



Rent, Interest, Property Taxes, and Land Prices

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RENT, INTEREST, PROPERTY TAXES, AND LAND PRICES

Mason Gaffney

The following tables show how ground rent and land price are affected by the interest rate (i), and the property tax rate (t), using simple assumptions. The specific assumptions are realistic for many times and places, but of course not all. The numbers assumed are simply to give the reader a feel for the ballpark. Generic equations and derivations are given in which readers can use any other numbers they desire.

Ground rent is an annual concept. Where there is no fixed capital to install up front, ground rent is simply operating cash flow. Sometimes annual rents are easily identified, as with parking lots, or yearly rents for grazing, or growing field crops. Normally, however, there is a heavy initial outlay for building, followed by a long cycle of capital recovery. Our model is designed to convert this irregular pattern into the equivalent annual ground rent: to "annualize" it. Thus we can deal with the relationship of interest and taxes to ground rent.

We assume a commercial site where there is an initial capital input (K_0), to be replaced after n years. We levelize or "annualize" K_0 by multiplying it times the Amortization Factor (AF), defined below. That is, we convert it into the equivalent level annual payment of n years. "Equivalent" means the present value of the stream of payments is K_0 .

This factor (AF) is always greater than the interest rate, i . For low values of i and n , $AF \gg i$, and approaches the value $1/n$, that is, a simple yearly mean. For high values of i and n , $AF \rightarrow i$. We label this annual payment ($K_0 \times AF$), as "Debt Service" (DS), assuming for simplicity that the K_0 is 100% financed, all interest is explicit, and the debt is fully amortized in level payments over n years.

To find Ground Rent (GR), we simply subtract DS from Cash Flow (CF). Cash Flow here means operating cash flow, i.e. no interest is subtracted to get Cash Flow. Cash Flow means gross current revenues less current expenses (other than interest).¹ For simplicity, we also assume CF is level over n years.

¹Much of current expense is labor, and much is materials. The proportions chosen will vary with relative costs. This matter is glossed over here. In a more complete model we should consider the composition of expenses. In addition we should consider the ratio of expenses to gross revenues: the more K_0 is used, the less expenses are needed later to yield a given gross revenue.

Several tables are presented. The independent variable is $\underline{i}$, which rises from .04 to .12 reading from left to right.

Table 1 shows ground rent, GR. The following parameter values are chosen:

$$K_0 = 100$$

$$CF = 12$$

$$n = 25 \text{ years}$$

$I = 1+i$ ($\underline{I}$ is an arbitrary expression chosen to simplify writing and reading equations.)

$$AF = i/[1-I^{-n}]$$

$$GR = CF - K_0 \times AF$$

E (for Epsilon) = "elasticity," that is the % drop in GR divided by the % rise of $\underline{i}$ that causes it. This is for finer work than most readers are interested in initially.² Values are given for -E. E is negative here because a drop in $\underline{i}$ causes a rise in the dependent values.

TABLE 1: Ground Rent and the Interest Rate

$\underline{i} =$	.04	.05	.06	.07	.08	.09	.10	.11	.12
DS (100xAF)	6.40	7.10	7.82	8.58	9.37	10.18	11.02	11.87	12.75
GR	5.60	4.90	4.18	3.42	2.63	1.82	.98	.13	-.75
% drop	-. -	12.5	14.7	18.2	23.1	30.8	46.2	86.7	676.9
-E	-. -	.500	.735	1.27	1.62	2.46	4.16	8.67	74.5

Note that GR is highly sensitive to $\underline{i}$, especially at higher $\underline{i}$. This is due to leverage: CF is fixed at 12.00, so as $\underline{i}$ rises, and AF rises, and makes DS approach CF, a small % rise of AF causes a large % drop in GR: so much so, in fact, that GR finally falls below zero.

²Its technical value is to compensate for the fact that the % changes in $\underline{i}$ are not constant from step to step. Thus, E values are properly comparable from step to step, whereas % drop values are not quite so. The step from .04 to .05 is a 25% jump in $\underline{i}$; from .10 to .11 is a 10% jump.

Table 1 is here to bring out this leverage effect starkly. In doing so, however, it exaggerates the effect of i on GR, by holding K_0 constant. Actually, landowners can and will avoid the worst effects of higher i by lowering K_0 , even at the cost of lowering CF, thus avoiding negative GR. In Tables 4 and ff. we make this adjustment. First, however, we use the GR of Table 1 to show the further effects of i on Level Land Price (Table 2), and Speculative Land Price (Table 3).

Tables 2 and 3 show that land prices are even more sensitive to i than GR is.

TABLE 2: Level Land Price (LLP) and the Interest Rate

Level Land Price = GR/i									
$i =$	.04	.05	.06	.07	.08	.09	.10	.11	.12
LLP =	140.0	98.0	69.7	48.9	32.9	20.2	9.8	1.2	-6.3
% drop		30.0	28.9	29.8	32.7	38.5	51.5	87.8	625.
-E		1.20	1.45	1.79	2.29	3.08	4.64	8.78	68.75

Note what happens to LLP as i rises from .04 to .05. The % drop of LLP (30.0%) is nearly 2.5 times higher than the % drop in GR (12.5%, from Table 1). That is because the drop of GR is fortified by the rise of the divisor, i .³

Table 3, below, shows that land price is even more sensitive to changes in i when the market expects rents to be rising. Table 3 shows the effect of i on Speculative Land Price (SLP). Here, land price is derived from two elements, A and B. A is the present value of GR in its current use, Generation #1 (G_1); B is the present value of higher future uses, $G_2, G_3, \dots$, etc. in perpetuity.

A and B could be joined by summing. Appendix 2 shows how to do so, and has some heuristic value, although with some loss of generality. (Table 5 shows how to do so without loss of generality, but only by restating the method developed here.) It is basically simpler, more elegant, more widely adaptable, and more generally valid, however, to use a multiplier, the method used here.

³At higher values of i this effect is obscured, in Tables 1 and 2, because of the exaggerated drop in GR. However, in Table 4 the effect is clear at all values of i , because in Table 4 we have removed the exaggerated drop in GR.

Each future Generation has a present value, as of its own starting year, higher than its preceding Generation by a factor $(1+g)^n$.

In Table 3:

$$SLP = \text{Speculative Land Price} = G_1 \times LVM$$

G_1 = Present Value of Generation #1, lasting n years

$$G_1 = GR \times PVF$$

PVF = the Present Value Factor, $[1-I^n]/i$
 PVF is the reciprocal of the AF.

g = annual growth factor. This is the annual growth rate corresponding to the step-growth of land price that actually occurs. That is, every n years a new generation of capital is invested on the site, such that: $G_1 \times (1+g)^n = G_2$,
 $G_2 \times (1+g)^n = G_3$, etc. ad inf.

LVM = the Land Value Multiplier:

$$LVM = \frac{1}{1 - \frac{(1+g)^n}{I^n}}$$

LVM is found by summing the infinite geometric progression whose first term is 1, and whose rate of progression is $[(1+g)/I]^n$.⁴

$$g = .03.$$

⁴See handwritten Appendix 1, "Deriving the Land Value Multiplier."

TABLE 3: Speculative Land Price (SLP) and the Interest Rate

i=	.04	.05	.06	.07	.08	.09	.10	.11	.12
GR=	5.60	4.90	4.18	3.42	2.63	1.82	.98	.13	-.75
PVF=	15.6	14.1	12.8	11.7	10.7	9.8	9.1	8.4	7.8
G ₁ =	87.4	69.1	53.5	40.0	28.1	17.8	8.9	1.1	-5.9
LVM ⁵ =	4.66	2.62	1.95	1.63	1.44	1.32	1.24	1.18	1.14
SLP=	407.3	194.9	104.3	65.2	40.5	23.5	11.1	1.29	-6.67
% drop	-.-	52.1	46.5	37.5	37.9	42.0	52.8	88.4	617.1
-E	-.-	2.08	2.33	2.25	2.65	3.36	4.75	8.84	67.9

Comparing Table 3 with Tables 1 and 2, we see that the element of rising future rents raises the sensitivity of land price to $\underline{i}$, and does so by a great factor. When $\underline{i} \rightarrow \underline{g}$ (as when $\underline{i} = .04$), SLP rises to very high values. When $\underline{i}$ rises from .04 to .05, SLP falls by 52.1%.

The corollary is, of course, that a rise of $\underline{i}$ will deflate land prices extremely. In practise, moving from the strictly mathematical to the social-psychological, such deflation often dashes cold water on expectations of future rents. It does so by forcing attention to the surplus of land seeking buyers. Thus, it lowers the value of $\underline{g}$ in the LVM. The double effect is doubly deflationary. $\underline{g}$ is based entirely on subjective conjectures about the distant future: this helps account for extreme ups and downs (amplitudes) of swings in land prices over cycles.⁶

We now need an adjustment of GR, as promised earlier. The figures on the right side of Tables 1-3, at $\underline{i} > .08$, are dominated by the steep slide of ground rents (GR) toward zero and below. This slide, as noted earlier, is an artifact of an unrealistic simplifying assumption that K_0 remains fixed, even as $\underline{i}$ rises to high levels. It is time to relax that assumption and let our

⁵ $\underline{g} = .03$

⁶ $\underline{i}$ is also partly a forecast, because it is future interest rates that it refers to. Long-term funds may be contracted for in the present at known rates: such long-term financing is a primary influence on $\underline{i}$. However, future resale prices for land, and future GR, all will depend on future rates at which long-term funds may be contracted.

hypothetical land managers act more like real ones, and react to higher $\underline{i}$ by using less K_0 .

In Table 4 we correct for this. With each step of $\underline{i}$ upwards, we drop K_0 by 12%. Of course, this also lowers cash flow (CF), which we drop by 8%. This tempers the drop in ground rent (GR).⁷

⁷The difference in the percentage drops reflects diminishing returns to capital. The question may be raised, if you can cut costs by 12% and cut CF by only 8%, why not have done it anyway? And why not continue doing it back to $K_0=0$? The answer is that K_0 is not the only input; land is also an input. Lowering K_0 means underusing land. The bottom line is the ground rent (GR).

If the numbers were mis-selected, it might be possible, at any fixed $\underline{i}$, to gain by using less K_0 . However, I do not believe this is possible at any point in the Table.

Table 4: Repeat of Tables 1-3 with Adjusted Ground Rent

i=	.04	.05	.06	.07	.08	.09	.10	.11	.12
AF=	.0640	.0710	.0782	.0858	.0937	.102	.110	.119	.127
K ₀ =	100.0	88.0	77.4	68.1	60.0	52.8	46.4	40.9	36.0
DS=	6.40	6.25	6.05	5.84	5.62	5.38	5.11	4.85	4.59
CF=	12.0	11.0	10.2	9.34	8.60	7.91	7.28	6.69	6.16
GR=	5.60	4.79	4.11	3.50	2.98	2.53	2.17	1.84	1.57
% drop=	-.-	14.5	14.2	14.8	14.9	15.1	14.2	15.2	14.7
LLP=	140.0	95.8	68.5	50.0	37.2	28.1	21.7	16.7	13.1
% drop	-.-	31.6	28.5	27.0	25.6	24.5	22.8	23.0	21.6
PVF=	15.6	14.1	12.8	11.7	10.7	9.8	9.1	8.4	7.8
G ₁ =	87.4	67.5	52.6	40.3	31.9	24.8	19.7	15.5	12.2
LVM ⁸ =	4.66	2.62	1.95	1.63	1.44	1.32	1.24	1.18	1.14
SLP=	407.3	176.9	102.6	65.7	45.9	32.7	24.4	18.3	14.0
% drop=	-.-	57.6	42.0	36.0	30.1	28.8	25.4	25.0	23.5

In Table 4, GR drops about 14.5% with each step-up of i. LLP is found by simply dividing GR by i. This lets us see the pure effects of capitalizing. LLP drops at more than twice the rate of GR, adding the effect of raising the cap rate to the effect of lowering GR.

SLP drops most of all, especially between $i=.04$ and $i=.05$, where it drops 57.6%. This high sensitivity obtains because more of the present value is derived from distant future rents.

The point is that the present value of speculative land is subject to extreme deflation with a rise of i. One practical consequence of that is that banks should not lend on speculative real estate. Recent history has made the point resoundingly. So has earlier history, for those who read it. Practical regulators have recognized the problem at least since the English Bubble Act of 1720.

⁸ $g=.03$.

At the same time, less practical regulators have regularly wished the matter away, and circumvented The Bubble Act and its counterparts. This usually has happened after a few years of rising values and buoyant markets. The present theory may have some value in warning persons of an ahistorical mindset of the perils of lending on speculative real estate.

The tables have several other uses. Another point is that the ability to buy and hold land is closed to all but those who have access to funds at low $\underline{i}$.

Table 4 may also be used to show the separate effects of ad valorem property taxes on buildings and on land. The tax on buildings has the same effect on GR as raising $\underline{i}$. That is, a tax rate ($\underline{t}$) of .02 plus $\underline{i}$ of .05 is the same as $\underline{i}$ of .07. In Table 4 that lowers GR from 4.79 to 3.50, a drop of 26.9%.

A land tax, on the other hand, has no effect on GR. It neither raises DS on building capital (K_0), nor induces any reduction of K_0 . It affects only the cap rate divided into GR to find LLP, and used with GR and $\underline{g}$ to find SLP. The figures in Table 4 cannot be used directly, because they are based on changes in GR as well as in the cap rate. However, it is simple enough to let GR remain constant. Then, for LLP, just do this. A land tax rate ($\underline{t}$) of .02 added to $\underline{i}$ of .05 raises the cap rate by 2/5, or 40%, and lowers LLP by 40%, GR remaining constant.

For SLP the calculation is a little trickier. The work is done, however, and presented in Table 5. We must find the combined effects of a lower PVF and a lower LVM, holding GR constant. The result gives a notion of how land taxation takes the inflation out of Speculative Land Prices.

It is useful to divide land prices into two elements, A and B. Element A derives from the current use, or "possessory interest." Its value is that shown as G_1 in Tables 3 and 4. G_1 is much less sensitive to $\underline{i}$ and to $\underline{t}$ than are LLP and SLP, - especially SLP - although it is a part of each of them. It is the other part, Element B, that is highly sensitive to $\underline{i}$ and $\underline{t}$.⁹

Element B derives from future generations of use. Call it the "holding value" of land. Its contribution to SLP is shown by

⁹Of course it is also sensitive to $\underline{g}$, which we are holding constant throughout. The effect of raising $\underline{g}$ is easy to take from the Table, however: it is the same as the effect of dropping $\underline{i}$ or $\underline{t}$ by the same amount. In interpreting $\underline{g}$, remember that mathematics masks the highly subjective and speculative nature of $\underline{g}$. $\underline{g}$ is a precise expression of an imprecise, excitable psychological condition, a perception of the future that sometimes seems driven by hallucination.

LVM. Subtract 1 from LVM, and multiply times 100 to get the % added to G_1 to get SLP. For $i=.05$, that is 162%; for $i=.07$, that is 63%. Thus, in that example a land tax of .02 deflates Element B by 61%.

Our last table, Table 5, shows the effect of raising the land tax rate, t . The tax rate on buildings is constant at zero¹⁰. i is also constant, at $i=.04$. This keeps GR constant. g is also constant, at $g=.03$. In Table 5, t is the independent variable, but it applies only to Land Price. GR being constant, raising t has the same effects (on all rows below GR) as raising i - you simply add i and t together, and proceed as before.

Element A, i.e. the present value of Generation #1 (G_1), falls moderately when we raise t , even though GR remains constant. That is because future rents are discounted by the sum of i and t . Element B, i.e. the present value of all Generations >1 , falls hugely when we raise t . Land taxes fall only lightly on Element A, the possessory interest in land price; they fall heavily on Element B, the holding value of land, which some call the "speculative" interest, and others call the "store of value" motive for holding land.¹¹

Table 5 has the advantage, for some readers, of dispensing with the LVM. Most of us get rusty on our math, and find a coefficient like LVM to be alien and hard to embrace. Actually it is just a shorthand way of adding Element B to Element A. Table 5, however, explicitly uses addition to perform the same operation. It keeps the two Elements isolated, each with its own row of figures.

Table 5 has the following parameters:

$$i = .04$$

$$GR = 10$$

$$G_1 = A = GR \times PVF$$

$$n = 25$$

¹⁰It could also be constant at some rate above zero. Constancy is the point here. We choose zero for simplicity.

¹¹The effect of high land taxes is somewhat like having a land system that limits tenures to possessory interests for fixed terms. Such systems have a long history, going back at least to the Mosaic Law of The Jubilee, limiting terms to 49 years. Cf. also George's comments on placer mining tenures in the California gold rush (Progress and Poverty, pp. 386-87). Cf. also the "Land to the Tiller" concept in some 3d World land reform programs.

$$g = .03$$

B/A = ratio of Element B to Element A. It is found by subtracting 1 from LVM. It may also be calculated separately as the reciprocal of $[(1+g)^n/(1+i+t)^n - 1]$. In the last form it is often called "The Faustmann Factor," in honor of Martin Faustmann, a German forest appraiser who discovered it in 1848.

$$B = B/A \times A$$

B is the speculative element in land price, singled out for special attention.

Table 5: Possessory Value and Resale Value of Speculative Land

GR	10.	10.	10.	10.	10.	10.	10.	10.	10.
$(i+t)=$	.04	.05	.06	.07	.08	.09	.10	.11	.12
A									
$(G_1)=$	156.	141.	128.	117.	107.	98.	91.	84.	78.
% drop	-.-	9.6	9.2	8.6	8.5	8.4	7.1	7.7	7.1
$B/A=$	3.66	1.62	.95	.63	.44	.32	.24	.18	.14
B=	571.	228.	122.	73.7	47.1	31.4	21.8	15.1	10.4
% drop	-.-	60.0	46.5	39.6	36.1	33.3	30.6	30.7	27.8

The burden of Table 5 may be summarized by contrasting the drops in G_1 (Element A) and Element B, from extreme left to extreme right. Element A drops from 156 to 78, an overall drop of 50%. Element B drops from 571 to 10.4, an overall drop of 98.2%.

What has caused these drops? It is the rise in t , the land tax rate. t has risen from .00 to .08. t is the independent variable, and no other parameter changes. (Remember, i is held constant at $i=.04$, so row #1 is $t+.04$. The building tax is constant, so GR remains unaffected by changes in t . g is constant at $g=.03$.)

From a Georgist view, these data display another reason why banks should not lend on SLP. When SLP is banked it creates a new set of vested interests in supporting SLP. Those who speak for rent-takers seize upon this to demand public support for the land market. Thus Paul Craig Roberts: "Depressed real estate prices are not only an important reason why we are in recession but they are likely to make it all but impossible for us to spend

our way out of it." We must lower taxes to "breathe life back into real estate values, save many financial institutions from failure, and save the government - or taxpayers - billions of dollars in bailout costs. ... The downward spiral will have a long way to go if regulators succeed in forcing financial institutions to 'mark-to-market,' or value at current market prices their long-term investments."¹²

These data also indicate why there will always be extreme pressure from landowners to lower land tax rates, once they are installed. Reading the rows from right to left, Element B rises from 10.4 to 571 when t falls from .08 to .00. That is a gain of 5,390%. To overcome such pressure, we need to show that such gains are illusory because lower land taxes necessitate higher taxes of other kinds.

For a "quick and dirty" summary of the sensitivity of SLP to i and t , let $n=1$ in the LVM equation on p.4. This does away with long cycles of investment and liquidation, reducing all rents to annual numbers. Now we have $LVM=1/(i-g)$ ¹³. The tax rate is also added to the denominator, so $LVM=1/(i-g+t)$.

By inspection, this new equation makes LVM highly sensitive to t when $i \rightarrow g$, or $g \rightarrow i$. It also makes it possible for $g > i$ without raising land prices to infinity.

This equation is in common use, because of its simplicity and clarity. Its problem, obviously, is its highly restrictive assumption that $n=1$: that is why we developed the other equations. However, having the more general equations in the background for reference, we can with confidence use this simpler equation to make the main points. The now minor exercise of preparing tables is left to the reader.

¹²Business Week, 18 Feb 91, p.18. This comes from an economist who calls himself a supply-sider and a free-market booster. His inconsistency in those matters results from his consistency in supporting rent-takers at any cost.

¹³Technically, it is that plus $i/(i-g)$. We eliminate this minor value by having all rents concentrated at the end of each year.

APPENDIX I: Deriving the Land Value Multiplier

APPENDIX II: Simplified Expression, Land Price with Rising Rents