Land Valuation Issues: Past, Present, and Future

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The following paragraphs contain excerpts from a keynote address that ORER Director Peter Colwell presented to the European Real Estate Society in Glasgow, Scotland on June 5, 2002.

The title of this Address is *Land Valuation Issues.* By land valuation, I mean the technology of estimating land value. To a great extent, the issue involves developing a modeling technology. Modeling technology includes deciding which variables to include, as well as determining how and whether to specify the nature of relationships. Of course, concerns such as those predate the construction of explicit models. Today much modeling remains casual, impressionistic, and intuitive. Modeling technology interacts with the development of theory: if we do not know what to look for and where to look, we are not likely to find anything interesting. Without theoretical constructs, we are likely to misinterpret what we do find. So it is impossible to create a fabric out of the disparate threads of research in land valuation without weaving in some notions from theory.

My remarks will surely contain some errors and omissions. Fortunately, there is a helpful precedent that I can cite. The Navajo Indian weavers from America's southwest rationalize their errors on the basis that each mistake lets evil spirits out. I plan to follow their lead.

Expert Views and Rules of Thumb

People who seek to understand land values today are likely to begin their quest just as their forebears did hundreds of years ago: by asking questions of those they see as experts. Who are the experts that we should be asking? Appraisers in the US, or surveyors in the UK, are among the likely candidates. Also, individual land owners tend to know a great deal about their own properties, though they tend to have statistically biased views of the values of land they possess. But usually, those who seek insights into land values ask professionals with broad market expertise; this approach was taken in Ireland by William Petty in the 17th century, and seemingly by George Olcott in his 20th century study of Chicago.

Petty, an English economist, went from county to county in Ireland assembling local experts to value all property. His was not the first such effort, but may have been the first credible attempt of its type. The principal purpose turned out to be to give Cromwell a way to compensate his soldiers with Irish land prior to bringing them home. (It is generally a good idea for political incumbents to pay soldiers prior to bringing them home from a foreign campaign.) Olcott's work has been extremely important in the history of urban economic thought, but his *Blue Book of Chicago Land Values* has been a Black Box. No outsider really knows how Olcott's *Blue Book* was created, or how closely it mirrors actual transaction data. His methodology may have been as simple as interpolating between sales in space. But it clearly embodies some valuation rules.

Valuation rules vary from the most simple, such as a constant assumed value per acre or hectare, to the rather sophisticated, such as various depth rules. A straightforward example of these more sophisticated devices is the 4-3-2-1 rule, whose use in its heyday a century ago reflected the fact that a given city tends to have lots of a standard depth. In New York City this frequently encountered lot depth is slightly greater than 100 feet. Under the 4-3-2-1 rule, the first quarter of a standard urban lot's depth is deemed to contain 40% of the value; the next quarter is deemed to contain 30%.

So, by this logic, the first half of a lot, as we walk back from the street, accounts for 70% of the total value. The third quarter accounts for 20%, and the last quarter accounts for the remaining 10%. Accountants will recognize this function as the one they use in the sum-of-the-years-digits method for computing depreciation. Mathematicians will recognize the 4-3-2-1 rule as a quadratic function, while they would be quick to see that more complex depth rules have been based on power functions or logarithmic functions. We should note that most depth rule designers have treated value as having a linear relationship to frontage, but a nonlinear relationship to depth. Specifically, they have viewed value as a variable that increases at a decreasing rate as depth increases.

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Depth rules were widely used in US assessment practice in the late 19th and early 20th centuries, but their use has diminished dramatically since. What may have been most interesting about these rules of thumb is not that they implied nonlinear value functions, but that they suggested a *type* of nonlinear pricing precisely the *opposite* of the nonlinear pricing envisioned by appraisers of the time, a concept known as *plottage*, to which I will return soon.

A timeless and universal lesson from the depth rule literature is that land value may depend more on a site's *dimensions* than on its *area*. This view has profound consequences for such issues as property taxation and "urban sprawl." Many issues related to sprawl (the idea that cities have become overly large, in some geographic sense) really relate to total street length: street and sewer repair, congestion, police patrols, emergency response times, and other concerns related to the need to deliver public or private services over greater road lengths. Local government could address many of these issues by levying a user charge on frontage. In the US, a tax on frontage is called a *special assessment*.

In the modern era, we still use some rules of thumb. Consider direct capitalization under the income approach to valuation, in which we assume that a relationship between income and value, once determined for a particular type of property, can be generalized to similar lots or improvements in the nearby area. One application of income capitalization is the *land residual* technique, in which we estimate land value based on income that would not relate to improvements. Specifically, from an improved property's net operating income the analyst subtracts the construction cost times the building capitalization rate; this difference can be interpreted as the residual income associated with the land. Dividing this residual income by the land "cap" rate yields an estimate of land value.

A number of notions underlie these valuation techniques; one is that a new building's value is the cost to build it. A fundamental issue is whether the land value and the building value sum to the value of the developed property. Option pricing theory would suggest that undeveloped land's value derives largely from the option to develop it. Once the development option is exercised, the land's value drops dramatically. So if total property value equals land value plus building value, can we infer that buildings – which tend to reduce the land's option value – are typically worth much more than they cost, to make up for "lost" land value?

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The Gradient Question

Statistical analysis may be the key to answering many land valuation questions. Economists have long tried to measure real estate values through an application of regression analysis called *hedonic regression*, in which total or per-unit value (proxied by sale price) is the dependent variable and property attributes are the independent variables. Regression was used to value real estate as early as 1922, while the term *hedonics* dates to the late 1930s, though the theoretical constructs we use today were introduced by Sherwin Rosen in 1974. From then on, hedonic regression was seen to be a reduced form analysis, whose parameters contain information on both supply and demand. Even before Rosen, an oral tradition among economists recognized this fact.

Edwin Mills, one of the fathers of urban economics, conducted a hedonic analysis of Chicago land using Homer Hoyt's early data on the city's land transactions and then switching to Olcott's data, to offer empirical support for the monocentric urban model. The use of Hoyt's data is ironic, in that Hoyt did not buy into the standard urban model as put forth by Ernest Burgess (who took von Thunen's model into the urban context and presaged the work of Mills, Richard Muth, and William Alonso). Mills's first task was measuring the *gradient* that describes the rate at which land value falls as distance from the city center increases.

The nonlinear pricing of urban land is a topic I have tried to shed light on in work with various co-authors. The idea that values vary in a nonlinear fashion with *something* has been with us for a long time; *plottage* – the idea that price should increase at an increasing rate with parcel size – was accepted by appraisers long before statistical models arrived on the scene. Working with Henry Munneke, I have found evidence that plottage exists in central city locations. But others have shown the opposite in most situations, terming as *plattage* the idea that prices rise at a *decreasing* rate with parcel size. Working again with Munneke, I have shown the relevance of this kind of nonlinearity for estimating gradients; the estimates are too large if nonlinear pricing is ignored. Yet gradients do not go away even with nonlinear pricing, though they become tiny. Hoyt would be proud.

The Role of Externalities

Work I conducted with Paul Asabere reveals the impact of relative lot areas. Under this theory, a tract of land has value that is a function of its own size *and* the sizes of other parcels in its neighborhood. The *relative lot area hypothesis* thus is an externality argument. Measuring externalities by detecting their capitalization into land values is an important cottage industry, which has identified several issues. First, we must determine the value surface's shape prior to the time when the externality comes into existence (or when some announcement or other event causes people to anticipate that the externality will arise). The reason is that negative externality producers may locate at low points in the value surface, to minimize political and other costs they might face. Thus, any measurement should reflect the "before" as well as the "after."

Apparently, many externalities do not travel far. A practical outcome is that most of us embrace NIMBY (not in my back yard), but only a few diehards embrace BANANA (build absolutely nothing anywhere near anything). A theoretical implication is the challenge created for measuring externalities' impact on land values. It is preposterous to create a gradient that *starts* at each externality source; any attempt to do so results in chaos in the overall implied value surface. Yet it is almost as wrong-headed to create gradients whose effects *end* at the edge of some zone; the result would be price discontinuities at zone edges.

A useful model should not permit discontinuities, because of *arbitrage* possibilities, unless the discontinuities result from topography or variations in regulation or taxation. Instead, the model builder's externality variables should apply over a small area. The approach could be as simple as including a *dummy* variable, perhaps measuring whether the parcel is within sight of the offending use or within some distance (*e.g.*, 100 feet) of it. A more sophisticated approach might be to create a distance variable that has a zero value beyond a ring surrounding the externality source, but gets bigger as the source is approached. This technique would maintain continuity of the land value surface, while showing that surface to have some pimples and pocks.

The idea that significant externalities do not travel far suggests that we should expect to see higher land values in higher use zones (in the jargon of zoning regulation) as long as the market is unaffected by zoning or other land use regulations. Here I mean that prices should be higher in the *interior* of a residential zone than in a commercial zone. Higher prices should prevail in the residential zone's interior than on the boundary with the commercial zone because negative externalities flow from commercial to residential areas. At the same time, if equilibrium prices were not the same at the boundary between zones, the boundary would shift through interuse arbitrage.

More Advanced Analytical Techniques

The point is that measuring zoning regulation's impact can be tricky. If a set of zoning variables produces no significant pricing effects, then zoning has some impact, eliminating externality-based pricing effects that would be found in an unregulated market of the type just described. But if, as usually occurs, the *lower* use has higher prices (commercial land selling for more per square foot than residential), then zoning regulation has *profound* effects; it goes too far. In modern land use regulation analysis, we recognize the endogenous nature of zoning. Ordinarily, the problem is called *selection bias*, and we use two or more stages to reveal zoning's effect on land values.

In addition, nonparametric statistical techniques have begun to gain ascendancy in the study of land values. Kernel approaches are the most popular of these. Observations are weighted based on some kind of function, such as tri-cube, or normal density. The analyst predicts values for a grid intersection or another key point in space, and then repeats the process for another point in space. This approach generates a value function that knocks off the peaks and valleys. Another nonparametric approach is piecewise parabolic multiple regression analysis, which could be viewed as a very simple spline technique. This approach generates a function showing continuous values, but it potentially reveals the highs and the lows. Problems arise with the edges of the data associated with kernel and piecewise parabolic approaches. It is best not to try to produce estimates at the very edge. Spatial autocorrelation also shows promise as a tool for explaining land values. The underlying idea is that land sales are not independent spatially.

A Navajo might suggest that spatial autocorrelation has gained some favor because there are holes in our parametric models. The spatial autocorrelation approach depends upon the notion that spatially closer sales are potentially related. And, in many cases, they are related. However, these tools totally miss the dependencies that are linear – those associated with proximity to a road, a canal, or a shoreline, for example, or those that repeat at spatial intervals, such as corner lots. So why not simply patch the holes in our modeling?

Some say we can not estimate land values from vacant land transactions, because land sales are rare in central cities. But it is actually the part of a city outside the commercial hub that will typically have few land transactions.

Getting Back to Basics

Another important valuation technology is repeat sales analysis – analytically, simply the ratio of two hedonic models (a second sale model and a first sale model). A lot of things cancel out if parameters and attributes do not change between the first and second sale. This situation creates both a problem and an opportunity. It is a problem if we use the repeat sales analysis as if there have been no such changes. But it is an opportunity in the sense of seeing the possibility for hybrid hedonic-repeat sales analysis. This kind of analysis has been done, by Brad Case and John Quigley. But there is room for future research to focus on changing parameters on location variables, combined with repeat sales analysis. So just as we can mix parametric and nonparametric models to get semi-parametric models, mixing repeat sales and hedonics yields a perfectly fine hybrid approach.

Many authors have imagined that we can learn the truth about land values by using data on developed property (land and buildings). Perhaps they are right in principle, but the practice has left much to be desired. First, when our data reflect improved properties we must include land and building attributes in a single equation. After all, building attributes are correlated with land value (economic persons substitute more capital for land when land is more dear). Identifying land value as the residual from an equation incorporating only building variables would be a serious mistake, because the building variables would proxy for the omitted land attributes.

Second, the form of the equation must allow for the separation of land from buildings. For example, a linear function will do nicely in this regard (but not in most other respects), but a log linear function (logs on both sides) will not be separable. A test for determining whether this requirement is satisfied is simply to substitute a zero for all the building attributes, and then see whether the magnitude that remains is sensible as a value of the land (for example, it should not be zero). No matter what creative things we might try in the context of using developed land sales, we will encounter serious problems by omitting critical land attributes from the equation.

Why, then, do we not simply estimate land values from data on transactions involving vacant land? Some authors argue that doing so is an impossible dream, because land transactions are almost nonexistent in central cities. But, in fact, the contrary is true. Major urban downtowns are home to numerous sites with almost zero capital; these sites include parking lots and teardowns. Transactions involving these sites are essentially land transactions. In fact, it is the part of a developed city *outside* the hub of commercial activity that will typically have few land transactions. Occam's Razor directs us to analyze problems by taking the simplest possible course. What simpler and better way could there be to understanding land markets than studying purchases and sales of land? ■