformations (doublings or halvings of the area of the baseline 20,000-square-foot building). We further arbitrarily defined the baseline building along the same lines of reasoning (as the middle of the range) as follows:

20,000-square-foot building area

1970 construction date, without significant upgrade

18-foot clear height

15% office finish

One-story, concrete-block and steel bar joist construction

Face brick or decorative block one side

30% building-to-land ratio (66,667 square-foot lot)

The model would thus derive from buildings with characteristics within a certain range. For size, for instance, we would make use of only those sales within the range of 5,000 to 80,000 square feet. For valuation purposes, the model would be applicable only to properties within the same range. To value a 400,000-square-foot building or an older, mill-style, multistory brick building would require a second and a third model, as neither of these fits the parameters for sales from which the model described here is derived.

A screening of sales is necessary to determine those that are to be included in the model. Sales excluded were generally those that resulted from foreclosure auctions, those of properties under long-term leases, those at which the buyer changed from industrial use (demolishing the building; converting to commercial use), those that suffered unremediated contamination, and those clearly skewed by circumstances that produced sales not meeting the market value definition. Sales were inspected in the field, and, on occasion, parties to transfers were contacted for questioning regarding circumstances. The screening process produced 350 transactions suitable for inclusion in the data group.

The locations of the sales were then plotted on a map of the region. The plotting produced a varied arrangement. Many sales were isolated at a distance from others and other sales were clustered tightly into relatively small geographic areas. Clustered data of this latter kind are essential for developing the regression model. Where the characteristics of a neighborhood were relatively uniform in terms of highway access, quality of service roads, and adjacent development, we made a presumption of a single baseline value for the neighborhood-that is, that identical buildings would have the same value regardless of their location in that neighborhood. The clustered sales in neighborhoods of this kind form a subgroup that allows calculation of the rates of adjustment for all other factors influencing value.

One such neighborhood is Stoughton/Avon on Route 24 south of Boston (see Figure 1). Here, 10 sales are scattered in a neighborhood where all properties are roughly equally served from highway access and none benefits from the prestige of high-quality neighbors in a planned industrial park or suffers adversity from access through a residential district or other such factors. The presumption of equality of location within this neighborhood allows us to subject the data from the neighborhood to regression analysis, to establish the effects of other variables on price.

Experience in the standard method of

valuation of a large number of industrial buildings had resulted in a refinement of techniques for sales adjustment, such that it seemed that a handful of adjustments accounted for the majority of price differences in the market. Adjustment at fixed rates for these differences invariably caused the indicators from diverse sales to converge. These, then, were established by hypothesis, for testing, as fields for adjustment. (Other factors may and, likely, do affect price as well. For the purpose of this initial model, however, the fields for adjustment are limited to those described here.)

The fields applied in this test model are as follows:

Time (months expired from the baseline date of January 1992 to the date when a particular sale occurred)

Building area (with adjustment for the number of doublings or halvings of building area that are required to make a sale equal to the 20,000-square-foot baseline building)

Building-to-land ratio (with adjustment for the number of doublings or halvings of the ratio that are required to make a sale equal to the baseline 30% ratio)

Building quality (with adjustment for the number of degrees of difference between the baseline building and a sale, the baseline building being arbitrarily assigned a rating of six and the sales ratings from 1 to 11; the ratings for building quality result from a system that takes account of building age, construction style, functionality, appearance, clear height, and percent of office finish; for brevity in this discussion, the system is not fully described; a more elaborate model might incorporate each of these as a separate field)

The formula for deriving the baseline indicator from each sale is as follows:

Baseline indicator = Price per square foot of building, from sale x Time factor x Building size factor x Building-to-land ratio factor x Building quality factor

or

Baseline indicator = n x (1/(1 + a)[sup r]) x (1+ (b x (log (s/t)/log 2))) x (1 + (d x (log ((s/w)/(t/z))/log 2))) x (1+(0.01x(u-v)x c))

where, n = Price per square foot of building, from a comparable sale

a = Rate of appreciation or depreciation per month

b= Rate of change in price per square foot of building as building size is doubled or halved

c= Rate of change in price per square foot of building per grade change for quality and condition

d= Rate of change in price per square foot of building as floor area ratio is doubled or halved

Months elapsed from January 1992 to date of sale

Building square foot area for comparable sale

t = Baseline building area (20,000 square feet)

u = Baseline building rating (6)

Building rating for comparable sale (1 to 11)

w = Land area for comparable sale z= Land area for baseline building (66,667 square feet)

The formula incorporates rates of adjustment for each of the factors that account for price differences, the rates expressed above as a, b, c, and d. Numeric amounts for each of these may be derived by multiple regression analysis of the subgroup of sales that cluster by neighborhood. Multiple regression analysis allows derivation of the rates of adjustment that produce the least deviation of the indicators from their neighborhood average and, thus, the "best fit."

Multiple regression analysis is applied in this manner to several such neighborhoods of presumed uniform locational equality. (Note that these neighborhoods may differ from one to the next but that, within a given neighborhood, locational quality is presumed to be equal.) In this model, 86 sales are located in 13 such neighborhoods of locational uniformity. Regression analysis of this body of data produces the following results, as the optimum rates of adjustment:

For time-Appreciation of 0.45% per month since January 1992

For building size-Decline in price per square foot of 15.5% when size is doubled

For building-to-land ratio-Increase in price per square foot of building of 9.5% when building ratio is halved

For quality-Increase in price per square foot of 5.8% per stage for each of 11 stages

**GIS MAP**

Calculation of the optimum rates of adjustment allows us to apply these same adjustments to each sale in the larger body of 350 industrial sales regionwide and to make use of each sale as an indicator of the value of the baseline building at that sale's location. The results of this adjustment process for the Stoughton/Avon neighborhood are displayed in map form (see Figure 2). From the adjusted data points, the baseline map for the region is produced. The baseline map is a geographic information system (GIS) map of all industrially zoned neighborhoods that depicts the price per square foot for the baseline building within each neighborhood. The baseline map for Stoughton/Avon and its surroundings north to Route 128 is shown in Figure 3. Note that, in crafting the baseline map from the adjusted data points, considerable judgment is exercised by the appraiser. In our map-making and assignment of value to a neighborhood, we have given considerable weight to the indicators from buildings that best conform to the baseline building model and thus require the least adjustment. Others would likely calculate in a different fashion-by averaging the indicators equally or by other means.

A map of this kind is striking in itself, in that it brings into view locational relationships that previously were largely unseen. In the baseline map of industrial property for Greater Boston, property along the innermost of the region's two beltways, Route 128, stands at a level of value about twice that of identical property on the outer beltway, Route 495. Baseline rates in the best-quality, planned industrial parks are at a level on occasion double that of identical property outside the parks; however, parks of lesser quality appear to experience little or no advantage. Prices in parks along highways are higher than at the most central urban locations, where the amenities of suburban parks are absent. Core urban locations demonstrate wide variation over short distances, while exurban locations (including locations in outlying satellite cities) form a shallow terrain of relatively consistent, low baseline value. For the region studied, baseline values range from a low of about $15 per square foot of building for locations with access through residential neighborhoods in older cities to as much as $75 per square foot for locations in the best-quality suburban park.

With the compilation of the map and model, the work of the appraiser is largely complete. To value a particular subject, the appraiser draws a reading of the baseline value for that property's location from the map. He or she then enters the baseline reading into an equation that is the reverse of that used to derive the baseline. Numeric values are entered for the subject property's specific characteristics for building size, land ratio, date of valuation, age, finish, and quality (or any other factors that may have been found to be important value determinants). The result is the indicator of value for the property in question. A typical analysis for a hypothetical building in Stoughton is shown in Figure 4. The result can be delivered to the client together with a reporting of the model's overall measure of accuracy.

## ADVANTAGES

An important advantage of analysis using a regression model is that it allows the value conclusion to be reported immediately. Because market research and analysis are completed in advance, all that remains for the valuation of a particular property is inspecting the property and determining its characteristics. The conclusion may be delivered in relatively short order, and the report made available after the usual time requirement for drafting.

The value conclusion derived from the regression model in an important sense may be viewed as more comprehensive than one derived from standard analysis, in that it takes direct account of a large body of data rather than a small sample. Valuations made through the standard method for the sales comparison approach, by means of a typical sample of three to eight sales (albeit with knowledge of a larger body of data on the part of the analyst but with direct use of only a few) maybe vulnerable to an argument that they are inaccurate as a result of the possibility that one or more of the sales is an anomaly that skews the estimate. With the use of a larger sample in regression analysis, the potential for distortion from any one anomalous data point is reduced. Moreover, because adjustments in regression analysis are derived from a large body of data, they can be subjected to tests for statistical significance. In standard analysis through the sales comparison approach, statistical significance is unproven and, thus, is largely presumed.

Improved accuracy is part of the promise of regression analysis. Further, a measure of accuracy is available for values derived through regression. In standard analysis through the sales comparison approach, the conclusion is typically a one-number answer. The appraiser (and, thus, the client) has little information with which to judge the accuracy of the estimate. The appraiser may inform the client that the value of a property is, say, $1 million. The client can understand that amount as the appraiser's estimate of most probable selling price, but neither has much basis to answer the question of what is the likelihood of a selling price of $900,000 or $1.2 million. The regression model, on the other hand, produces not only a most probable price (the mean) but the standard deviation. The range within one standard deviation of the mean is a confidence interval of about 68%. Standard deviation, a statistical measure of variation measures distance from the mean. For all populations that follow the distribution pattern of the standard normal curve, the proportion of the population within one standard deviation of the mean is approximately 68%. Presuming that the value estimate for the subject property as derived from the model experiences a likelihood for reliability at the average for the model, it can be said that the accuracy of the estimate for the subject is the same as that for the model. In the case of the model presented here, the standard deviation is 14.09%. The appraiser can inform the client that the client can be confident at the rate of 68 chances out of 100 of a selling price in a range from $860,000 to $1.14 million.

The likely response of some clients, of course, is that the range is broad and that the estimate appears insufficiently accurate. Variation can result from two sources: inaccuracy of measurement and variation in an imperfect market. In relatively efficient markets, like those for single-family dwellings, variation is generally small. In more imperfect markets like those for commercial property, variation can be large. It may be that, with perfectly accurate measurement through a model more comprehensive and refined than that presented here, the standard deviation for an imperfect market like industrials cannot be reduced far below a range of 10%. It is then the appraiser's job to communicate to the client the variability of the market itself (and the risks and opportunities that dealing in such a market entails). Contrast this with the difficulty of an appraiser's making use of the standard method to address variability by any statistically supportable method, with the result that appraiser and client alike are left with what may amount to little more than an illusion of accuracy, in the form of a non-existent high probability of a selling price near the value estimate.

The map of baseline values in itself is a useful tool for market insights. With reference only to the map, a developer can quickly know the change in value that results from developing a planned facility at one location versus another. An investor can locate areas of apparent opportunity. Multiple maps made over time can graphically display areas of increasing value and others of decline.

A further benefit of the regression method is that it allows statistical studies of a kind not easily produced by standard small-sample methods. For example, we may wish to study the effect of stigma from contamination on selling price. To do so, an appraiser would identify a number of properties (in this case, industrials) that have experienced contamination and have sold. Presuming that such sales are excluded from the model, the model may be used to estimate values for each sale as if uncontaminated, on the date each sold. The difference between the actual price and the predicted price is a measure of effect. The same may be applied for any widespread influence one may wish to measure.

A last benefit of regression is its resistance to manipulation. Standard analysis through the sales comparison approach is subject to few proofs at the level of statistical rigor of regression analysis. For instance, sales pairings can be found to justify adjustments at widely varying rates. One appraiser may choose to make adjustments for certain attributes and another for others, and neither is "right," "wrong," or even more accurate in terms of the perception on the part of the reviewer because the analysis is largely conducted in the realm of opinion and judgment. The analyst is thus free, either consciously or subconsciously, to exercise judgments that can result in substantial changes in a value estimate and have a profound effect on the fortunes of a client. The regression system, on the other hand, puts far greater constraints on an appraiser and diminishes the ability to produce what a client might consider a "desired" outcome.

## DISADVANTAGES

In a practical sense, a disadvantage of a regression system is the initial time investment required to produce the first value estimate. The time required to adequately research the body of data on which the model is based, to create the model, and to create the map are well in excess of what is required for even the most thoroughly researched individual report. The disadvantage is acceptable only if an appraiser knows that the time invested can be spread over a volume of future work and can produce advantages that offset costs.

Analysis through the baseline method is less suited to court work than to investment advice. In the courtroom, a property that has sold is either comparable or not comparable to the subject. The tendency is often to find the majority not comparable and to deal with only a few. For better or worse, regression finds most sales comparable, in order to allow the production of conclusions that meet tests for statistical significance. An appraiser who enters the courtroom with a regression model based on a large volume of data that may include sales that the court may find not comparable runs the risk that the analysis itself may be rejected.

Perhaps the most significant drawback of analysis through a regression model like the baseline method is the impracticality of making the full valuation system available for review. The standard for appraisal reporting in current appraisal practice is the self contained report. To include all the data and regression that are part of the baseline model would result in voluminous reports. Moreover, it would make tens of thousands of dollars' worth of research available for the cost of a single report. It may be that analysis by regression methods is better suited to reporting through summary rather than self contained reports, with only the most significant portions of the model displayed. A more practical use of the baseline method in a self contained report may be as an adjunct to standard analysis.

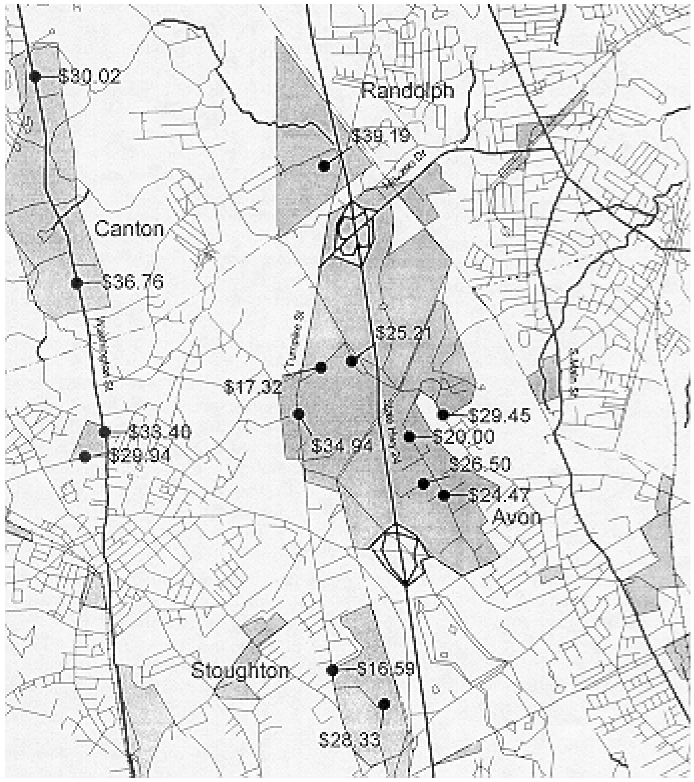
Of course, it may be that some would view certain attributes of regression that are presented here as advantages to be instead disadvantages. Advantage, like beauty, may be in the eye of the beholder. Whether it is advantageous to report a high degree of potential inaccuracy to a client accustomed to a belief in a high degree of accuracy in all value estimates or whether it is advantageous to remove the ability to shape the value estimate from the appraiser's control are matters for individual appraisers and their markets to sort through.

## CONCLUSION

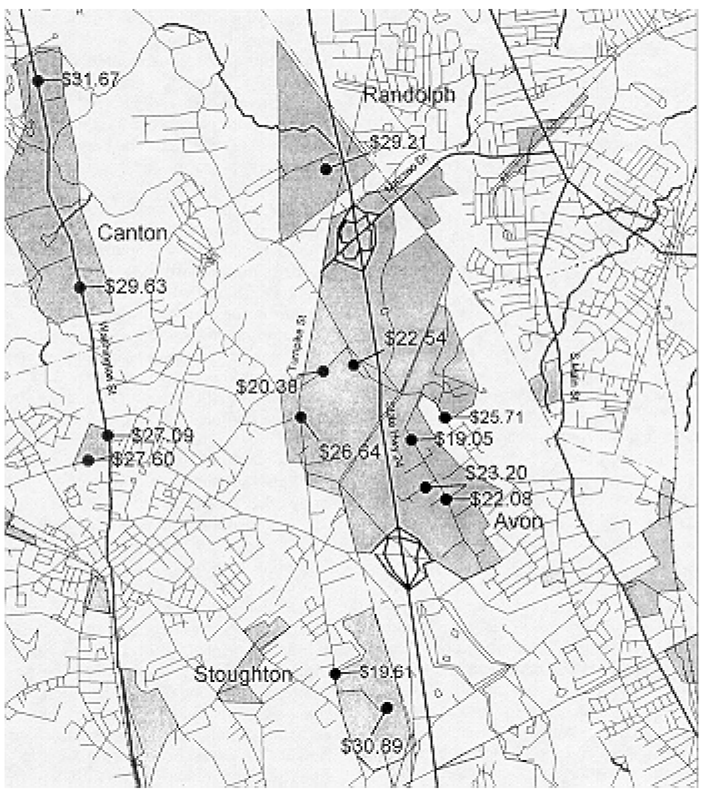
Regression analysis holds the promise to produce value estimates by wholly automatic means, without exercise of judgment on the part of the operator. The valuation model presented here differs, in that considerable expertise is required. Mathematical expertise is necessary. Skill and judgment are required in establishing the baseline model at the midpoints of the data range; in identifying major attributes of difference between sales, for application of adjustments; in determining whether a data point is an outlier best excluded from the population; in judging how most accurately to translate data points into a baseline value for a neighborhood; in determining how to conclude and report accuracy; and in judging how to reconcile the indication from the baseline method with the indications from other valuation techniques. Analysis through the baseline method is thus a further extension of the appraiser's tools rather than a wholly foreign technology.

One model is insufficient to describe a market as large as the market of industrial buildings. At the low end of the quality spectrum and in dense, older urban neighborhoods where value may change rapidly over the span of only a few streets, the model described here has proven less accurate than when it is applied to more homogeneous, modern properties along the region's beltways. To describe an industrial market fully may require the operation of several models-one for intermediate-sized buildings like those described here, one for large buildings, another for older buildings, and still another for multistories. Some buildings may be capable of analysis by application of more than one model: a 60,000-square-foot building, for instance, by means of both intermediate and large building models. In the event that these models produce disparate results, further evaluation of the strengths and weaknesses of each may be required.

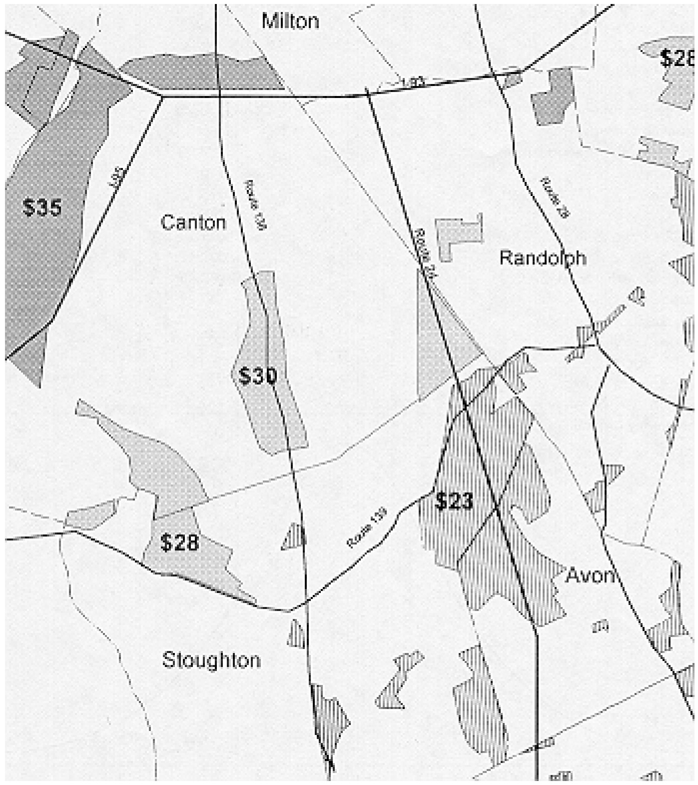
Baseline methodology is applicable to any large market in which properties are bought and sold for owner-occupancy and for which locational differences are a strong price determinant. Single-user industrial buildings are a ready example from the commercial field. Commercial land is likely to be another. Whether a similar technique that makes use of a large body of data-perhaps rental, expense, and sales in combination- may be useful in the valuation of other property types such as retail facilities, apartments, and offices that ordinarily are valued through the income capitalization approach can only be known once new techniques of these kinds are developed and applied.




*MAP: FIGURE 1 Sales of Industrial Buildings in Stoughton/Avon 5,000-80,000 square feet of building area 1992-1995 Displayed as price per square foot of building*




*MAP: FIGURE 2 Sales Adjusted to Produce Indications of Value of 20,000-Square-Foot Baseline Building in Stoughton/Avon*




*MAP: FIGURE 3 Baseline Map of Industrial Market in South Boston Value per square foot of building 20,000-square-foot baseline building January 1, 1994*

**FIGURE 4 Sample Baseline Analysis**

| | | |
|---|---|---|
| Subject Description | | |
| Location | | 25 Industrial Way, Stoughton |
| Land area | | 25,212 |
| Usable proportion | | 88% |
| Building area | | 65,000 |
| Age in years | | 1965 |
| Construction | | Block and steel |
| Clear height | | 15 feet |
| Office proportion | | 9% |
| Effective date (month/year) | | October 1995 |
| Baseline Analysis | | |
| Baseline rate per square foot | | $28.00 |
| Adjustments | | |
| Time | x | 1.098876 |
| Building size | x | 0.791410 |
| Building quality | x | 0.896057 |
| Floor area ratio (and ratio) | x | 1.003311 |
| Adjusted rate per square foot | | 21.891695 |
| Rounded | | $21.89 |
| Building square footage | x | 65,000 |
| Value | | $1,422,850 |
| Rounded | | $1,422,000 |
| Standard deviation | 14.09% | |
| 68% confidence interval | $200,480 (+/-) | |