Nonlinear Effects in...

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...Easement Valuation

Abstract. **Rules of thumb have been developed to assist appraisers in dealing with the uncertainties that abound when easement values must be estimated. An economic analysis of one popular rule-of-thumb technique, based on a fixed percentage of the value of a hypothetical fee simple interest in the affected land, reveals that such methodology could not generally be expected to yield meaningful results. If a rule of thumb were to be employed, its use would be more supportable if the underlying assumptions reflected the nonlinear structure of land values.**

Introduction

In this issue, our article "Valuing Easements: A Simple Bargaining Framework," offers an economics-based framework for estimating easement values in some situations. Our work was motivated, in part, by concerns over fixed percentage rules of thumb sometimes used by appraisers who must estimate easement values. In the discussion that follows, we address a common rule-of-thumb technique for valuing easements, offering some arguments that might seem to support such a rule, but ultimately demonstrating why this type of rule could not yield consistently valid answers. While our goal is not to establish a different rule-of-thumb standard, or to promote the use of rule-of-thumb techniques, we do demonstrate that rules of thumb could be used more reliably if they reflected the idea, as generally observed, that the value of land does not vary linearly with parcel size.

Using Rules of Thumb to Value Easements

Because of the difficult nature of easement valuation, parties that must acquire or appraise easements have, over the years, developed rules of thumb for estimating the applicable values. These rules of thumb are often based on fixed percentages of hypothetical fee simple values for the affected land. For example, appraisers have used geometric formulas in computing such percentages for use in valuing aircraft avigation easements (Hall and Beaton, 1965). In a different context, a utility firm might offer to pay 10% to 15% of the estimated value of a fee simple interest in the affected acreage in order to gain a temporary easement (Pattison, 1986),[1] and those valuing scenic easements have traditionally found it useful to think in terms of percentages of underlying property values (Sutte, 1966; and Williams and Davis, 1968). The fixed percentage chosen for this type of rule can fall within a wide range;

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one study of easement appraisals showed value estimates for temporary or permanent easements ranging from 0% to 100% of the values that would prevail if the claims on the burdened parcels instead represented fee simple interests (Corey, 1989). Some courts have ruled that a permanent easement denies the underlying fee owner the use of the property and, therefore, should be compensated at 100% of the value of the affected land;[2] while others have ruled that an easement is treated by the law as less valuable than fee title, and therefore must be compensated to a lesser degree than could be a fee interest.[3] Generally, the law does view an easement as having lower value than a fee interest. In fact, if the language in documents of conveyance leaves ambiguity as to whether a fee or easement interest has been created, courts sometimes consider as evidence the amount of consideration that was paid.[4]

One rule of thumb that has sometimes been employed in condemnation situations is to value an easement at 25% of the value of a hypothetical fee simple interest in the quantity of land encompassing the easement, a rule that has been used at least since the early 1950s (Wall, 1952). For example, if a governmental unit desired an easement across a privately-owned parcel, and if the market price for purchasing the strip of land outright would be $4,000, then the estimated value of a mere easement over the strip would be .25 × $4,000 = $1,000. Could such a general rule, which suffers from the weakness of always treating larger easements as more valuable (despite the fact that someone needing access to a parcel would likely seek the shortest possible route),[5] and of treating all easements as equally burdensome, generate meaningful estimates of easement values? Exhibit 1 provides a structure for an initial analysis of this issue.

Exhibit 1
Linear and Nonlinear Land Value Functions
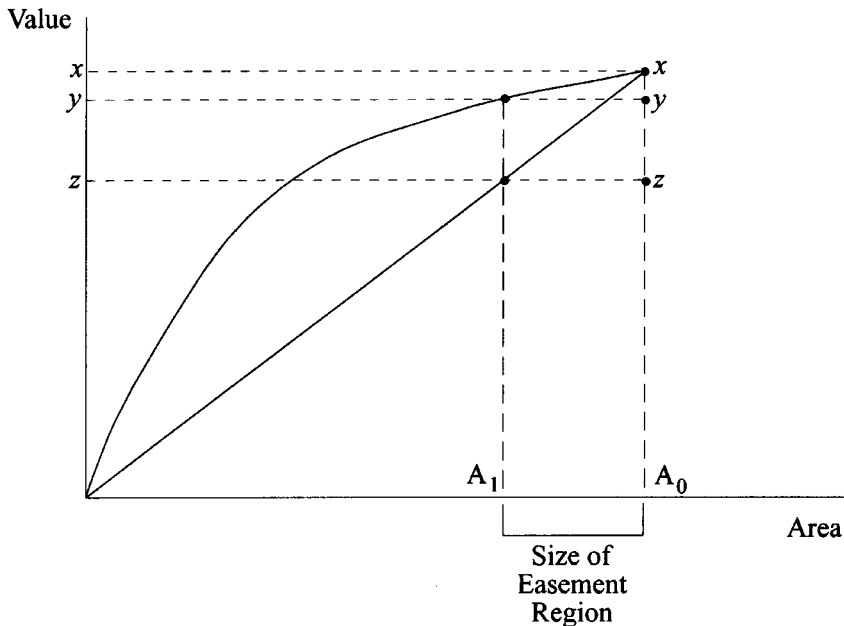
The exhibit is a representation of land values in a particular market. The curved line extending from the origin represents the *total* value, in that market, for parcels of varying potential sizes ranging up to A_0 acres. The line's curvature indicates that the change in land value with respect to parcel size is described by a nonlinear (more specifically, a *concave*) function; as the size of the parcel increases, value increases, but at a decreasing rate. Thus, a parcel twice as large as some benchmark parcel is not worth twice as much as the benchmark or, viewed another way, a parcel only half the size of the benchmark parcel is worth more than half as much as the benchmark.[6]

The work of Colwell and Sirmans (1978, 1980) and others provides justification for the assumption that the area/value relationship is nonlinear. A simple nonlinear value function can be expressed as:

$$V = cA^\beta,$$

an equation in which V is the value of the subject parcel of land, c represents the effect on value of factors unrelated to the size of the parcel, and A is the land area, which we might think of as some number of acres. The exponent *beta* (β) is the percentage change in price associated with a percentage change in parcel size (the area elasticity of price); its magnitude determines the curvature of the total land value function. A β of 0 would indicate no increase in value as parcel size increases, while a β of 1 would indicate direct proportionality in the area/value relationship. If an increase in parcel size is accompanied by a less-than-proportional increase in value, as shown in Exhibit 1, then β must be greater than 0 but less than 1. The appropriate choice of β is an empirical question, the answer to which would vary with locality and with land use.[7]

Why Fixed Percentage Rules of Thumb Might Seem To Work

Consider a case in which a government agency condemns an easement over a strip of land measuring $(A_0 - A_1)$ acres, situated on a servient estate A_0 acres in size. The area that remains unencumbered therefore is A_1 acres. In Exhibit 1, the value of a parcel of size A_0 is shown as height x, while the value of a parcel of size A_1 is shown as height y; in the market represented, the complete loss of $(A_0 - A_1)$ acres reduces the value of the owner's holding by the dollar amount represented as distance $(x - y)$. The amount $(x - y)$ therefore *should* be the estimate of the easement's value *if* the servient estate's owner deems the easement's creation to be tantamount to a full taking of rights over the $(A_0 - A_1)$ affected acres.

Yet anecdotal evidence, including the examples offered in appraisal texts, suggests that appraisers continue to base their land value estimates on *average* per-acre values, such that the area/value relationship is implicitly assumed to be linear.[8] In Exhibit 1, the slope of the solid straight line extending outward from the origin measures the average value per acre for a fee simple interest in a tract of size A_0. If land value *did* vary linearly with area, then a fee simple interest in a parcel of size $(A_0 - A_1)$ acres could be represented by height $(x - z)$, whereas if we can assume that the value function is actually nonlinear, a parcel of the specified size should have a value, as

noted earlier, represented by height $(x - y)$. If we were to compute the correct (nonlinear) fee simple value loss $(x - y)$ from the average (linear) function, we would therefore have to multiply the amount $(x - z)$ by some percentage s. The appropriate level of compensation thus would be $C = (x - y) = (s)(x - z)$ if the servient estate owner deemed the easement's burden to equate to a *full* loss in value for the affected land.[9]

To examine this result within the context of Exhibit 1, assume that A_0 is twenty acres and A_1 is sixteen acres, such that there is a four acre easement on a twenty acre servient estate. If recent comparables involving fee simple transactions indicate that a twenty acre parcel should be worth $x = \$50,000$ (\$2,500 per acre, on average), and the government therefore attributed to a sixteen acre parcel a value of $z = 16 \times \$2,500 = \$40,000$, then the appropriate compensation for the taking of a fee interest in the four lost acres might initially appear to be $4 \times \$2,500 = \$10,000$. Of course, if the land value function is nonlinear as shown, then the true value of a sixteen acre parcel is y (perhaps \$47,500, consistent with a β of .23 in our nonlinear value function) rather than z (\$40,000), and the appropriate compensation for taking a fee simple interest in the four acres should be $(x - y) = \$2,500$ rather than $(x - z) = \$10,000$. Recall that s is the percentage we must apply to a linearly-determined average value in order to derive a true nonlinearly-determined fee simple value. If the government applied a fixed 25% rule of thumb in valuing easements ($s = 25\%$), then its estimate of the appropriate compensation for taking only an easement over a four acre portion of the twenty acre servient estate would, in our example, be $.25 \times \$10,000 = \$2,500 = (x - y)$. The servient estate owner would actually be correctly compensated — through a circuitous and probably unintended route—*if* the easement's burden was viewed as tantamount to a 100% taking.

Why Fixed Percentage Rules of Thumb Do Not Work

The use of such a fixed percentage rule of thumb is, however, fraught with problems. One problem is that the value s, which is $(x - y)$'s percentage of $(x - z)$, must itself be an amount that varies with the magnitudes of A_0, A_1 and β (the curvature of the land value function), as a quick examination of Exhibit 1 should reveal. More specifically, we must solve for the appropriate s factor with the formula:

$$s = \frac{1 - (A_1/A_0)^\beta}{1 - (A_1/A_0)}.$$

The uniqueness of s for several possible A_1/A_0 and β combinations is shown in Exhibit 2.

Note that $A_1/A_0 = .8$ in our numerical example (with $A_0 = 20$ and $A_1 = 16$), so an s value of approximately 25% (shown more precisely in Exhibit 2 as .250) emerges, if the easement is seen as effectively taking the full bundle of rights on the affected land, *only* if β is .23 in our $V = cA^\beta$ function.[10] Yet a .23 β value is unrealistically low in comparison to the elasticities that studies of land markets would suggest, and

Exhibit 2
Calculation of *s*

A_1/A_0	Beta								
	0.23	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.9	0.239	0.311	0.413	0.513	0.613	0.711	0.808	0.905	1.000
0.8	0.250	0.324	0.427	0.528	0.627	0.723	0.817	0.910	1.000
0.7	0.263	0.338	0.443	0.545	0.642	0.737	0.828	0.915	1.000
0.6	0.277	0.355	0.462	0.564	0.660	0.752	0.839	0.921	1.000
0.5	0.295	0.376	0.484	0.586	0.681	0.769	0.851	0.928	1.000
0.4	0.317	0.401	0.511	0.613	0.705	0.789	0.866	0.936	1.000
0.3	0.346	0.433	0.546	0.646	0.735	0.814	0.883	0.945	1.000
0.2	0.387	0.479	0.593	0.691	0.774	0.845	0.905	0.956	1.000
0.1	0.457	0.554	0.669	0.760	0.832	0.889	0.935	0.971	1.000

even if it were credible, an s value of .25 would be inappropriate for any A_1/A_0 value other than .8. Note that if β were .5, the correct s percentage would range from 51.3% to 76.0% for the various A_1/A_0 magnitudes shown. From Exhibit 2, it should be evident that a fixed percentage rule of thumb measure could not be workable over the wide range of circumstances that can characterize land values relative to parcel sizes.

Another serious problem follows from the partial nature of the easement interest. Because the servient estate's owner will be prevented from fully using the affected portion of land, an easement will be viewed, whether acquired through eminent domain or in an arm's length negotiation, as imposing a burden. However, if (as would be likely in most cases) the owner perceived only a *portion* of the affected land's value to have been lost through the easement's creation (rather than being equivalent to a full taking), then the perceived percentage loss would be less than 100%, and the true loss in value would be less than $(x - y)$ in our example. We can represent the perceived burden as k, a percentage of the value of a hypothetical fee simple interest in an $(A_0 - A_1)$ acre parcel, such that the appropriate level of compensation for the taking of a partial interest—in this case, an easement—should be $C = k(x - y) = (k)(s)(x - z)$. If the landowner perceived the creation of an easement to be tantamount to a full taking of the land involved, then k would be 1 and C would equal $(x - y)$, but with $k < 1$, as we would generally expect, the appropriate compensation C would be less than $(x - y)$.[11]

Thus, for a fixed percentage rule of thumb (as applied to average value) to provide a useful estimate of the damage the easement causes to the owner of the servient estate, the percentage factor would have to be ks, a magnitude less than the percentage of value lost (*i.e.*, $ks < k$, such that $s < 1$).[12] In other words, the percentage used in a rule of thumb applied to linearly-determined values must reflect not only the nonlinearity of the true land value function (s), but also the fraction of fee simple value deemed to be lost (k) by the imposition of an easement. The idea that a fixed

rule-of-thumb percentage, such as 25%, could correctly and consistently incorporate the wide range of possible s and k values is implausible.[13]

Assume, for example, that the goal of the rule of thumb were to provide compensation equaling only 25% of the true fee simple value of the affected acreage. The appropriate compensation therefore would be $(k)(x - y) = (k)(s)(x - z) = (.25 \times .25) \times \$10,000 = \$625$, whereas the application of a 25% rule of thumb to the linearly-determined loss in fee simple value would indicate .25 x \$10,000 = \$2,500. Using the rule of thumb thus would overcompensate, paying the owner *four times* the perceived burden on the affected land. In fact, simply applying a fixed percentage to a linearly-measured fee simple value will always overcompensate[14] the value loss, if the true value function is concave.[15] In our example, involving $A_1/A_0 = .8$ and $\beta = .23$, $(k)(s) = (.25)(.25) = 6.25\%$, a figure substantially lower than the 25% frequently used.

Exhibit 3 illustrates the percentage of the hypothetical fee simple value that the land owner would be compensated under specific percentage rules of thumb. To compute each of these percentage-compensated levels, we multiply the fixed rule-of-thumb percentage by the reciprocal of the s factor. Because the rule of thumb percentage equals ks, our computation yields the "k" fraction implicitly being compensated when a fixed percentage rule of thumb is applied to linearly-determined values. The resulting amounts are shown for various fixed percentage rules and relative easement sizes, and for β values of 0.23, the value that caused the 25% rule of thumb initially to seem plausible, and 0.50, a more realistic value based on formal evidence and informal observations [Colwell and Munneke (1997) found a β value of approximately .50 for vacant land of various types, based on data from the Chicago area].

In our example, with $A_1/A_0 = .8$ and $\beta = .23$, a combined percentage factor (ks) of 25%, applied to a linear value measure, would lead ultimately to a level of compensation equivalent to an implicit $k = 100\%$, not the intended 25% of the fee simple value of the affected land. Exhibit 3 confirms this outcome (a 1.00 value appears in Column 2 of Row 2, Panel A). And this result, like others we have described, holds only if β is .23, a magnitude that would be considered too low under many circumstances.

If we were to compute a similar value based on a more realistic β of .50, the compensation generated by applying a 25% rule to the linear measure of value loss would be an implicit $k = 47\%$, not the intended 25% of the true fee simple loss (note the .47 value in Column 2 of Row 2 in Panel B of Exhibit 3), a less severe overcompensation but still clearly in excess of the 25% target. Furthermore, if β were to be only .23, then a rule of thumb based on a fixed ks percentage even as low as 25% would lead to compensation of more than 100% of the affected land's hypothetical fee simple value for higher A_1/A_0 magnitudes (*i.e.*, with the easement covering only a small proportion of the servient estate, as we would typically expect). In fact, under the conditions described, any fixed percentage rule would compensate more than the indicated loss in value (even the smallest number in each column is

Exhibit 3
Implied *k* Percentage of True Fee Simple Value Compensated by a Fixed Percentage Rule of Thumb

A_1/A_0	% Rule of Thumb										
	0.20	0.25	0.30	0.40	0.50	0.60	0.70	0.75	0.80	0.90	1.00
Panel A: $\beta = 0.23$											
0.9	0.84	1.04	1.25	1.67	2.09	2.51	2.92	3.13	3.34	3.76	4.18
0.8	0.80	1.00	1.20	1.60	2.00	2.40	2.80	3.00	3.20	3.60	4.00
0.7	0.76	0.95	1.14	1.52	1.90	2.29	2.67	2.86	3.05	3.43	3.81
0.6	0.72	0.90	1.08	1.44	1.80	2.17	2.53	2.71	2.89	3.25	3.61
0.5	0.68	0.85	1.02	1.36	1.70	2.04	2.38	2.54	2.71	3.05	3.39
0.4	0.63	0.79	0.95	1.26	1.58	1.89	2.21	2.37	2.53	2.84	3.16
0.3	0.58	0.72	0.87	1.16	1.45	1.74	2.03	2.17	2.32	2.60	2.89
0.2	0.52	0.65	0.78	1.03	1.29	1.55	1.81	1.94	2.07	2.33	2.59
0.1	0.44	0.55	0.66	0.88	1.09	1.31	1.53	1.64	1.75	1.97	2.19
Panel B: $\beta = 0.50$											
0.9	0.39	0.49	0.58	0.78	0.97	1.17	1.36	1.46	1.56	1.75	1.95
0.8	0.38	0.47	0.57	0.76	0.95	1.14	1.33	1.42	1.52	1.70	1.89
0.7	0.37	0.46	0.55	0.73	0.92	1.10	1.29	1.38	1.47	1.65	1.84
0.6	0.35	0.44	0.53	0.71	0.89	1.06	1.24	1.33	1.42	1.60	1.77
0.5	0.34	0.43	0.51	0.68	0.85	1.02	1.19	1.28	1.37	1.54	1.71
0.4	0.33	0.41	0.49	0.65	0.82	0.98	1.14	1.22	1.31	1.47	1.63
0.3	0.31	0.39	0.46	0.62	0.77	0.93	1.08	1.16	1.24	1.39	1.55
0.2	0.29	0.36	0.43	0.58	0.72	0.87	1.01	1.09	1.16	1.30	1.45
0.1	0.26	0.33	0.39	0.53	0.66	0.79	0.92	0.99	1.05	1.18	1.32

greater than the percentage that constitutes the column's heading), for any β value less than 1.00.

A More Workable Rule of Thumb

The idea of fixed percentage rules of thumb thus is flawed, not only because such rules have typically been applied to linearly measured land values, but also because the magnitude of *k* surely would differ from case to case. The ideas presented in Exhibits 2 and 3 do point, however, to a more defensible framework for developing rules of thumb. A relationship that takes into account the potential for a nonlinear value function, and is applied to the servient estate's total fee simple value, can be written as:

$$C = k \left[1 - \left(\frac{A_1}{A_0} \right)^{\beta} \right] x.$$

Under this method, if the easement were deemed to impose a 25% loss on the owner, we would find the proper \$625 compensation for our example by multiplying the larger tract's full fee simple value of \$50,000 by .0125, computed as $0.25 \times [1 - (16/20)^{.23}]$. The bracketed factor reflects the correct percentage change in value for the complete loss of $(A_0 - A_1)$ acres, and applying the appropriate k factor provides the correct compensation for the partial loss imposed by an easement or other partial interest.

This technique differs from the use of fixed percentage rules; note that instead of simply applying a standard percentage to an average value based on an estimate of x, the appraiser must estimate the values of β and k, along with x, although if $\beta = 1$ our rule becomes a fixed percentage rule. (The fixed percentage rule therefore is a special case of our more general rule.) While finding supportable β and k percentages might seem to be very difficult exercises in themselves, a rule that incorporates these magnitudes would provide a more supportable measure of the loss in value that an easement would impose. This requirement does not actually place new duties on the appraiser. After all, k should be estimated in any easement appraisal that is based on underlying fee values; and the recognition of nonlinearities, along with the correct β measurement of the degree to which value changes with parcel size (perhaps through the examination of varying sized comparables) should be an important step in the value estimate for any fee or partial interest. Allowing k to assume a value of 1 renders this C computation a useful structure for estimating the appropriate compensation in full fee simple sales or takings, as well as in easement or other partial interest valuation cases.

Conclusion

The argument that a widely-used rule of thumb might be empirically, if not theoretically, valid is consistent with the economic argument that common law leads to efficient outcomes because the court rulings that are further litigated are those that have provided inefficient distributions (Cooter and Ulen, 1997). If a fixed percentage rule of thumb has, in some situations, become a standard because both grantors and grantees tend to accept the resulting distributions, then supporters of such a technique might argue that there is some underlying method in what seems, in some ways, to be only madness. A more plausible argument, however, might be that fixed percentage rules have gained acceptance, especially in condemnation situations, because their use (if applied to average per-unit values) compensates more than the purported percentage when marginal land values are decreasing. After all, an "overpaid" recipient would be loath to complain, and the taxpayer-financed easement purchaser might lack the incentive to battle for the lower compensation that theory would suggest, especially in light of the higher attendant legal and administrative costs.

Fixed percentage rules of thumb, as applied to linearly-determined land values, ignore the demand side of the market, and the relationships that underlie any existing relevance are subject to change. Therefore, values derived through the use of quick formulas such as the 25% rule might best be avoided, in favor of the results obtained through more thorough analyses. Any rule of thumb clearly should be utilized only

if it can be shown empirically to have validity. A more defensible rule would have to reflect the nonlinearities that typically characterize land values. The framework that we have suggested would be useful in valuing the loss of part or all of the bundle of rights accompanying a particular quantity of land, although estimating the β factor that describes the nonlinear value function, and even the degree of burden k, could, in many cases, be difficult.

Notes

[1] Examples of rules of thumb ranging from 10% to 25% of the fee value, based on such considerations as the placement of the easement on the burdened parcel, are offered by Green (1992).

[2] *Chicago Mill and Lumber Company vs. Board of Directors*, 236 Ark. 322, 366 S.W. 2d. 184, cited in Eaton (1995).

[3] *Mitchell vs. Texas Electric Service Company*, 299 S.W. 2d. 183 (Tex.), cited in Eaton (1995).

[4] See Bruce and Ely (1988:1/141).

[5] On the demand side of the analysis, we would expect a party who needs to gain access to a parcel to seek an easement involving the smallest lineal distance or land area. A smaller easement area minimizes the initial cost of paving or otherwise improving the affected land, and also minimizes the ongoing cost of traveling across the servient estate and maintaining (plowing, repairing) the easement.

[6] We therefore treat marginal prices, in this situation, as falling. Actually, marginal prices might be expected to fall in some instances and to rise in others. Rising marginal prices would reflect a condition long known as *plottage*, an outcome often observed in central business district locations, where a developer must assemble numerous existing tracts to create a parcel of sufficient size to meet the demands of buildings constructed in the modern era. Our example of declining marginal values reflects the phenomenon now known as *plattage* [a term apparently coined by Colwell and Sirmans (1980)], in which falling marginal values lead developers to subdivide land. This latter effect is often observed where an established community borders on the surrounding agricultural area.

[7] A β value between 0 and 1 would reflect plattage in the market, while a β value exceeding unity would reflect plottage in the market.

[8] Appraisers certainly understand the nonlinearity idea, but do not seem to apply the idea much in practice. Even appraisal texts, which discuss the underlying theoretical issues, generally offer numerical examples that reflect linear assumptions.

[9] The owner's perception of a condemned easement as equivalent to a full taking is consistent with Fischel's (1985) observation that the involuntary nature of eminent domain can impose disutility on the affected landowner beyond the market value of the rights lost.

[10] If $V = cA^\beta$, then values of \$50,000 for 20 acres and \$47,500 for 16 acres are consistent with a β of $(\ln 50{,}000 - \ln 47{,}500)/(\ln 20 - \ln 16) = (10.81977828 - 10.76848499)/(2.995732274 - 2.772588722) = .23$. Stated differently, note that the 16 acre parcel's \$47,500 value is 95% of the 20 acre parcel's \$50,000 value, and that $16^\beta/20^\beta = .95$ only if $\beta = .23$.

[11] If k reflected a market-determined degree of disutility, then we could call C the "just compensation" level in an eminent domain situation. Because in a broader valuation context (including arm's length negotiations) k could include a particular landowner's idiosyncratic or other personal sense of loss ("investment value"), we identify C more generically as an "appropriate" compensation level.

[12] Recall that the example involves a market characterized by decreasing marginal values. In a case involving increasing marginal values, s would exceed unity.

[13] The value of k would vary with the views of a particular owner and with the circumstances. Even if an appraiser ignored individual effects by estimating the burden that a ''typical'' landowner might perceive under the specific circumstances, the wide range of possible circumstances would serve to render fixed percentage rules of thumb unworkable.

[14] The result would ''overcompensate'' relative to what the rule of thumb purports. Yet even this amount might not be overcompensation in the eyes of the servient estate's owner, whose investment value for the affected land might greatly exceed any market value measure.

[15] It would, similarly, underestimate the loss if the land value function were *convex*, with increasing marginal values.

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