Tax-Induced Slow Turnover of Capital, I

By MASON GAFFNEY*

"Ye build! ye build! but
ye enter not in."
. . . LYDIA HUNTLEY SIGOURNEY

I

Introduction

PRESENT DOLLARS are heavy dollars; future dollars are light dollars. The effort of taxpayers to retard tax liabilities and advance tax write-offs follows as the night the day, and economists understand the rudiments of this game: taxes deferred are taxes denied.

The economics profession has lagged in developing capital theory and more so in incorporating it in its teachings. It is catching up, but the particular application to tax policy still lags.[1] This is a serious omission, since taxation has the most profound effects on the intertemporal allocation of resources and, by retarding replacement of capital, on gross investment and national income.

This study purports to help recover the lag; to develop the thesis that excise and income taxation as practiced today bias investors toward the future; to specify a modified definition of depreciation that would remove the intertemporal bias; to advance the thesis that tax neutrality requires that we tax appreciation and deduct depreciation at the time they accrue; and that these reforms would convert the income tax into the property tax.

The early enthusiasts of income taxation believed that the tax would not much bias resource allocation because that use of a resource which yields the highest returns before taxes still yields the highest return after taxes,

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[1] The lag does not suggest complete neglect. The timing of tax liability and write-off were matters whose importance was evident to Irving Fisher, with his proposal for an expenditures tax; William Vickrey [*38*, 7, 137–38]; Henry Simons, who emphasized the desirability of taxing asset appreciation currently rather than waiting for realization; Harold Hotelling, who advocated defining depletion as the drop in value of a mine due to use, a lesser figure than the spot value of minerals severed [*18*, 170]; Richard Musgrave, who seeks a basis for a neutral depreciation schedule [*23*, 338–44]. But none of these dwelt on the question long enough to integrate the parts into a general theory of the subject, or arrive at operational results.

all returns being reduced pro rata. L. C. Gray applied this principle to one instance of intertemporal allocation, mineral conservation [*15*]. He noted that a mineral should be extracted when the percentage growth rate of its net value falls below the interest rate; and that that percentage growth rate was the same after taxes as before.[2]

From that he concluded that a tax on land income could be free of intertemporal bias. We have no major quarrel with that finding, although much depends on how the tax is announced. But Gray's example is quite a special case, where investment at time zero consists of foregone gain on early realization of a rent. We will see below (Section V) that such passive investments automatically receive unusual tax treatment—they are "expensed"—written off as current expenses—implicitly.[3]

In the more general case, early costs are written off over time or at maturity. Then income taxation loses its intertemporal neutrality. Still Gray's demonstration holds forth the hope that we might devise a tax system free of such bias. This paper has both aims: to demonstrate that prevailing tax methods bias investors toward longevity; and to show how we may modify the income tax to remove the bias.

The importance of the subject for micro-economics is self-evident: a bias towards longevity keeps sovereign consumers from getting what they want. It ties up scarce capital in trees or premature utility extensions yielding society, say, 4 per cent yearly, while small merchants and manufacturers cannot finance inventories that would yield, say, 15 per cent, and would also sharpen competition.[4]

The importance for macro-economics is even greater. Almost everyone has learned to eschew the "broken-window fallacy" (that even wanton destruction is healthy because the replacement employs people); and hardly anyone endorses planned obsolescence as a means of increasing employment. Economists do not like macro-economic benefits that violate micro-economic principles. And, although we have accepted many wastes in the name of full employment, we cherish a particular distaste for artificial acceleration of turnover and replacement.

[2] $\frac{R_n(1-t)}{R_o(1-t)} = \frac{R_n}{R_o} = (1+i)^n$, when R = net revenue of mineral severance, with all costs assumed current (a very limiting assumption).

[3] Because the resource whose gains are foregone incurs no tax liability in the year when committed to a long term investment. To anticipate Section V, expensing is tantamount to tax exemption, which accounts for the seeming absence of bias. It is not the rent which is exempted, but interest on deferral of rent.

[4] Small businessmen with weak credit ratings are on the whole the more competitive firms in the economy. Because of their weak credit they tend to specialize in enterprises where the capital turns over faster, and the marginal rate of return is higher. These more competitive firms are the ones our tax system hits harder.

This is not to suggest accelerating replacement by any artificial means that would impose micro-economic wastes. But what if there is a large institutional bias that artificially retards replacement? We would expect economists to oppose it for both micro- and macro-economic reasons. We will show that excise and income taxation do just that. The macro losses of slow replacement were long ago outlined by Böhm-Bawerk and Wicksell,[5] and more recently restated by Domar, Dorfman, Terborgh, Brems, and others,[6] and we will not labor them here. The micro losses will be obvious in our exposition.

The importance of our topic to the distribution of wealth and the allocation of resources is manifest in the fact that higher income groups take higher shares of their income in the form of capital gains, a fact of modern life documented in many recent studies.[7] The taxpayer gains from the lower tax rate on capital gains, of course. But even at equal rates he would gain by the deferment of tax liability, and this second benefit often outweighs the first and affords the paramount motive for arranging one's affairs so as to convert ordinary income into capital gains.

To the extent that taxpayers can convert ordinary to gains income by mere paper manipulations, the effect is only distributive, an important matter in itself. But there are few paper manipulations without their real counterparts, and the general effect of this tax-avoidance maneuver is to reallocate real capital. Investments that pay out fast lose their lustre relative to alternatives that pay out slower. Tax bias makes pie in the sky look better than pie on the plate. Capital moves into growth situations; submarginal utility extensions to capture remote future markets; minerals exploration far in advance of need; premature research; building up farms by current losses for future gains; elbowing for Pacific airline routes that might yield returns some day; purchase and development of exurban land for appreciation; tree farms; institutional advertising; grandiose visionary

[5] ". . . any given total of present goods, be it large or small, is sufficient to purchase and remunerate the total supply of labor. . . . All that is required is to bring about a corresponding contraction or extension of the production period." [*4*, 354].

"If . . . a *shorter* period of production . . . is adopted, . . . the capital which was before insufficient is now able to give employment to all workers." [*42*, 127. See also 131–33, 145–46, *et passim.*] See also Wicksell's *Lectures on Political Economy* [*41*, 172–78].

[6] See Domar, *Essays in the Theory of Economic Growth* [*9*, 33]; Dorfman, "Waiting and the Period of Production" [*11*]; Terborgh, *Bogey of Economic Maturity* [*37*]; and Brems, *Output, Employment, Capital, and Growth* [*5*]. Other economists writing on the macroeconomic importance of replacement frequency have been Senior, Ricardo, Von Thünen, Jevons, Barone, Åkerman, Spiethoff, and Hayek.

[7] See Internal Revenue Service, study of 1962 tax returns, reported in *Business Week*, Feb. 11, 1967, p. 90.

enterprises of all kinds. Meantime, capital neglects more pressing immediate and intermediate needs and opportunities: operation and maintenance of central buildings and rental property; adequate inventories; tools and machinery; developing and extracting known mineral reserves; rolling stock; poultry and hogs (which mature faster than cattle); vegetables (which mature faster than fruit); prosaic "fillers" needed to complement the visionary "builder" investments in every industry. Those are faults of which we love to accuse the Soviets; but before picking the mote from our neighbor's eye, let us check with our own ophthalmologist.

The bias is to neglect immediate opportunities in favor of Boulding's "benefits hereafter"[8] with the associated benefit of taxes hereafter. A review of the many specific maneuvers by which corporations and people of means avoid taxes suggests that the allocation of capital has become downright dominated by the motive to defer tax liability—a motive which our mathematics will demonstrate, and which is not hard to credit in an age of tax rates at 50 per cent and more.

In an age of such high tax rates, again, we may dismiss the old red herring that investors are not rational enough to follow the thinking involved in maximizing their after-tax returns, or even in distinguishing pre- and post-tax returns. Surely there is great irrationality to be observed on every hand; and Ezra Solomon has recently shown that conventional accounting practice usually misstates true rates of return.[9] At the same time, rates of interest on tax-exempt municipal bonds are advertised in the daily press specified to four significant figures, suggesting that someone calculates after-tax returns carefully. This generation of lawyers and accountants has made a major profession of "tax engineering," and one may take their growth as prima facie evidence that tax avoidance has become a major determinant of investment decisions.

On the other extreme, some mathematical readers may regard our argument as too obvious to labor. If we do draw that response, we will congratulate ourselves on a successful conversion and take some credit for having made it so obvious. As indicated at the outset, Professors Simons,

[8] If memory serves: "In modern industry, research
Has become a kind of church
Where rubber-aproned acolytes
Perform the ceremonial rites
And firms spend funds they do not hafter
In hope of benefits hereafter."—K. Boulding.

[9] Solomon's "Return on Investment: The Relation of Book Yield to True Yield" [*30*]. Among other things, he shows that conventional practice usually overstates the return on longer maturities relative to short. So if irrationality does prevail here, it may reinforce the bias to longevity.

Fisher, Hotelling, Vickrey, Musgrave and other have all anticipated parts of our thesis. But the most recent of these, Professor Musgrave, left the subject, which he treats by an arithmetic example and a trial-and-error approach, with the observations that, ". . . the problem does not lend itself to a simple mathematical solution. . . ." [*23,* 340] and ". . . the task of formulating a truly neutral-depreciation policy becomes exceedingly complex." [*23,* 343]. It is this exceeding complexity which we believe we have overcome. Another prominent tax economist, Professor E. Cary Brown, has reached a conclusion the reverse of ours, with much laying-on of hands.[10] On different grounds, Professor Stephen McDonald has maintained that business income taxes are biased against capital-intensive industries.[11]

Obviously our finding should not appear trivial to those who teach that an income tax need not deflect resources from the uses they would otherwise have: we find that it does. Our analysis will also discredit the belief that an excise tax may be neutral so long as it is general. Most important, our analysis will suggest that macro-economic policy makers need attend to the effects of tax and depreciation methods on the longevity of investments and thereby on frequency of *re*investment.

For introductory expository purposes, it is useful to divide real assets into four classes with different major traits, which we will treat in order. There are:

1. *Appreciating assets,* like trees or cattle, whose primary yield is their salvage value at maturity. These obviously benefit more than other assets from deferral of tax liability (except that most inventories, which fall in this class, have lives too short to receive any benefit in practice, or much in theory). This is the "point-input," "point-output" case.

2. *"Full salvage" or constant value assets.* This is a model case that is

[10] See Brown's "Business-Income Taxation and Investment" [*6*]. The denial is on page 529 of the reprint. Selection by Editors Musgrave and Shoup does not, of course, imply their personal endorsement of every position held by each contributor. Indeed, Professor Shoup's article in the same volume [*29*] might be construed to hint toward the opposite conclusion, *i.e.* the one we endorse. Inclusion does imply, however, that the work is regarded by elders of the profession as a "classic." Professor Musgrave elsewhere [*23,* 337, n. 1] refers to this work as "the basic article" on the subject although, again, Professor Musgrave's text on pages 340–42 of the very same work finds a bias against short investment. So his own position would seem like ours rather than Brown's.

[11] Stephen McDonald has maintained that business income taxes are biased against capital-intensive industries [*21*]. For a summary of extended subsequent debate between McDonald and several critics, see S. McDonald, "Percentage Depletion Expensing of Intangibles, and Petroleum Conservation," [*22*]. Professor McDonald, like ourselves, finally finds a high degree of neutrality in the long-scorned property tax. For that position see McDonald, "The Effects of Severance vs. Property Taxes on Petroleum Conservation" [*20*].

useful for exposition because of its analytical simplicity. It may be approximated by the milk cow. The asset costs C_0 dollars at time *0;* yields a regular income for *m* years of life; and then returns a full salvage value of C_m dollars, the same as its cost. It neither appreciates nor depreciates. It is like a time deposit from which one regularly withdraws all the interest.

3. *Depreciating assets,* like plant and equipment. These yield a regular cash flow that includes both income and return of capital. Here, the division of gross income between taxable income and capital recovery is more difficult than in the simpler cases 1 and 2; but we will expound a technique for doing so which can be applied to other assets as well, and which, applied to determine deductible depreciation, could remove much of the intertemporal bias from income taxation. Assets depreciate over time both because their life expectancy declines and because they yield less each year. The first is analytically simpler if taken alone, and, for expository clarity, on this basis we subdivide class 3 into: a. Assets yielding a constant cash flow over finite lives, and depreciating only because they approach end of life. (Anyone who has dealt in the academic flesh market will recognize this concept.) b. Assets yielding changing cash flows over finite lives. Usually the change is negative, but many assets yield undulating returns and we will ultimately frame a general formulation to cover all cases (Appendix II). Initially, however, we expound the simpler case 3a.

4. *Land*. Here there is infinite life. Partial depreciation is possible due to declining income, but appreciation is more common and may continue indefinitely. Here, as with case 1, the possibility of tax deferral is a maximum. There can be no tax bias to construct more durable land, of course, since it is not produced and its longevity comes from nature. There can occur, however, an interclass distributional benefit to owners of this asset; and within the class a special benefit to holders of appreciating land. There can also be a special incentive to investment in what Wicksell called "rent goods," *i.e.* nearly permanent land improvements like filling in shallow water sites, or damming up artificial lakes to sell lakeside lots, or grading and filling land for subdivisions. These improvements are closely associated with land. They take on some of the qualities of land itself, and often are realized on only by selling lots.

For brevity, we omit *paper assets* from the list, with the thought that these are ultimately claims to real assets, so that our list is reasonably comprehensive as a beginning. But certainly paper operations like the plowback of corporate earnings to convert stockholder income into later capital gains, or the assignment of earnings to contingency reserves, are central to our subject and warrant early attention. Again for brevity, we assume that our investors are self-financed and cannot deduct interest from taxable income. When interest is deductible it adds some interesting wrinkles to the analysis, but in essence it merely adds a step without changing the basics, for what is deductible to the borrower is taxable to the lender.

We assume expectations of no change in tax rates, and we ignore the progressive rate structure. It has been suggested that investors expect to move into higher brackets and so prefer present over future tax liabilities. No doubt such cases can be found. We suspect, however, that a large share of investing by individuals is done by older people nearing retirement, with the prospect of lower marginal tax rates. To resolve that question is beyond our present scope.

We assume away the possible acceptance of a lower rate of return on shorter maturities due to liquidity preference. In a perfect market that should not be a factor anyway, since longer maturities are liquid through resale or hypothecation. Our conclusions need to be refined to take account of the fact that, under taxation, the investor, to gain the benefit of tax deferral, has to avoid sale, *i.e.* is "locked in." This itself destroys any perfect market in long maturities and should make investors require a premium for loss of liquidity when they invest long. However, they can borrow on these assets, and so liquidate them without sale or tax. Perhaps the major problem to note here is that the opportunity to achieve tax avoidance by deferral tends to be invidiously reserved for the rich and creditworthy who can afford to absorb any loss of liquidity and whose loss is the least because of better credit ratings.

It is also often assumed that investors accept lower returns on shorter-lived investments because of lesser risk. We reject that assumption. It would involve transferring an observation (a questionable one at that) from the bond market, a sanitary refuge where there are no price risks, but only lenders' (credit) risks and risks of general changes in interest rates, to the firing line of real goods investments where there are a dozen more risks.

Consider the investor as the residual claimant on the product over time. The leverage on his share of the product varies inversely with the period of investment. To earn 5 per cent in one year, in a point case, the investor must sell a $100 investment for $105. A 5 per cent drop of selling price below his expectation wipes out his income completely. To earn 5 per cent in 56 years, he must sell for about $1,600. A 5 per cent drop of selling price scarcely ruffles his return. It would have to drop by $1,500, or 94 per cent to wipe out his income.

So we doubt if in pre-tax equilibrium longer investments require a risk premium any more than shorts, and for brevity we assume no premium either way.

With those preliminaries and ground rules, then, let us lay out the effect of tax avoidance on investment longevity in the four basic classes of real assets. We will first show biases within each class, and later comment on interclass bias.

(Continued)

Resources for the Future, Inc.
Washington, D. C. 20036

Economists and Sociologists Needed

A CONTINUING RECRUITMENT PROGRAM for persons with background in economics and sociology is being directed by New York State's Narcotic Commission to meet the demands of its expanding program of treatment and rehabilitation of drug addicts, Commissioner Lawrence W. Pierce has announced.

Qualifications for positions with the commission in this area include a bachelor's degree from an accredited college or university and a professional background in economics and sociology. Annual salaries for these positions, when they are available, range from $7,200 to $16,490, depending on experience and qualifications.

The program, initiated in April, 1967, by Governor Rockefeller, provides for the commitment of court-certified addicts, followed by a rehabilitation program having the broadest applications. Included in the program are medical care, group counseling, psychiatric and other rehabilitative therapy, job training and placement.

To maintain the high standards set by the commission's program, persons with formal educational training and practical experience in social work, education, psychology, sociology and law, are frequently needed to fill important civil service posts.

Information about the program and employment opportunities can be obtained by writing to the personnel director of the State Narcotic Commission at Executive Park South, Albany, N.Y. 12203. [From the Commission.]

Tax-Induced Slow Turnover of Capital, II

By MASON GAFFNEY

II

Appreciating Assets

WE BEGIN with a simple "point-input point-output" model investment approximated by a tree plantation. All cost, C_0, is incurred at the beginning of year *0;* all returns come at the beginning of year *m* (maturity). There are no intermediate explicit revenues or explicit costs, although of course there are implicit interest costs every year, and implicit site rents, and implicit income through appreciation.

In the absence of taxes investors adjust to an equilibrium so that trees of whatever maturity yield the same yearly rate of return, *i*. Each tree has two values: a liquidation value for immediate harvest; and an investment value for buying and holding to maturity. The investment value begins at the planting cost, C_0, and grows at the rate of interest. The liquidation value is always below the investment value except at maturity, when it catches up by virtue of faster growth. At this point both grow at the rate of interest, *i;* thereafter the liquidation value would have grown slower, which is why maturity had arrived.[12]

Some trees mature fast, others slow, others slower yet. In pre-tax equilibrium, prices and costs all adjust so that each has an optimal maturity year when it yields *i* percent; that is when investors do harvest them; and this represents a normative condition in which the sovereign consumer reigns and rules.

Algebraically, the equilibrium condition is:

$$(1) \qquad (1+i)^m = R_m$$

where R_m is the ratio of stumpage revenue in the year of maturity, *m,* to planting costs, C_0. If you prefer, R_m is revenue per dollar of cost; or it is revenue on the assumption that $C_0 = \$1$.

Now the state imposes an ad valorem severance or excise tax, *i.e.* it takes a fixed percentage, *t,* of the gross value of stumpage. The investor's rate of return after tax, *r,* is, of course, now reduced below *i*. But the reduction is not uniform. The longer the maturity, the less the reduction. Let us show that algebraically:

$$(2) \qquad (1+r)^m = R_m(1-t)$$

[12] In a more refined model we would include a separate term for land cost and allow for some shifting of the tax into lower site values. See below under V, Land, for a preliminary model giving separate treatment to land.

where r is the yearly rate of return after tax

m is the year of maturity

R_m is the revenue in year m per dollar of cost in year 0

t is the tax rate.

Substituting from (1):

(3) $$(1+r)^m = (1+i)^m (1-t)$$

Solving for r:

(3a) $$r = (1+i)(1-t)^{1/m} - 1$$

In (3a) one may see that r varies with m, because $(1-t) < 1$, and the higher the root of a number less than one the higher the value of the root, approaching unity as a limit when m is very large.

The value of r varies from a low when $m = 1$ to a high when $m = \infty$. When $m = 1$:

(3b) $$r_1 = (1+i)(1-t) - 1 = i(1-t) - t$$

This r_1 will actually be negative whenever $t > \frac{i}{1+i}$, *i.e.* for all tax rates equal to or greater than a value just below the interest rate.

But when $m = \infty$

(3c) $$r = (1+i)(1-t)^0 - 1 = i.$$

The taxpayer achieves full tax exemption by investing in a tree of infinite maturity. Of course, there are none such, but the point is that r approaches i asymptotically as m rises, and the investor achieves a high degree of tax exemption by investing in a tree of, say, 50 years' life. If $i = 10$ per cent, $t = 50$ per cent, and $m = 50$ years, then $r = (1.1)\ (1 - .5)^{1/50} - 1 = 1.1 \times .986 - 1 = .0846$, or about 8.5 per cent, a reduction of $\frac{1.5\%}{10\%}$, or 15 per cent, from i. Thus a fierce nominal tax rate of 50 per cent on gross income has been tamed to a meek 15 per cent of net income. Among other things we now begin to see why timber holders fight so hard for severance taxation. It is virtual tax exemption for them, especially in the West where maturities are long.

Algebra aside, whence springs this bias? Basically it is from the deferral of tax liability inherent in longer maturities. With each passing year the taxpayer defers taxes not just on the value accruing in the current year, but on the sum accrued in all prior years. The value of this deferral grows with time so as finally to dominate the matter.

The law taxes income if and when it is *realized* in cash. But the investor constructively receives income at the time it goes to work earning more income for him. The investment value of timber (different, recall, from the liquidation value) grows at compound interest. That means that each year its value grows enough to earn interest on the interest accrued the year before, as well as that accrued from all prior years. (Money makes money, and the money money makes makes more money.) Thus the investor has contrived to receive his income and reinvest it, but without yet paying a tax on it. (The money money made paid no tax before making more.) He can even realize this income in cash, by borrowing on the collateral of the appreciated asset, without incurring tax liability, and deduct the interest payments to boot. A tree is like a corporation that pays no dividends for decades but plows back all its earnings to increase its assets and let the shareholder take his income as deferred capital gains.

At the short end of the continuum of maturities, the rate of return after taxes is dominated by the fact that the excise tax on gross sales taxes not just net income, but also the turnover or recovery of capital. That is why the after-tax income can actually become negative for short maturities.[13] The power of tax deferral to afford tax exemption is dramatized when we note from our earlier example of a 50-year maturity and a 10 per cent before-tax true yield, that by waiting 50 years a taxpayer gains a major exemption of *net* income from the nominal tax rate, even though he is being taxed on *gross* income!

But at the short end capital recovery is the lion's share of gross receipts and the excise tax cuts deeply into net income. Another way of perceiving the bias toward longevity is to see the excise tax as a tax on real capital turnover—not on turnover in the exchange sense of passing from hand to hand, but in the basic Wicksellian-Austrian sense of a cycle of real investment and real recovery of capital. Each time capital cycles, in this sense, it is taxed. The tax-avoiding investor naturally therefore moves toward investments that cycle less often through time. He thus minimizes his burden, both by lowering its total value and by deferring it.

A tax that is intertemporally neutral would lower r by the tax rate for all lives, so that $r = i(1-t)$ at any maturity. For the excise tax there is only one intermediate year of maturity when $r = i(1-t)$, and it is simply the balance of the two biases.[14] For short maturities $r < i(1-t)$ because

[13] If $i = .10$ and $t = .50$, then for all maturities less than 6.6 years, $r < 0$. In general, the investor must hold long enough for money to double at the before-tax yield before the after-tax yield becomes positive, since the tax takes half the gross.

[14] The year is the m that satisfies equation (3) when $r = i(1-t)$. Substituting and solving for m we get:

$$\frac{m = \ell n\ (1-t)}{\ell n \left[\dfrac{1+i(1-t)}{ln+i}\right]}$$

if $t = \frac{1}{2}$ and $i = 10\%$, $m = 15$ years.

the excise tax base includes capital recovery as well as income. For longer maturities $r > i(1-t)$ because the benefit of tax deferral comes to outweigh the fact that capital recovery is taxed.

In summary, then, the severance or excise tax on gross receipts is doubly biased toward futurity because it both taxes capital turnover and defers the tax on unrealized income. It is more biased than any tax on net income. We have examined it in some detail because it is the first case presented and many readers will appreciate careful orientation; and because in some ways it is the simplest case, useful as a point of reference in more complex cases. It is also important in its own right: a large share of tax revenue is from excises on gross sales, many of them sales of appreciating assets.

Next, consider how the bias changes when the fisc lets the taxpayer deduct his costs. A gross bias is removed—no longer is capital recovery taxed. But the benefit of deferring tax liability is still a motive for tax avoiders to lengthen maturities.

It is here that we run counter to Professor Brown's conclusion on the subject. He based his analysis on the present value of depreciation (henceforth PVD). He noted that the longer write-off is deferred the less is the PVD for any dollar of cost; and from that concluded that, "This effect may change the ranking as to their profitability of various outlays on durable goods. Shorter-lived assets would move up the scale relative to the longer-lived." [6, 529].

We agree with Brown that the PVD is lower for longer maturities (assuming that write-off dates in practice retreat in step with cash flow, which we will later question). But we believe he overlooked the larger point that the present value of the tax liability itself also falls with futurity.[15] And since the gross tax liability is greater than the write-off (so long as there is any net income), the net bias is still toward longevity.

Let us now modify equations (3) to show the rate of return after taxes when the base is not gross sales, but is net income over costs. Here the taxpayer may write off or deduct initial cost, C_0, from taxable income, exempting capital turnover from taxation. This moderates the bias to futurity, but by no means eliminates it, as we will show.

The timing of write-off is important. We begin with the most plausible assumption, that costs are capitalized and written off in the year *m*, when

[15] This refers to the tax liability that would be due at the beginning of any given year *n* if it is deferred one year to $n+1$. The effect is veiled by the fact that additional income accrues during year *n*, just enough to offset the drop in present value, so the present value of the growing tax liability is always the same since it grows at the rate of interest.

they are recovered. This is the actual practice with timber planting, although subject to some chiseling.

Now the rate of return after tax is:

$$r = [(1+i)^m (1-t) + t]^{1/m} - 1 \tag{4}$$

Equation (4) is like (3) but for the addition of the write-off to the right side. It appears as the unwritten coefficient *\$1* before *t* in the brackets—\$1 is the initial cost, C_0, and the value of the write-off is *t* per cent of *\$1*, or just *t*.

Here again *r* varies positively with *m*, although not so obviously as before. We will demonstrate this by graph and by calculus, but first illustrate it by a numerical example.

Table 1

RATES OF RETURN AFTER INCOME TAX AT DIFFERENT MATURITIES

(when the rate before tax is constant at 8%, write-off is in year of maturity, and tax rate is 50%)

Point-input point-output case.

$$(1+r)^m = (1.08)^m (1/2) + 1/2$$

m	$(1.08)^m$	$(1+r)^m$	r
1	1.080	1.04	.040
5	1.469	1.24	.043
10	2.159	1.58	.047
15	3.172	2.09	.050
20	4.661	2.83	.053
25	6.848	3.92	.056
50	46.902	23.95	.065
100	2199.798	1100.40	.072
∞	–	–	.08

When $m = 1$, $r = (1+i)\ (1-t) + t - 1 = i(1-t)$. That is, for a one-year cycle, the investor bears the full nominal tax rate. Unlike the excise tax the income tax exempts his capital recovery, and so his income is reduced by no more than the nominal tax rate, and there is no stage of negative *r*.[16]

But for longer cycles he bears less than the nominal tax rate, as witness Table 1, which anyone may duplicate from standard interest tables.

[16] In this introductory paper we omit the treatment of cycles under one year. Here, so much depends on administrative practice and tax dates that a quick theoretical generalization based on simple assumptions would be misleading. Suffice it to observe that I.R.S. practice is diligent in preventing kiting practices which would benefit short investors. For example, a business is taxed on increase of inventory in a year, preventing anyone's deducting costs a year before incurring tax liability. This strictness contrasts with the laxity for long investments, and adds to intertemporal bias.

That is less intertemporal bias than the excise tax exerts, but still great. Further, the advantage of deducting costs looks dimmer when we note that the tax rate, *t*, must be higher under the income tax to yield the same revenue, since the base is smaller; and the impact of any bias increases with the tax rate.[17]

A simple graphical exposition is in Figure 1. The semi-log scale has several properties that help us visualize the case:

—any straight line from the ordinate represents a constant percentage growth rate from the y-intercept value. Thus the curve $R = (1+i)^m$ shows the growth of $1., the intercept whence it begins, at *i* per cent, the equilibrium rate of interest. In equilibrium without taxes, all investments of $1 grow to touch this curve at maturity.

—the steeper the straight line curve, the higher the value of *i* it represents. Thus a set of rays from the origin, as shown, represent different rates of return on $1 of initial cost. Negative slopes represent negative rates of return. Doubling the rate of return doubles the slope.

—constant vertical lengths represent constant percentage changes, so $R_m(1-t)$ is represented by a line parallel to R_m, as shown, representing 50 per cent of R_m for all values of m.

—any curve radiating from the origin that is concave upwards represents a rate of return that rises with *m*, since it cuts continually higher straight rays from the origin. The lump sum received after taxes at maturity must describe such a curve, since it begins at *1* when $m = 0$, because $(1+r)^o = (1+i)^o\ (1-t)+t = 1$. The curve rises slowly at first, and then approaches asymptotically the lower parallel curve, $R_m(1-t)$.

—any straight curve emanating from an intercept below *1* represents likewise a rising rate of return on *1*, since it cuts steeper and steeper rays from *1*. But it represents a constant rate of return on the intercept value. Thus the curve shown, $R_m(1-t)$, represents a constant return of *i* per cent on an initial investment of $(1-t)$, in this example 1/2. So, as we see presently, if the fisc puts up half the initial investment by letting the taxpayer expense capital outlays it can take half the gross receipts without lowering his rate of return at all—and without gaining anything for the government except a market return on its own investment.

—the most convenient way to convert the graph into numbers is to think of money doubling every so many years at different interest rates. The

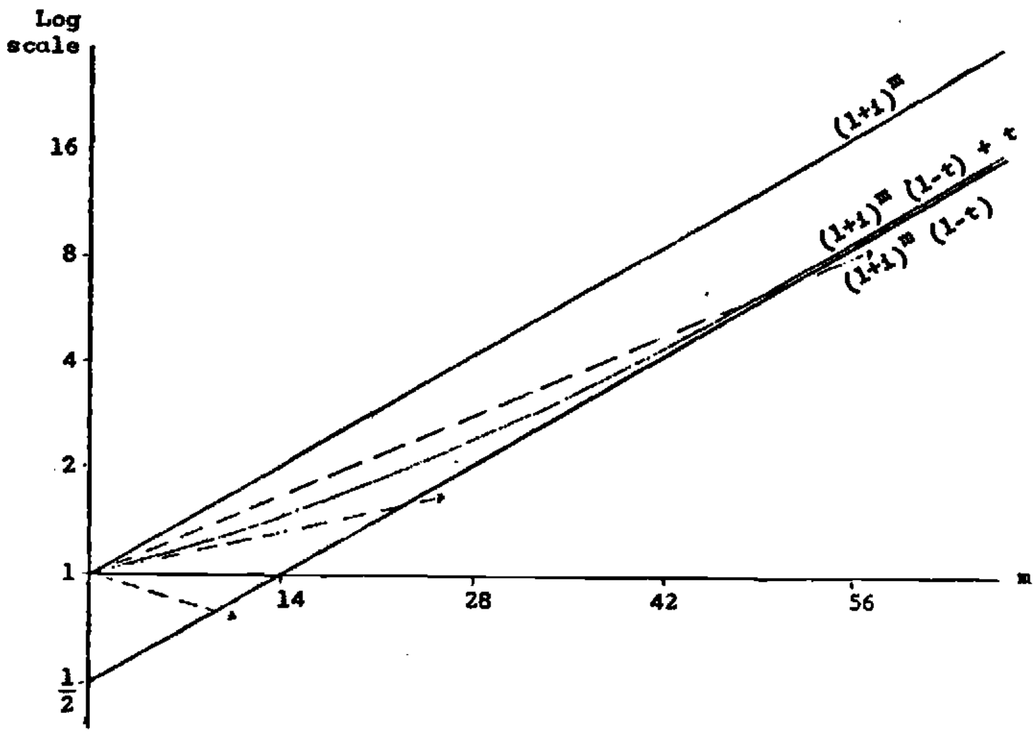
[17] But we would avoid much emphasis on the last point, because if we brought land into the analysis we would see that the seemingly lower tax base of the income tax is made up by the shifting of the tax benefit into land rents, which are still part of the income tax base.

numbers shown refer to 5 per cent, at which money doubles approximately in 14 years. (For computer programming, this fits the binary system nicely.)

From Figure 1 it is now evident that after-tax returns corresponding to constant before-tax returns get higher and higher as maturities lengthen. In the absence of any write-off the effect is much stronger: rates of return after an excise tax are shown in the slopes of rays that cut the lowest curve,

Figure 1

Growth of Investments at compound interest before and after taxes



$R_m(1-t)$. Write-off tempers but does not eliminate the effect: rates of return after an income tax are represented in the rising slopes of rays that cut the middle curve, $R_m(1-t)+t$.

The decline of the present value of depreciation (PVD) with rising *m*, the point Professor Brown stressed, may be visualized as the diminishing vertical distance between the lower two curves as *m* rises. If we draw from any point on the middle curve a straight line parallel to the lower curve, its y-intercept is the present value of the middle curve discounted at *i* per cent. As *m* rises, this y-intercept falls, indicating a falling present value of the lump sum which the investor keeps after taxes. This fall is due to the falling present value of $t \times 1$. This would seem to point to Brown's conclusion that investors would favor shorter maturities to advance their write-offs. We believe this to be an error.

The fallacy lies in using the wrong rate of interest, *i*, for discounting. We are here concerned with taxpayer incentives and the taxpayer is moved by *r*, his return after taxes, and not *i*, which includes the fisc's take. If he discounted using *i*, all the present values of after-tax returns would be less than \$1, an impossible result since no one would pay \$1 for an asset whose present value was less than \$1 and there would be no investment at all.[18]

To confirm the need to use *r* instead of *i* for discounting future rebates, the following is conclusive. Assume a point case, and a rebate, W_m, due in year *m*. To begin, $(1+r)^m = \frac{(1+i)^m + W_m}{C_0}$. The question is, is that ratio, obtained by adding *W* to revenues at *m*, equal to the ratio obtained by substracting discounted W_m from costs at time *0?* Discounting at *i*, the answer is no: the result is an inequality. But discounting at *r:*

$$(5)\quad \frac{(1+i)^m + W_m}{C_0} \overset{?}{=} \frac{(1+i)^m}{C_0 - W_m (1+r)^{-m}} = \frac{(1+i)^m}{C_0 - W_m \dfrac{C_0}{(1+i)^m + W_m}}$$

$$(1+i)^m + W_m - W_m \overset{?}{=} (1+i)^m$$

$$0 = 0$$

Returning to Figure 1, any ray from the origin that cuts the middle curve has a lower slope than the top and bottom curves. Consider the topmost ray. Any parallel line above it cuts the middle curve farther to the right, and has a higher y-intercept, indicating that at the rate of return which the taxpayer uses and which guides his behavior, the longer maturities have higher present values. Of course the topmost ray may not be *the* equilibrium *r;* but whatever ray does represent *r* it has the property that all longer maturities have higher present values, and all shorter ones have present values less than \$1 and will not be invested in at all.

We believe that the present value approach is clumsy for this purpose, and henceforth will write in terms of *r* as a function of *m*. We did think

[18] This same basic error appears consistently in Prof. Brown's sequel, "The New Depreciation Policy under the Income Tax: an Economic Analysis" [7]. It is, however, avoided by Prof. Musgrave, who scrupulously distinguishes before- and after-tax rates of return [23, 339]. (Musgrave denotes our *r* as i_t. Musgrave uses his i_t to discount future write-off rebates to present values in his equation (14–17) wherewith he analyzes straight-line depreciation. We follow the same practice for all cases.)

it necessary, however, to meet the Brown argument in its own terms, for in those terms it can seem quite convincing. The simpler refutation is to note, as we have, that r rises with m. Another refutation is to note that as m rises the taxpayer's loss due to deferring write-off of $1 is exactly offset by his gain from deferring taxes on recovery of $1, leaving him a net gain of deferring taxes on all income above the initial $1 of costs. Thus Brown reached the wrong conclusion by spotlighting a lesser factor and omitting a greater one.[19]

For a rigorous general proof that r rises with m, it is necessary to find $\frac{dr}{dm} > 0$. The proof is not trivial, and appears in Appendix I.

So far we have not discussed shifting the tax, but assumed it fell wholly on the nominal taxpayer, the investor. Some readers might think the intertemporal bias would disappear as the tax is shifted, but such is not the case. Indeed, shifting is never automatic but results from reduced supply, so only the absence of shifting is consistent with neutrality in taxation.

In this case two concepts of shifting are entailed: first, shifting away from capital, which would bring r back up to the initial level of i, i_b (the *b*ase interest rate), and would push i up to a new level, i; and second, shifting among maturities, which will occur whether or not the total supply of capital changes, and whether or not r reattains the i_b level.

The two concepts of shifting are separate, but related, because shifting to longer maturities has much the same effect on the bargaining power of capital vis-a-vis labor as emigration, consumption, or hoarding of capital—the other avenues by which it flees from taxation and shifts taxes. Longer maturities imply a substitution of capital for labor, as Wicksell showed, hence a reduced demand by capital for labor and a shifting of the tax to labor in the form of lower wage rates and/or higher prices.[20]

Shifting among maturities is inevitable, because in after-tax equilibrium it is the value of r, not of i, that investors will tend to make the same for all maturities. They will do so by shunning short investments in favor of longer ones, until the premium of short i over long i is enough to equalize short and long r.

[19] By way of analogy: "There was a young lady of Crete
Who was so exceedingly neat
When she got out of bed
She stood on her head
To be sure of not soiling her feet."
—Thanks to Miss Ann Gaffney

[20] Longer maturities, however, increase the demand for land. Each module of "frozen labor" now requires more years of land-time before liquidation, so the effect is to worsen the bargaining position of labor *vis-a-vis* land. See also note 5.

Even if the aggregate capital supply were wholly inelastic, the supply at each maturity is still elastic because capital shifts into longer maturities. This elasticity of supply at any maturity is what lets capital shift the tax off the particular maturities on which it falls heaviest and spread it among all maturities.

Graphically one may visualize this on Figure 1. Imagine that the middle curve, $R_m(1-t)+t$, is a curve in the road that Paul Bunyan wanted to straighten. Assume, further, that most economists remember their native folk legends. Paul hitches Babe, the Great Blue Ox, to the end of the curve and with a mighty yank pulls it straight!

This orthopraxy is not achieved without some side effects. The top curve is rigidly connected to the middle one by the requirement that they differ by $t(R_m-1)$. So the top line develops a curve. It becomes concave downwards, a mirror image of the middle curve shown on Figure 1. This mirror reflects the fact that *i*, the gross-of-tax rate of return, must now be higher for shorter maturities, in order that *r* be the same for all.

Stephen McDonald has developed an ingenious thesis about such shifting that might temper the basic effect. He points out that shifting by industries whose operations entail shorter maturities is easier because the gross returns comprise less return *on* capital and more return *of* capital, the second representing payments to labor and other initial inputs. Indeed, McDonald goes so far as to conclude from this that the tax biases investors against longer maturities. We believe that he has taken a responsive, equilibrating effect and made it the prime mover, overlooking the initial cause: the force that initiates shifting is a move to longer maturities. The McDonald effect[21] might temper the primary movement but could not overpower it because without the initial cause there would be no McDonald effect. Shifting may or may not be easier at shorter maturities, but what reallocation does occur will have to be toward longer maturities.

We believe that McDonald's thesis is also open to the criticism that slower maturing investments, while the value of their final product contains a high interest component, as timber, also consume years of land-time and have a high component of land rent. So while shifting to labor is harder, shifting to land is easier, and it is not certain that on balance the longer maturities will impede shifting.

We began by observing that the timing of write-off is important, and assuming that it occurred at maturity, *m*. Now let us see how advancing the date of write-off affects intertemporal bias. We will show that it

[21] We do not here judge the quantitative importance of the effect. which we regard as plausible and ably argued but as yet moot. See also note 11.

appears to reduce intertemporal bias, but that the appearance is deceptive because it does so only by eliminating the tax [*23*, 343–44].

Let w be the year of write-off. We have so far let $w = m$. Now let $w = m - 1$. The write-off now yields the investor one year's interest before maturity, so the value to him at m of the two lump sums he gets is $R_m(1-t) + t(1+r)$.

Note that the year's interest gain to the investor is at the rate r, and not i. r is the rate which he can get and keep for himself by investing the write-off dollar a year before maturity. To compound the write-off at the rate i would overstate its value to the investor.

Now let w fall, and $t(1+r)^{m-w}$ rises. Interest earned by the write-off dollar helps pay the tax at m. As w moves toward zero, the middle curve in Figure 1 both rotates upward and straightens out. If this is not intuitively obvious, it becomes so when we consider the extreme case when $w = 0$, *i.e.* when the taxpayer may write off capital investments as though they were current expenses ("expense" them). Then, interest earned by the write-off dollar pays the *entire* tax at all maturities, and the middle line becomes the same as the top line.

This straightening indicates the removal of tax bias. By letting investors expense capital investments we have removed bias from taxation. This discovery might be a boon to mankind like fire or the wheel but for one flaw: it also eliminates the tax.

Algebraically, the point is clear by solving for r when $w = 0$.

$$(1+r)^m = (1+i)^m(1-t) + t(1+r)^{m-0} \tag{6}$$
$$(1+r)^m(1-t) = (1+i)^m(1-t)$$
$$(1+r)^m = (1+i)^m$$
$$r = i$$

The taxpayer gets the full rate of return. All the fisc gets is a market return on its own investment of t per cent of \$1 at time zero. The easiest way in general to view this case is that the taxpayer and the fisc have been partners in this investment. The fisc puts up t per cent and the investor $(1-t)$ per cent. Each earns i per cent on its share of the investment.

It would be misleading to think of expensing as an approach to neutrality, therefore. A neutral tax must first be a tax. It would also be misleading to think that some halfway measure like making $w = \frac{m}{2}$ would lessen intertemporal bias, for that would reduce revenue and require a higher tax rate to maintain revenue. That would actually increase bias as may be seen by shifting the lowest curve in Figure 1, $R_m(1-t)$, downwards.

But while expensing does not convert the income tax into a neutral tax on that capital which turns over, it does contain an important element of neutrality which we have not brought out yet. Land does not turn over, and the Internal Revenue Service, although it does many strange things, in this case quite properly and logically rules that land purchase is not a cost and may not be depreciated and written off, much less expensed. Expensing effectively exempts from tax the income of expensible investments, but not of land. Thus it tends to convert the corporate income tax, which exempts wages, into a tax on land income.[22]

Since land income is rent, the tax may be neutral. However, tax neutrality requires more than a base which is rent, *i.e.* a base whose supply within the tax jurisdiction is fixed. Rent is a surplus which *may* be preserved unabated by skillful taxation, but not one which *cannot* be destroyed by taxation. As a means of taxing land rent, expensing of capital investments under the corporate income tax has some merit, but on the whole seems to us less promising than the conventional approach of modifying the ad valorem property tax to exempt capital. So we will not pursue it other than to summarize the faults we find:

—expensing in practice discriminates against investments of less than one year's maturity (which are a large share of the gross investment flow) because the tax calendar is discontinuous. To achieve exemption, an 11-month investment would have to be expensed at the beginning of month *0* and taxed at the beginning of month 11; in practice it would be taxed and expensed simultaneously.[23]

—expensing can only be neutral for long run decisions *ex ante* the investment. *Ex post,* all short run decisions are biased by the tax rate on gross cash flow, which operates just like an excise tax. This rate might have to be higher to compensate for exempting so much.[24] The short run bias would then reflect back and affect the long run decision *ex ante* investment, since the investor would anticipate his later short run reactions. Only if the initial investment were completely irreversible and controlling, so no later adjustments were possible, would the tax be neutral.

[22] Or would, if the fisc maintained tax rates on the remaining income. Congress has been generous in extending the expensing privilege to oil men, for example, but then it also exempts their rent income by the depletion allowance.

[23] In addition, the current "investment tax credit," a species of partial expensing, is not fully allowable for investments unless their life exceeds 8 years, a most explicit bias against short maturity. This and other measures suggest it actually is the intent of Congress to favor long maturities.

[24] This is advanced tentatively, because some of the advantages will be shifted to land rent and still be part of the tax base therefore. We have reserved treatment of this important issue for a sequel.

—the advantage of expensing is denied to new, small, and losing firms, which have no outside income against which to write off new investments.
—after write-off in time zero the investor is locked in, *i.e.* he cannot sell an immature asset in year *n* without incurring his accrued tax liability, whereas if he holds to maturity he defers the tax accrued by year *n* to year *m* without increasing its amount, a clear gain. Thus the market in longer maturities is virtually destroyed. The net loss of investor welfare, as earlier noted, is mitigated because the assets are still bankable; but an economical allocation of resources may be blocked, and vertical integration to defer tax liability receives a big boost with resulting damage to competitive market structure.
—in practice, investors have learned to disguise land purchase as purchase of old buildings on land, and write off much of it, often more than once. Unless this practice were drastically reformed, investors would expense land purchase too and the tax would have little or no base at all.
—taxation of the current yearly appreciation of land prices, which is income just like appreciation of trees, would still be deferred until sale, or if never sold, forever. Land appreciation may be converted to cash at any time, not just by banking on it (mortgaging it) but, more commonly, by consuming the cash recovery from other assets, especially the buildings on the land in question,[25] and relying on the land value increment as the sinking fund.

Universal expensing of capital investments would have the very real advantage of making general one invidious advantage now granted explicitly to oil ("intangible" well costs and dry holes), to R & D (research and development), to advertising and other "intangible" costs, and taken implicitly in a dozen devious ways: by gentleman farmers who build up old farms by "losing money" on capital improvements written off as current expenses; by utilities which suffer current losses in new territory to nail it down for future exploitation; by oligopolists who incur current losses in price wars to secure future markets, or underwrite premature suburban retail outlets to secure position; by land developers who sell or rent the first units at a loss in order to enhance the others; by land speculators who lose money operating nurseries or farms or drive-ins so they can satisfy the I.R.S. rule that the land is used in their business, and qualify for capital gains; *et hoc genus omne*. Further, universal expensing

[25] ". . . depreciation funds are seldom provided for the buildings in New York, dependence being placed upon the increase in land values to counterbalance the decrease in building values through wear and tear." See Robert Haig, "Some Probable Effects of the Exception of Improvements from Taxation . . ." [16, 133–34].

would make general the advantage of deferred tax liability now reserved for appreciating assets. If, upon realizing income, I can immediately reinvest it and write it all off, I have no tax to pay, and am as well off as though my original asset had continued to appreciate without being taxed.

On balance, however, we do not recommend expensing as the best way to tax land rent since the ad valorem property tax on land values is an available alternative which lacks the faults just listed. Land value is the sum of future discounted income less costs, with all costs, including capital costs, dated at the time they are expensed. Levying on the land value base, therefore, is the counterpart of expensing under the corporate income tax, with the difference, of course, that the ad valorem approach bases the tax on assessment of the land's market price or opportunity cost rather than on records of the present owner's receipts and expenses.

So far we have considered write-off at maturity, $w = m$, and expensing, $w = 0$. There are other possibilities, which we now entertain: a constant w independent of life, $w = k$; a w always k years short of life, $w = m - k$; and a w always some fraction of life, $w = \frac{m}{k}$.

If $w = k$ the bias to longevity is much greater than if $w = m$, obviously, because longer life defers tax liability, just as with the simple excise tax on gross, but does not defer write-off. Maturities less than k are especially hard hit.

This might seem a fanciful case, but far from it. We remarked earlier, in discussing Cary Brown's thesis, that we would question the realism of assuming $w = m$ in fact. The write-off periods of assets tend to be based on arbitrary lives specified in I.R.S. *Bulletin F* or Revenue Procedure 62-21. Lawyers tend to think in categories, not continua. More durable plant and equipment of a category given 15 years in *Bulletin F* are most likely to get 15 years, regardless of actual life.[26]

If $w = m - k$, the bias would be against longevity. Maturities of less than k would be written off before they were born; and by turning capital rapidly one could drain the Treasury. This *is* a fanciful case![27] Not that no one is allowed to drain the Treasury, but the privilege is reserved for investors with long maturities.

[26] Breeding cows get 8 years, for example: producing lives may be as high as 15 years. See Oppenheimer's *Cowboy Arithmetic* [24].

[27] Under these rules: "There was an investor named Bright
Whose money moved faster than light
He invested one day
In a roundabout way
And cashed in on the previous night."

If $w = \frac{m}{k}$ the outcome is somewhere between $w = m$ and $w = 0$. The return after tax is shown in equation (7) where $k = 2$.

$$(7) \qquad (1+r)^m = (1+i)^m (1-t) + t(1+r)^{m-m/2}$$
$$(1+r)^m [1 - t(1+r)^{-m/2}] = (1+i)^m (1-t)$$
$$(1+r)^m = (1+i)^m \left[\frac{(1-t)}{1 - \frac{t}{(1+r)^{m/2}}} \right]$$

As m gets large the right fraction approaches $(1-t)$ as a limit and the case resembles earlier cases, Equations (2) and (3), where $r \to i$ as $m \to \infty$. Formal rigorous proof that r rises with m follows the lines of Appendix 1. Arithmetic illustration follows the lines of Table 1. We omit these exercises because they are repetitive variations on a theme.

An easy near-proof is to take the natural log of both sides of (7).

$$(7a) \qquad m \cdot \ln(1+r) = m \cdot \ln(1+i) + \ln(1-t) - \ln[1 - t(1+r)^{-m/2}]$$

But when r is in the normal range of interest rates:

$$\ln(1+r) \cong r, \text{ and } \ln(1+i) \cong i,$$

and so:

$$(7b) \qquad r = \frac{mi + \ln(1-t) - \ln[1 - t(1+r)^{-m/2}]}{m}$$
$$= i + \frac{\ln(1-t) - \ln[1 - t(1+r)^{-m/2}]}{m}$$

The only thing that keeps r below i is the fraction on the right (note that it is negative) whose denominator is m. As m rises, this fraction declines in relative weight, and r rises to approach i.

So even under the write-off assumption most favorable to brevity and still levying a tax, the bias is to longevity. There is no escaping it, so long as taxation waits on realization. Equation (7b) is generally applicable to all the point-input point-output cases. Simply replace $\frac{m}{2}$ by whatever value w has; or if no write-off is allowed strike out the second *ln* in the numerator altogether.

It is easy to tear down. Let us turn now to reconstruction. How might we levy an intertemporally neutral tax on the income of capital? We begin with some criteria learned above.

a. Initial costs must be deductible, to avoid taxing capital turnover.

b. Unrealized appreciation must be taxed as it accrues, not waiting for realization in cash.[28] Thus tax liability is not deferrable by lengthening maturity.[29]

c. Write-off must synchronize with capital recovery; earlier write-off grants partial or complete tax exemption.

The investment value of our immature trees in equilibrium grows at the rate of interest, i. An income tax as above would take each year the tax rate times the base $V \cdot i$. There would be no other tax because at maturity all appreciation would already have been taxed; and the write-off of initial cost, C_0, would exactly offset the recovery of C_0.

The reader's skepticism may rise when he suddenly realizes that our neutral income tax is very like a property tax on standing timber: it takes a percentage of the market value each year! Can a tax in such bad odor actually be a good one?

The neutrality of the tax is shown as follows:

r is defined in Equation (8).

$$(8) \qquad \$1 = \frac{-it}{1+r} - \frac{i(1+i)t}{(1+r)^2} - \cdots - \frac{i(1+i)^{m-1}t}{(1+r)^m} + \frac{(1+i)^m}{(1+r)^m}$$

which says that the present value of gross receipts less the present value of taxes must equal the initial cost of \$1. Summing the geometric progression and switching the last term to the left side:

$$(8a) \qquad 1 - \left(\frac{1+i}{1+r}\right)^m = \frac{-it}{r-i}\left[1 - \left(\frac{1+i}{1+r}\right)^m\right]$$

$$r - i = -it$$

$$r = i(1-t)$$

And this holds true for all m.

The rationale of the tax, and its intertemporal neutrality, stand out clearly when we consider what the tax would be if we let the amount due accrue in a sinking fund. The present value at time zero of the taxes is, from (8).

$$(8b) \qquad PVT_0 = \frac{it}{r-i}\left[1 - \left(\frac{1+i}{1+r}\right)^m\right]$$

But $\dfrac{it}{r-i} = -1$

[28] Alternatively, to avoid liquidity problem cases, unpaid accrued taxes might be let grow in a sinking fund at interest, to be paid in cash at maturity. But the appreciated asset is always bankable, averting liquidity crises. Of course, the owner must then pay interest on the loan, but that is the whole point.

[29] It is as though the tree were sold each year, from one investor to another, so the whole time-consuming ripening process were "vertically disintegrated." The need for that is very clear upon considering one of its incidental benefits, which is to avoid discrimination between long-haul investors and quick in-and-out investors, and to avoid encouraging vertical integration to defer taxes.

So the value in year *m*, compounding at *r*, is

(8c) $$VT_m = (1+i)^m - (1+r)^m$$

That is, if we gave the taxpayer the choice of paying at maturity with interest, his tax burden would grow exponentially, like money in the bank, at a rate of interest equal to *r*, maintaining intertemporal neutrality of choice by maintaining a constant difference between *i* and *r*.

The remarkable fact emerges that the neutral income tax is like the property tax on standing timber! Can it be that this pariah of taxes, which we have scourged out of the system to the cheering of economists, was actually neutral?

It is neutral if we assume, as we have, no shifting of the tax, *i.e.* that capital bears it wholly in a lower *r*.

But that is not a very realistic assumption; neither is it permissible in a proof. To assume the absence of shifting of any kind is to assume tax neutrality, since it is tax-induced reallocation of inputs whose supply is elastic that causes tax shifting. We cannot prove a tax is neutral by assuming that it is. In Figure 1 we could prove the tax on realized interest income was *not* neutral, regardless of shifting to other inputs, because of intertemporal shifting. We have shown the tax on accrued interest income is intertemporally neutral if not shifted to other inputs. But now we must ask, what happens to intertemporal neutrality if it is so shifted?

Suppose a property tax is levied in a jurisdiction too small to influence national or world interest rates at all. Investors need not accept lower returns there than elsewhere, so capital emigrates until the tax is completely shifted.

Now capital is scarcer there and needs to be rationed at a higher interest rate. To ration this reduced supply best, a tax system needs to bear equally on all maturities. That is what the property tax and our neutral income tax would accomplish. Capital must now earn *i* (the gross-of-tax rate of return) in all uses and maturities to return to the taxpayer an after-tax return, *r*, that is the same for all uses and maturities.

Because capital is scarcer, some former uses of it must be abandoned. The question is, which ones? Under the property tax, capital-intensive enterprises are hardest hit, as forest owners have always complained. But that is as it should be: if capital is scarce, capital intensity is wasteful.

Capital longevity is of course synonymous with capital-intensity. Long-lived trees that tie up capital for 80 years or so become submarginal under the property tax. The jurisdiction's scarce capital supply is marshaled into shorter-lived investments.

The property tax and our accrued-income tax are neutral in this sense: once the decision is made to tax interest income and accept the consequent scarcity of capital, then the reduced supply is economically rationed by requiring all investments to earn *i* before taxes. The tax is neutral among all maturities at the higher rate of interest, *i*, which is now the equilibrium rate.

Higher interest rates of course tend to ration out longer maturities, and the result is to shorten lives. This bears the semblance of a tax bias against longevity, but that is not a meaningful way to perceive it. It is the tax-induced capital shortage that causes the bias against longevity. Our tax then rations capital economically under this new constraint.

Compare, now, the result of a tax on realized income if the tax is shifted. This bears lighter on longer maturities, and so causes the jurisdiction's scarce capital to be tied up in capital-intensive enterprises—exactly the wrong allocation to meet a shortage. It spares the investments that are marginal by virtue of longevity, but hits others. Capital is forced out of higher uses rather than lower uses.

There might appear to be some benefit in the realized-income tax basis to compensate for the bias to longevity, in that capital finds a tax shelter in long maturities and less of it need be driven to emigrate. But that would be a false hope to pursue. By avoiding taxes, capital deprives the fisc of revenue, forcing higher tax rates to yield the same revenue. The higher rates force out more capital, leaving us finally with less capital and more intertemporal bias. We cannot take comfort in the hope that tax avoidance for capital will be imputed into higher taxable land rents, as in the expensing case, because the same deferral of realization of income by which capital avoids taxes also defers realization of the associated land rents and lets land escape as well. In comparing the income tax and the excise tax we could truly say that the taxpayer benefits of the former over the latter would be imputed to land and so not escape from the tax base, because the income tax has less longevity bias than the excise tax. But now we are comparing the income tax and the property tax. The taxpayer benefits of the former over the latter are also shifted to land, but they *do* escape from the tax base even so because the resulting increase of land rents is deferred.

The only reason for preferring the realized basis, therefore, would be to dissemble: to appease voter clamor for taxes on property income while actually letting it escape. It is easy to imagine and to observe how such a device could be and is useful in politics. But it is not the function of economic science to supply ruses to mislead voters; it is rather to recommend the best possible policies in the public interest.

Let us summarize. Our accrued income tax, and the property tax which it resembles, are neutral intertemporally if capital absorbs the full tax without shifting. If capital emigrates to escape the tax, the emigration is itself a tax-induced misallocation, and the tax is not neutral. Only a tax on land, which cannot emigrate, can be fully neutral. But if society does tax interest income, our accrued-income tax base preserves intertemporal neutrality among investments at that higher rate of time-discount appropriate to the tax-induced scarcity of capital. Thus the accrued-income basis is distinctly superior to the realized-income basis of taxation, containing an important element of neutrality which the latter lacks, and the possibility of complete neutrality under the special and unrealistic assumption of non-emigration and non-shifting, or under the assumption that the property tax base has been modified to exempt improvements.

Historical opposition to and criticism of the property tax has resulted from the tax's making very visible the destructive effects of taxing the income of a mobile, migratory input like capital. That has been especially true in forestry. But shifting to the realized-income basis makes the tax no less destructive, only less conspicuously so. In the process of concealing the damage, however, the income tax adds greatly to it by driving capital into longer maturities. It also sloughs the tax burdens of property onto labor, which lacks equally effective means to avoid taxes.

(*Continued*)

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Cooperation in Antarctic Research

FIFTY SCIENTISTS from 12 countries which are signatories to the Antarctic Treaty, including the United States, Britain, Japan, and the Soviet Union, met in Tokyo in 1968 for the 14th general meeting of the Scientific Committee on Antarctic Research. The group decided on the establishment of an international cooperation system on geological studies, joint studies on logistical problems, and creation of a telecommunication system in the Antarctice. [From the U.S. Department of State.]

Tax-Induced Slow Turnover of Capital, III

By MASON GAFFNEY

III

Constant Value Assets: the Full Salvage Case

WE BEGAN with the point-input point-output case, thinking it was the simplest. It turned out to be rather complicated. That was partly because we took advantage of its simplicity to introduce a number of complications and establish beyond cavil our general thesis of a bias to longevity. That was worth some care, even though only a few real assets approximate the point-input point-output model, because all other models may be constructed as summations of point cases, and what is true for each of the parts is almost surely true for the whole.

Indeed, with that thought we might almost close here and take the remainder on faith. But as it happens some of the more complex models are easier to understand than the point case. Further, it is not immediately obvious from the point case what depreciation schedule would be neutral, how to judge the bias in schedules commonly used, or how to judge interclass bias. Also, critics of Austrian capital theory have never accepted the generality of the tree case. Finally, the more complex models help us frame some wider generalizations which we would leave with the reader.

We next consider an asset whose salvage value at maturity equals its initial cost; and which yields a steady net income in the years between. Call it a milk cow, Bessie, foster-mother to man over life, destined for sausage and shoe-leather on maturity. By assumption she neither appreciates nor depreciates throughout her life. She is much like a time deposit. The beauty of the Bessie model for tax analysis is the simplicity of defining income in the absence of depreciation and appreciation. The net current income is all income. There is no recovery of capital until her last day.

In this case a neutral tax results if the owner pays on current net income as received; and writes off capital cost in year *m* when he recovers it. Under this rule there is no tax on capital recovery, as with an excise tax, to penalize shorter maturities; nor any advance of write-off before recovery, as with expensing, to subsidize the investor and counteract the tax. The owner cannot avoid full taxation by turning to more long-lived Bessies, nor is he penalized if he jilts Bessie for Henrietta Hen, who yields a stream of eggs over a short life before broiling. At any life he bears the full tax, so $r = i(1-t)$.

If we let him defer taxes on milk income until maturity, the case would be like that of the tree with a bias to longevity and a wide-open route to tax avoidance. That is not done explicitly although he can do it indirectly by feeding more milk to calves for future income, and even by dumping milk in quixotic milk strikes in hope of higher future income. If we let him write off Bessie before her time he would also pay a lower effective tax rate (and that we do do, explicitly). As with the tree, expensing (writing off Bessie's cost as business expenses) would afford full tax exemption: the yearly interest on write-off at time zero would pay the yearly tax on income (and the tax rebate on write-off itself would just cover the tax on realization of salvage value). As with the tree, the bias to longevity caused by write-off in an intermediate year, w, would depend on how w varied with m. In practice it would be biased to longevity because w tends to vary insufficiently with m. That is equally true whether w is actually a single year or something like the mean year of a depreciation schedule taken as the unitary equivalent of the whole schedule.

An undepreciating asset like Bessie should not be written off over life, therefore, because to do so in any feasible way creates an intra-class bias. The only reason for allowing it would be to reduce the inter-class bias in favor of trees and other appreciating assets. But that is not a good reason either because it would increase the inter-class bias against depreciating assets, the most common kind.

The Bessie model is of course artificial, rigid, and unlikely to exist in pure form. Its value is to highlight basic criteria which we may seek to apply to the more difficult case of depreciating assets to help find a timing of tax liability and write-off that is intertemporally neutral. These criteria are:

a. Tax income when it accrues, either as appreciated value (the tree case) or in cash payments.

b. Write off assets only when they depreciate (or are liquidated outright, which we include with "depreciate").

To summarize (a) and (b) tersely: tax cash receipts, deduct cash outlays; tax appreciation, deduct depreciation.

Let us now apply those principles to the more general case of depreciating assets and find a formula for intertemporal neutrality.

IV

Depreciating Assets

ASSETS THAT YIELD regular or intermittent incomes over life may be analyzed, and usually are, as though they were aggregates of point-input point-output cases. That is, standard financial formulae for annuities are derived simply by summing up the present value of all the future payments, thus:

$$V_0 = \sum_{1}^{l} [a_n(1+i)^{-n}]$$

where l is life.

For a constant annuity of \$1 (beginning at the end of year zero)

$$V_0 = \frac{1-(1+i)^{-l}}{i}$$

and all annuity formulae are variations of that.

We should expect, therefore, that our conclusions from the tree case should apply to the present more general case, as the Austrians alleged. But that is quite a transfer to take on faith, and even if one did, the details of the transfer would still pose several perplexities. So we now present a model of a depreciating asset, the impact of taxation, and the write-off schedule needed to avoid intertemporal bias.

Assume our asset costs \$1 at time zero and yields a constant cash flow (net of current costs, of course) over life of l years. It is a depreciating asset not because of falling income but because of falling life expectancy.[80] In equilibrium without taxes the cash flow is the annuity, a, whose present value is one:

$$a = \frac{i}{1-(1+i)^{-l}}$$

a function tabulated in all interest tables. Sometimes it is called the "capital recovery" formula, because it returns a dollar of capital with interest at i per cent.

Now we levy an excise tax on this annuity. The taxpayer gets $a(1-t)$. His rate of return after tax, r, is now the capitalization rate that will give this reduced annuity a present value of one.

$$1 = \frac{i}{1-(1+i)^{-l}}(1-t)\frac{1-(1+r)^{-l}}{r} \tag{9}$$

Table 2 is a numerical example from the interest tables showing that r rises with l.

Here, as in the point case, excise taxation without deduction of costs results in extreme bias against short lives, and for the same reason. Any tax rate higher than 8 per cent makes r negative for maturities of one year

[80] As we said in the introduction, we are treating here only this case and not the case of a falling income stream. The latter is comprehended in the general formula in the appendix.

or less. The 50 per cent rate of Table 2 makes r negative for maturities under 19 years.

Table 2

RATE OF RETURN AFTER EXCISE TAX OF 50% ON ANNUITY WHOSE PRESENT VALUE AT 8% IS ONE (1)

l	$a = \frac{i}{1-(1+i)^{-l}}$	$a(1-t) = \frac{1}{2}\,a = \frac{r}{1-(1+r)^{-l}}$	r %
1	1.080	.5400	−45.
5	.2505	.1253	−14.
10	.1490	.0745	− 5.
(19)	(.1041)	(.0521)	(0)
20	.1019	.510	.2
30	.0889	.0444	2.0
40	.0839	.0419	2.8
50	.0817	.0409	3.3

The case is so obvious from Table 2 that we dispense with graphical illustration and rigorous proof by differentiation. It is enough to solve (9) for r and inspect it:

$$r = i(1-t)\left[\frac{1-(1+r)^{-l}}{1-(1+i)^{-l}}\right] \tag{9a}$$

When $l = 1$, $r = i(1-t)$–t and r is negative for all $t > \frac{i}{1+i}$. But as l grows, the fraction in brackets approaches unity and $r \rightarrow i(1-t)$.

The interesting project now is to find a depreciation schedule that may free the tax of intertemporal bias. The Bessie case leads us to expect this is possible by writing off capital at the time recovered. The trick in the annuity case is to separate income from capital recovery.

The project involves four steps:

First, modify equation (9) to include the depreciation rebate.

Second, define true yearly depreciation as the drop in value of an asset.

Third, substitute the true depreciation into modified equation (9).

Fourth, show that $r = i(1-t)$ for all lives, l, when true depreciation is allowed.

Beginning with the first, the taxpayer's r is now redefined to show the write-off:

$$1 = \frac{i}{1-(1+i)^{-l}}(1-t)\frac{1-(1+r)^{-l}}{r} + t\sum_{0}^{l}\left[d_w(1+r)^{-w}\right] \tag{10}$$

The last term is the tax rate times the present value of all depreciation write-offs, d, in all years, w. The effect of adding a term to the right side is to raise the value of r, since now the investor can capitalize his after-tax annuity at a higher rate to make it equal \$1.

We use r rather than i to discount future d_w to present values in equation (10) because the original equation (9) was set up to define that r necessary to discount after-tax incomes to present values in order to make the sum equal the initial investment, one. That is what the first term on the right side of equation (10) does. Write-off rebates are just like another after-tax income payment at the date received, and discounting by r treats them parallel to other after-tax income. r is the discount rate that reduces the sum of all future after-tax payments, including write-off rebates, to \$1 [*23*, 339, Equation (14)–(17)].

Second, we define true yearly depreciation as the drop in value of an asset. Here is an asset yielding a steady annuity of a over l years and then ceasing abruptly. It depreciates not because of declining yearly income but declining life expectancy.[80] We might call it the one-hoss shay case but that would have only poetic value since new rolling stock tends in fact to fall rapidly in annual use-value, resulting in the typical ski-slope depreciation curve traced by Blue Book values of used cars. The present case is more the slum tenement which with advancing years is sub-divided, maintaining gross income, but accelerating depreciation, until one day it is condemned and closed, or perhaps demolished due to locational obsolescence.[81]

The present value of this model slum tenement is the sum of the discounted values of all future incomes:

$$V_0 = a_1(1+i)^{-1} + a_2(1+i)^{-2} + \ldots + a_l(1+i)^{-l} \tag{11}$$

The passage of year zero does not reduce its value much. It might seem at first that V_0 would fall by the loss of the first term $a_1(1+i)^{-1}$, which is the largest term. But that is to reckon without the appreciation of all the later terms which move one year closer to the present. When all the a values are the same, the end result is to remove the last term, not the first.

[80] Once again, see fn. 30.

[81] Thanks go to Dr. Herbert Dorau, who has let the writer examine his unpublished *Integration of the Straight Line Accrual* in which he treats building depreciation in much the manner that we do here. Earl Bossard has used this method in forecasting the property tax base of Shaker Heights [*36*, 43].

Philip Stern points out that this pattern of building depreciation is implicit in repayment patterns on mortgage loans in equal monthly installments. If buildings depreciated like cars, owners would soon have no equity and lenders would have insufficient collateral security [*33*, 152–53]. Frederick Babcock's classical *Valuation of Real Estate* also treats depreciation essentially in this manner (chap. 27).

Thus:

$$\text{(12)} \quad d = V_0 - V_1 = a(1+i)^{-1} - i\left[a\frac{1-(1+i)^{-l}}{i} - a(1+i)^{-1}\right]$$
$$= a(1+i)^{-1}[1+i] - a[1-(1+i)^{-l}] = a(1+i)^{-l}$$

As a counterpart and confirmation of this definition of depreciation, note what it implies about the value of income, $a - d$.[32]

$$\text{(13)} \quad Y \equiv a - d = a - a(1+i)^{-l} = a[1-(1+i)^{-l}]$$

But

$$V_0 = a\frac{1-(1+i)^{-l}}{i}$$
$$\therefore Y = V \cdot i.$$

Income is defined now simply as interest on the remaining value of the asset, a credible notion in its own right. In early years when value is high, the cash flow is mostly income, with only a small depreciation write-off; in later years the cash flow is mostly depreciation. This also accords nicely with the observed fact that older buildings usually pass into high density use, occupied by lower status tenants who tend to have higher propensity to wear and tear in using the premises.

The acute reader will have noted that our definition of income now leads directly to the conclusion of making the income tax bear on buildings in the same time pattern as the property tax: high in early years, low in later years, taking always a constant share of a base which varies directly with the capital value. This harmonizes with our conclusion about the tax on timber, and is subject to the same severe qualification. The tax on buildings, is a damaging tax. Hardly anyone has a good word for it, least of all the present writer. But it is visibly damaging precisely because it does what it is alleged to do, it taxes the possession of capital and is not avoidable, save by emigration. If the income tax is less damaging it is not because it is a better way to tax property, but a way to let property avoid taxes and shift more burden to labor. In the process of avoidance, capital twists and contorts itself into uneconomic time-patterns, abandoning urgent needs and superior before-tax returns to sequester itself in an inadequate number of excessively durable buildings.

Having defined true depreciation, we have completed Step 2 of this project. That brings us to Step 3, which is substituting true depreciation into Equation (10). This is a delicate stage of the operation. We must sum the elements of the present value of depreciation in one simple expression. There are several points where one misstep would ruin the whole job.

A touchy matter is to get the end points right.[33] Depreciation during

[32] Credit is due to Professor Samuel Thorndike, Jr., for raising this point.

[33] Thanks are due to Professor Robert San Souci for repeated emphasis on this as the key to the mathematics of finance.

the first year of life is, we have shown, $a(1+i)^{-l}$, representing the loss of the present value of a_l, (the *a* due at the end of the last year, *l*.) Succeeding discount powers would fall by one each year, giving exponents of $1-l$, $2-l$, $3-l$, etc. The last term is not, however, raised to the power $l-l$ or *0*, but rather -1, or $l-l-1$. Because depreciation during the last year of life cannot be the full value of *a*, which by assumption is received at the end of the year. The value of the asset at the beginning of the year is $a(1+i)^{-1}$, and that, obviously, is all there is left to depreciate during year *l*.

In general, then, for any year *n*, the depreciation is $a(1+i)^{n-l-1}$ [23, 341].

A close look at year *l* also tells us why we use *i* rather than *r* to define depreciation. Income in year *l* is now $a - a(1+i)^{-1} = a[1-(1+i)^{-1}] = [a(1+i)^{-1}]i$. That is, income is interest on the value of the asset when the year began. Now, this income is our tax base. If we used *r* instead of *i* to define it, the tax base would be the after-tax income, an obvious error.[34]

It might seem that the market value of the asset at the beginning of year *l* would be $a(1+r)^{-1}$, making our depreciation schedule arbitrary, and departing from market values which would be set by discounting at *r*. But remember there are two tolls to pay for passage through the year: after-tax interest, *r*, and also taxes themselves. To be worth a price π on January 1, our asset maturing on December 31 must return not just $\pi + \pi r$; but also πit to pay taxes. But $r + it = i$, so $\pi(1+r+it) = \pi(1+i)$. From that it follows directly that $\pi = a(1+i)^{-1}$, where *a* is a payment due at year-end.

The rate the taxpayer uses for discounting future write-off rebates is, however, *r*, as in Equation (10). That is because the rebates are his without additional taxes.

Now we may find the present value of all write-offs, PVW, for substitution in Equation (10).

$$\text{(14)} \qquad \text{PVW} = a\left[\frac{(1+i)^{-l}}{(1+r)} + \frac{(1+i)^{1-l}}{(1+r)^2} + \ldots + \frac{(1+i)^{-1}}{(1+r)^{l}}\right]$$

The brackets enclose a geometric progression whose first term is $\frac{(1+i)^{-l}}{(1+r)}$, whose multiplier is $\frac{1+i}{1+r}$, and whose terms number *l*.

[34] We believe that Professor Musgrave falls into this error in his definition of the "annuity method" [23, 341]. It is perhaps this which prevented his finding a general solution.

$$(14a) \qquad \frac{PVW}{a} = \frac{(1+i)^{-l}}{1+r} \cdot \frac{1-\left[\frac{1+i}{1+r}\right]^{l}}{1-\frac{1+i}{1+r}} = \frac{(1+i)^{-l}-(1+r)^{-l}}{r-i}$$

Substituting (14a) in (10)

$$(10a) \qquad 1 = a(1-t)\frac{1-(1+r)^{-l}}{r} + ta\frac{(1+i)^{-l}-(1+r)^{-l}}{r-i}$$

Recall that $a = \dfrac{i}{1-(1+i)^{-l}}$

$$\frac{1-(1+i)^{-l}}{i} = (1-t)\frac{1-(1+r)^{-l}}{r} + t\frac{(1+i)^{-l}-(1+r)^{-l}}{r-i}$$

Now to Step 4: does *r* vary with life, *l*?

Equation (10a) is too formidable to solve directly for *r*. Fortunately there is an easier way. We simply test a hypothesis: is the equation satisfied if $r = i(1-t)$? A few substitutions and cancellations answer the question.

$$(10b) \qquad \frac{1-(1+i)^{-l}}{i} \overset{?}{=} (1-t)\frac{1-(1+r)^{-l}}{i(1-t)} + t\frac{(1+i)^{-l}-(1+r)^{-l}}{i-it-i}$$

$$\frac{1-(1+i)^{-l}}{i} \overset{?}{=} \frac{1-(1+r)^{-l}}{i} - \frac{(1+i)^{-l}-(1+r)^{-l}}{i}$$

$$0 = 0$$

(10b) is true for all values of *l*. This means that the use of true depreciation as the basis for tax write-off gives us an income tax that is free of intertemporal bias. The taxpayer's yearly rate of return is reduced by the full tax rate, regardless of the life of his investment.

This completes the fourth and last step of the operation. We have discovered that the income tax on depreciating assets may be freed of intertemporal bias by writing off capital at the time it is recovered. This reinforces our earlier findings for appreciating assets like trees and full salvage assets like the Bessie model. By following the simple rules of taxing appreciation and deducting depreciation we not only make the tax neutral within each class but also among classes, for in all cases the rules make $r = i(1-t)$.

The result is of practical interest as a benchmark against which to judge present write-off formulae. It is even more interesting as a practical reform proposal in its own right, because it is operational. It is simply the ad valorem property tax! The basic rules to follow are simple. It may have appeared complicated to prove that the rules led to unbiased results, but applying the rules poses no such problem. It is even simpler than following market depreciation downwards, or appreciation upwards. The practical "operationality" of our system may be better appreciated by realizing it does not call for a fine appraisal of each year's change in asset value, an apparent practical barrier that has dampened the ardor of some theoretical supporters. Rather, it defines income as a percentage of asset value, so that one capital value is all we need to know, as with the property tax, and an assessed approximation is tolerably acceptable. We will see that this principle holds as well for appreciating land values. Yearly reassessment is best, but not absolutely essential for a workable system. The idea is, if we know the market value we know how to allocate cash flow between income and depreciation, not perfectly, but much better than under any of the arbitrary formulae now in use.

To criticize our method, as some will, on the grounds that property appraisal is impracticable, would be merely captious, because all systems of taxing property income require property appraisal at some critical points. Furthermore, if property appraisal is impractical it is not just taxation but the free market mechanism that stands condemned, for how else do people buy and pledge property?

We have not as yet produced a completely general proof. However, we will from here on regard the proposition as proven, for three reasons: (1) it is proven for point-input point-output, and all cases are summations of point cases; (2) we have illustrated the proof in two models which were summations of point cases; and (3) we provide a completely general mathematical proof in an appendix.[85]

Now we are in a position to see clearly some further biases to longevity inherent in current income tax practice. If an asset yielding a constant annuity like our slum tenement model were to receive straight line depreciation, that would be too fast. True depreciation begins low and rises like a compound interest curve. Figure 2 points up the contrast. Granting straight line depreciation on the asset writes it off at a faster rate than the true one and therefore raises r above $i(1-t)$.

The resulting bias to longevity inside the subclass of tenement models (i.e. constant finite annuities) is only moderate. In the appendix we show how r varies with l, under straight line depreciation applied to an annuity.

But the bias is much greater if we compare constant annuities with assets yielding declining streams of income, like trucks. Their true

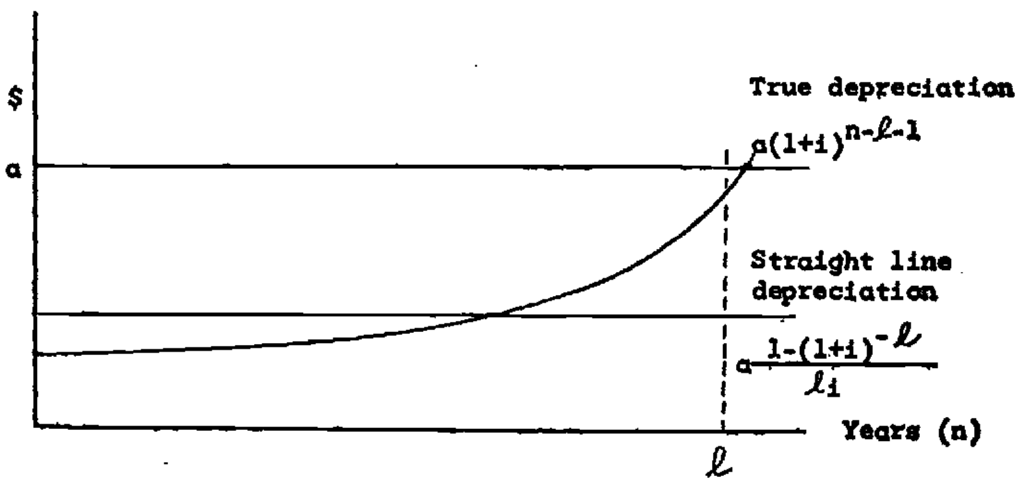
[85] Professor Musgrave has worked through an arithmetic example leading toward conclusions consistent with ours [23, 340]. His treatment is limited, however, to one case of straight line depreciation. We do not know what his position would be on our allegation that a neutral income tax is the property tax.

depreciation is much faster than the tenement model's, even assuming equal total lives. But here we again run afoul of lawyers who think in categories and not continua. In tax law, "pigs is pigs"[36] and "life is life," the number of years between birth and scrapping,[37] so trucks and tenements of the same "life" would be written off at the same rate regardless of the faster true depreciation of the trucks. This tends to make tenements relatively more attractive after tax than before. Trucks might very well end up yielding an $r < i\ (1-t)$; and that would obviously be so if, for example, half the value were recovered in one year and write-off took ten. Tax liability would then precede the mean write-off by five years.

In general, arbitrary write-off schedules based on "life" favor assets yielding steady or rising income streams and penalize their opposite numbers yielding falling income streams. Thus they encourage investors to build more durability into assets than they would in the absence of taxes; and they open a wide avenue of tax avoidance.

Figure 2

True depreciation and straight line depreciation for an asset yielding a constant annuity over life



[36] For the benefit of younger readers, the allusion is to a tale by Ellis Parker Butler wherein a narrow-gauged freight agent insists on shipping Guinea Pigs at the Swine rate.

[37] More realistically, between birth and statute life, based on broad guidelines depending on the category in which the asset's legal name places it, and only remotely related to economic life of the particular asset.

It is not just lawyers who may fall into this error. The Chairman of the President's Council of Economic Advisors, in L. B. Johnson's Administration, in seeking to deny that capital-intensity implies durability of capital instruments, makes his case with an example in which he alleges that three methods of production all involve capital of the same "life" because the fixed capital lasts for 10 years in each method. But the lives are the same only in the most superficial sense because they use different amounts of working capital. G. Ackley, *Macroeconomic Theory* [1, 467–69].

In fact, the tax laws have moved towards tax exemption for durable capital by accelerated depreciation, capital gains treatment, declining balance depreciation, sum of the years' digits, the investment tax credit, expensing of some durable investments, implicit expensing through allocating owned resources to building durable capital, (extra-legal) use of expensable hired resources to build durable capital, super-accelerated write-off for buildings placed on leased land, etc. In the abstract, these devices could benefit short maturities as much as long. In practice they usually benefit the long. First, they are mostly reserved for assets more long-lived than specified minimum lives;[38] second, they tend to make write-off schedules more and more independent of actual lives and time-patterns of income streams.

In addition, as everyone knows and most economists deplore, use of the realized-cash definition of income exempts altogether the implicit income from owner-occupied residences and other consumer capital. This creates in the income tax an additional bias to longevity. Of course short-lived consumer capital benefits as much as long from this exemption. The bias to longevity comes because the individual piling up tax-exempt consumer capital has to reduce its turnover rate to avoid increasing his rate of real consumption. Also, he now discounts future implicit income at the lower after-tax rate of return, r, which favors longer lived investments.

These various practices are not without short run macro-economic benefits. They raise the marginal efficiency of capital and encourage net new investment. They let capital avoid taxation at home and prevent its flight overseas. But they do so at a fearful price. They shift the burden of taxes from property to labor (land escaping also by various ruses we have mentioned and others yet to be shown). They misallocate capital into more long-lived forms than would best meet consumer demands. And they retard replacement in all future years, lowering gross investment in any year and thus lowering the sum of income-creating expenditures and the demand for labor.

(*Continued*)

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[38] For example, Congress in 1962 plugged a loophole by denying to personal property the privilege of capital gains treatment on the excess of sale value over book value resulting from excessive depreciation—but let real estate retain the privilege [33, 153]. Recapture of excess sale values is at a sliding scale of rates that declines with the period of time a building is held [33, 155–56]. The idea seems to be that long term investors are "legitimate," while others are "fast-buck artists." We think that the fast buck is socially superior to the slow one.

Congress' special partiality for real estate investors shows up again in the 1960 law letting Real Estate Investment Trusts deduct their *dividends* (sic) from taxable income.

Tax-Induced Slow Turnover of Capital, IV

By MASON GAFFNEY

V

Land

WE HAVE ANALYZED three classes of durable capital assets: appreciating, full salvage, and depreciating. Finally we come to the fourth and last, land. Land differs so much from the first three that many economists regard it as a class *sui generis*, and so do we, but the reader may prefer his own taxonomy and still note with us that land yields income in perpetuity; land purchase is not income-creating, macro-economically speaking; land never turns over in the Austrian sense of production and liquidation; land is immobile among taxing jurisdictions; land is periodically salvaged by demolition of old buildings and renewed with new ones; land grades off from the best down to a marginal supply which is virtually free.

Land has long been regarded as a peculiarly promising tax base because it cannot emigrate from a jurisdiction, nor be used up, nor otherwise flee from taxes. Marginal land is not sterilized by taxes on land rent or land value, because marginal land has neither (a point known to fame since Ricardo's *Principles*, Chap. X, "Taxes on Rents" [26]). So if an intertemporally neutral tax should fall on land rent the tax would not be shifted, but would remain neutral. It would never, like a tax on capital, lower the marginal efficiency of capital. To what extent does our present tax system take advantage of these opportunities?

Beginning with the excise tax, it favors land enormously because land never turns over. Only the net income of land could be subject to a retail sales tax. In practice, even that is often exempt. Whoever heard of an excise tax on ground rents from long term leases, for example, or on slum rentals, or on landlords' crop shares, or on implicit income from owner-occupied residences, or on parking fees? Excise taxes are a landowner's best friend. The doctrine that a general retail sales tax such as exists in many states is approximately neutral in its effects on sellers by virtue of its general application should be thoroughly discredited.

The income tax is quite another matter. Costs are deductible, so there is no tax on turnover, and no inherent bias in favor of land. On the contrary, the various devices for advancing write-off of depreciable or recoverable capital before capital recovery, although they do bias investors to longevity, should not bias them toward land, the most long-lived of assets, because land is not supposed to be written off at all. Rather, they tend by partially exempting capital from taxes to throw more burden onto land.

A simple tax on the net income of land would, so long as the land is unappreciating, lower income by the full tax rate, just as with Bessie's milk; and that would seem to be the end of it.

But it is hardly the beginning. In fact, land escapes the full impact of the tax rate in several ways: by being written off in disregard of law; by appreciating; by yielding deferred periodic incomes; by capturing the value of land development investments; and by submitting to capture under the rule of prescription. We will treat these in order.

Taxpayers have not found it very difficult to write off land purchases. Would that the I.R.S. offered as little resistance to the efforts of professional men to write off training costs. It is only necessary that one buy land under an old building. Then he allocates most of the purchase price to the depreciable building, and writes it off as depreciation—never mind how many times it has been written off before.[89] Thus land which the law says is not depreciable at all, may be written off not just once, but several times!

Were it not for this device the income tax would serve as an effective stimulus to urban renewal. Once the cost of an old building was completely written off the current operating income would be fully taxable. The law would recognize it for what it is, pure ground rent, and recognize the building for what it is, an empty shell, a shade enduring a life-after-death. Thus in the year after the last write-off the slum owner would suddenly face a much higher tax bill, which he could then mitigate by giving consumers what they want, a new building, and writing off its cost.

But under present practice the surest way to lose the privilege of writing off the cost of land is to clear it and erect a new building. For then the I.R.S., seeing through a glass darkly, finally perceives that what you bought really was not the old building but the land beneath it—and denies write-off. (After all, *someone* has to pay taxes to finance those Urban Renewal subsidies!) The net effect is this: you can depreciate land so long as you do not improve it.

The fact that land can be written off, even if only once, casts an entirely different light on the question of tax bias. To write off something which lasts forever is to receive from the Treasury a large share of the cost of an asset which continues to yield its income to you in perpetuity. After the last write-off the Treasury gets only a return on its investment. The land-

[89] If challenged, he can refer to the local assessor's allocation, which almost always understates the land component, partly no doubt to accommodate local people in their dealings with I.R.S., which accepts the local assessor's breakdown as conclusive evidence.

owner's equity is reduced by the full amount of the rebate, and on that reduced investment he receives an income 100 per cent tax-free. From the moment of full write-off, the land purchase has been handled as if it were a current expense,[40] like a disposable paper towel.

It has been suggested in the past that the fiscal authority should buy from landowners the right to tax them, *i.e.* it should compensate landowners before raising their taxes. By letting them write off land, that is exactly what it has done. Only the operation has been quiet and unacknowledged, and has not been matched by equal generosity to salaried men, who pay taxes for the original sin of being born, the curse of Adam, the privilege of giving involuntary military service, and the folly of voting for men who show them their interest in their ruin and their ruin in their interest. How the ancient gods must be laughing!

Not all land is written off, to be sure. It has to be income property; it has to be bought for a good price and under an old building. Owner-occupied residential land and the houses on it are exempt, as everyone knows, because implicit income is tax-free. Fringe land, we will show, is largely exempt because of appreciation. But there is another large class of land that achieves its exemption by write-off: minerals. I have treated this case elsewhere [*14;* see Editorial Conclusions]. Suffice it here that the depletion allowance lets the investor recover, tax free, not only his discovery and development costs (which have already achieved tax exemption by being written off as expenses), but the value of the mineral rights before discovery, a pure rent, a value that grew up from nothing and on which no income tax was ever levied.

A second way that land receives a lower effective tax rate is through appreciation. If the land is held idle while appreciating, the case is like that of the tree. In an informed market the market value grows at compound interest, so that each year's gain is automatically plowed back into the base and earns interest in the following years. But this income is not taxed year by year as it is constuctively received and goes to work earning more income. The tax is deferred until sale, at which time the rate is one-half or less that on ordinary income.

It is sometimes alleged that land and common stock price increments are not income because they are the price of future income; and that to tax them as well as the future ordinary income they yield is double taxation.

[40] If he sells, the landowner is taxed on the gain, seemingly limiting the time of the exemption. But he need never sell; and if he does the tax is deferred, and at capital-gains rates. Remember, too, that most of the write-off is taken well before the year of *full* write-off. Remember, finally, that the new owner may, and does, repeat the process, until the time of demolition and renewal.

Fortunately this is not a great issue—the law does recognize such gains as income. Anyone denying that the increment is truly income must be hard put to explain why the investor has kept his money tied up in idle land for 20 years. But the favored treatment capital gains receive may reflect some residual influence of the double taxation notion, so let us refute it.

Land prices rise because the passage of time brings higher future incomes closer to the present. This is a benefit above and beyond the incomes themselves. Value rises from the approach of higher future incomes, without any of them having necessarily been received. It is true that part of the future incomes will be taken by taxes; but land prices stem from the income after taxes, and price increments arise from the temporal approach of these higher after-tax incomes.

Putting it another way, suppose that after 20 years the original owner sold his appreciated land, and invested the gain in an earning asset. The land yields an income for the new owner; the new asset yields another income to the original owner. But now there are two incomes where there was one before. Or suppose the original owner spends the gain on consumption. He has consumed his entire income—yet the new owner continues to receive income, unabated, and the old owner has not drawn down his original capital but just consumed from income.

Appreciation is income for the same reason that depreciation is deductible from income. True depreciation is the present value of a loss or deferral of future income; appreciation is the present value of a gain or advance of future income. Indeed, referring back to Equation (12) it is evident that true depreciation is net of the unrealized appreciation of the unexhausted parts of an asset. So true depreciation already entails the concept of taxing unrealized appreciation. Annual taxation of unrealized appreciation is consistent with our definition of true depreciation, and *not* to tax the former would be inconsistent and unbalanced and would result in a distorted tax system.

So land appreciation is income, just like tree appreciation, and a neutral tax would take it as it accrues each year. The present system of deferred taxation grants it a lower effective rate, thus making purchase of land with appreciation potential relatively more attractive than it would be in the absence of taxes.

Another way of perceiving the point, one which would apply as well to the tree case, is to think of tax deferment on unrealized appreciation as tantamount to plowing back income into the land investment and *automatically allowing it to be written off as expenses,* deferring the tax until later. Thus the principle of taxing realized rather than accrued income is the same as granting the expensing privilege to each year's added incremental investment in the land value.

The privileged nature of this treatment may be appreciated by comparing the tax treatment of an E bond held in one's safe-deposit box. The law is explicit: declare and pay tax on the yearly interest, even though you never touch it and indeed cannot do so without penalty. Or consider the treatment of contributions to some pension funds. These are involuntary; withheld from wages; non-transferable; forfeitable; non-bankable—but fully taxable in the year withheld.[41] Or compare the F.I.C.A. payroll tax. Employees pay income tax on gross salary before the F.I.C.A. deduction, even though benefits are deferred to age 65—for those who survive.

Appreciating land enjoys further advantages due to its permanence. Comparing land with trees, land gets the better tax break because trees have to be cut and sold when ripe. Not so with land: it need never be sold, and if the owner has bought it for "expansion" in the future, he will have achieved a tax-free income when his need arrives. (He gets free something he would have paid for.) If the owner can hold on until death do the land and him part, his heir begins again with the higher basis, the tax being forgiven forever [*31*]. If he sells his "residence"—or a large lot around his house which a complaisant I.R.S. accepts as such—he can defer the tax by reinvesting in another residence within one year of sale. If his land is condemned he can do the same. If he is 65 or over he may be able to avoid the tax under a new law. Or if the land is a "farm" he can barter it, tax-free, for a larger "like property" further out of town, letting the new owner with a higher basis subdivide the appreciated one.[42] Or he can donate appreciated land to charity or education, writing off the appraised value without ever having paid a tax on the appreciation, and enjoy use of the land until death. All the local taxes and interest that he may pay during his wait are expensable even though they are properly viewed as part of the long-term investment itself and should

[41] Later growth of the fund at interest is not usually taxable until later, softening the contrast in treatment. Some pension fund contributions are not taxable even initially. There is great individual variation, much of it capricious. Contributions to the Wisconsin State Employees Retirement Fund, for one example, are taxable although not received.

[42] Section 1031 of the Internal Revenue Code provides: "No gain or loss shall be recognized if property held for productive use in trade or business or for investment (not including stock, etc.) is exchanged solely for property of a like kind to be held either for productive use in trade or business or for investment."

There is a good deal of "tailoring" of transactions to fit the letter. A prospective buyer of a suburban farm for cash may instead buy a rural farm (satisfactory to the prospective seller) and then swap farms with him. The rural land of "like kind" might also be a golf course, airport, cemetery, quarry, dump, etc. A network of brokers' clubs has developed to arrange such bartering.

be capitalized [*8*]. If he loses on a sale he can deduct the loss from ordinary income, often selecting the year of loss realization for his greatest convenience. He can sell on the installment plan and pay taxes only as the installments come in. He can sell on a contingent price basis and count all payments as non-taxable capital recovery until he has recovered his full basis, and only then start paying taxes—another long deferral of liability. If overall losses pile up, he can delay realization until after merger with a profit-making business. If the landowner is a church, school, charitable or fraternal or cemetery organization, its gains may be exempt, even though the same organizations would be taxed if they made money by rendering services. It is no straight narrow path that leads down to exemption, but a royal road, toll-free, posted and blazed all the way, with clergymen and educators for respectable companionship.[43]

A neutral income tax on increments to land value would take as its base the annual appreciation. In equilibrium the appreciation will just cover interest on the value at the beginning of the year (assuming, for simplicity, no other taxes or other carrying costs). Here, just as in the tree case, the neutral income tax base transforms the income tax into the property tax. If $S_n \equiv$ site value in any year, the neutral income tax base is $S_n.i$. The property tax base is S_n. In this case i is not lowered by the tax—land supply being fixed, the tax is entirely absorbed by land in lower values of S_0, following the traditional theory of land tax capitalization worked out by Jensen [*19*]. Tax anticipation lowers S_0—the early value base from which appreciation begins—by whatever amount may be necessary to let the holder earn i per cent while he holds it idle for appreciation.

A long-standing criticism of the property tax applied to suburban land that is rising in value is that use of capital value rather than current annual value as the base results in overtaxation of the land. The implicit assumption is that appreciation is not income and should be tax-free. The reason land sells for more than capitalized current income is the expectation of higher future income. This is not a static condition, but a journey between equilibria.[44] Each year the higher future moves closer to the present, a blessing signalized by the value's rising at i per cent. That is an income. Once that be accepted, and the bias of deferred taxation be accepted, then it follows that the capital value base is a way to tax this income, and more-

[43] On these matters the writer has received valuable insights from John Denton, Douglas Kilbourn, Daniel R. Dixon, and Ben Musa, to all of whom he offers sincere thanks. An excellent treatment is found in William Scofield's "Value and Competition for Land" [*27*].

[44] This helps explain the profession's difficulty in coming to grips with the question. We have all been nursed on statics.

over the best way, a neutral way. It may be done by use of either the property tax or the income tax.

In the analogous tree case we had to qualify our conclusions drastically on considering shifting. Here the analogy ceases, for there is no shifting of the land tax. It does not lower the rate of return in the first place, but rather the cost of buying the asset on which the return is reckoned. The asset being fixed in supply, that ends the chain of reaction.[45] There is no destruction of marginal supply, because the tax on marginal land is zero. There is no flight of tax base by emigration, by retarded turnover, or dissaving.

These matters may be clarified by constructing a model of land which appreciates and at the same time yields ordinary income. We call it the "Perpetual Appreciation" or PA model.

Suppose a (piece of) land yields a yearly income above current costs that grows by g per cent each year.[46] Let the income at the end of the initial year be *1*. The site value, S_0, is the sum of the progression:

$$(15) \qquad S_0 = \frac{1}{1+i} + \frac{1+g}{(1+i)^2} + \ldots + \frac{(1+g)^n}{(1+i)^n} \quad (g < i)$$

$$S_0 = \frac{1}{1+i} \cdot \frac{1}{1 - \frac{1+g}{1+i}} = \frac{1}{1+i-1-g} = \frac{1}{i-g}$$

From (15) it follows that

$$(15a) \qquad S_0 i = 1 + S_0 g$$

That means that $S_0 i > 1$. *1* is the yearly cash income. Therefore the income is too little to cover carrying costs and to warrant anyone's holding the land, with or without taxes. Shall we then conclude that no one can afford to own this land at the alleged price S_0?

How can anyone behave economically in this rising land market and add enough land to his holdings to equate marginal net yields with marginal carrying costs? Very simple: he counts the yearly increment as income *in the year it accrues* in the form of higher land price.[47] Anyone denying this must also deny that the land market works economically. The yearly deficit he must cover is $S_0 i - 1$, which from (15a) equals $S_0 g$. But $S_0 g$ is

[45] Or it would, if truth were altogether that simple. We still must consider the practical effect of lower land prices on the production of Wicksell's "rent-goods," or land development investments. We table that question for a few paragraphs. For the present, consider these investments to be skilfully deducted by the assessor in measuring the land value tax base, which rises because of the approach of the city and publicly financed works exogenous to the owner.

[46] For a thorough discussion of this case see Leon Walras [40].

[47] The writer is indebted to Mr. Nicolaus Tideman for introducing this concept.

exactly the yearly appreciation of S_0:

$$S_1 - S_0 = \frac{1+g}{i-g} - \frac{1}{i-g} = \frac{g}{i-g} = S_0 g \tag{16}$$

Therefore the cost of carrying land each year at the-price-S is just covered by the sum of net cash income plus current appreciation. Thus, if traditional valuation theory is correct, investors put a value on appreciating land which treats current appreciation as current income. Why, then, should an income tax on it be deferred? No reason in the world unless we intend, as a matter of deliberate public policy, to give partial tax exemption to landowners. For that is just what the present policy does when it defers taxation of capital gains until time of cash sale.

In this case, as in all previous cases analyzed, an intertemporally neutral tax is one that taxes a constant percentage of current income, and current income is a constant percentage of capital value.

We emphasize that the PA model clears away an alleged practical difficulty of including asset accretion in current income. Henry Simons, William Vickrey, and Irving Fisher all saw the intertemporal neutrality of the accrued basis. They hesitated before the practical problem of appraising property each year to tax the increment. The 1961 Joint Economic Committee added a jaundiced caveat [*43*, *69*], as did Lawrence Seltzer [*28*, *40*].

What we have just shown, however, is that the property tax that takes a percentage of capital value *automatically taxes increments.* No further increment tax is needed. So what we propose is not an innovation with no practical possibilities, but a strengthening and extension of the property tax on capital value, which we have always had. Be it further noted that it is quite inconsistent to claim that alleged practical difficulties prevent annual tax recognition of positive appreciation in a system that has devised several ways to allow negative appreciation annually.

A third general way for landowners to receive a lower tax rate is to select time patterns of land use that sacrifice smaller early rents for larger late rents. This is a form of investment, on the whole a legitimate one. Like all investments, these may enjoy some tax abatement by deferral of realization. The cost is the early foregone rent, the payout is the later premium rent. Not all land offers opportunity for this maneuver. There must be some intertemporal interdependence of rents. Examples are: starting new orchards (which require 5–10 barren early land-years as an input); forestry, deferral of mineral extraction (the L. C. Gray example with which we opened our Introduction); deferring site renewal in transitional land-use areas awaiting greater "ripeness" or certainty.[48]

[48] Another example is writing long term ground leases wherein early rents are low

The cost is not explicit, but is still as good as expensable since no tax is due on the foregone rent that would otherwise have been taxable cash income. That is, the effect is the same as though the early rent were received in cash and then reinvested and expensed. A good term for this is "implicit expensing." It is not reserved to landowners. The student who foregoes present income to devote his time to an education for enhanced future income is implicitly expensing the investment of his time as well. But land is a convenient vehicle for a great deal of this kind of thing, more so than other assets, because of its infinite life. Expensing, as we have seen, is tantamount to complete tax exemption. That is not to say that the entire land rent achieves exemption, but the gain from deferral does.

In this case that is not necessarily a bad thing. It means that a tax on land income, taken by itself, is intertemporally neutral.

Let us take a point-input point-output case on good land, where the investment has to grow fast enough to yield a rent (or a market return on the site value) as well as interest on the initial non-land costs, C_0. There is a periodic surplus of gross income over compounded C_0, which surplus we call the periodic rent, A_m. *m* is the year of maturity, and A is the periodic equivalent of *a*, the annuity rent. A_m and *a* are related by a standard tabulated financial formula:

$$a = A_m \frac{i}{(1+i)^m - 1} \tag{17}$$

At the interest rate *i* the investor is indifferent between the yearly rent and a periodic rent, A_m.

In the absence of any disturbance to *i*, a tax on A_m is equivalent to a tax on *a*, and leaves the indifference unchanged. That is:

$$a(1-t) = A_m(1-t) \frac{i}{(1+i)^m - 1} \tag{17a}$$

reduces to (17) because the factor $(1-t)$ cancels. The tax on rent does not itself disturb *i*, and so long as nothing else does either, the tax is neutral. The reason the tax does not change *i* is that it is fully absorbed into

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and later ones high. This might seem to be offset by an equal and opposite tax disadvantage to the lessee, but on the other hand it is a means of extending him credit at a time when he needs a lot, and it reduces his cost deduction during early years of high write-off, so it often suits nicely to maximize joint (after-tax) benefits of lessor and lessee. One also has the option of selling for capital gains just before the higher rent takes effect.

Another device is to allow lower rent in consideration for the lessee's leaving a good building at lease-end, which the fee-holder acquires tax free (taxable as a capital gain if he should ever sell) [33, 156–58].

lower site values, S. One continues to earn a market return on the reduced base. There is no loss of marginal production, and hence no shifting, because on marginal land the tax base is zero.

Why is the taxpayer indifferent between an earlier and a later tax in this case? Because the later tax is higher. A_m, the later tax base, is greater than $\sum_1^m a_n$, the earlier tax base. (17) is derived by compounding each a_n forward to year *m*, so $A_m = \sum_1^m a_n (1+i)^{m-n}$. The excess of A_m over $\sum_1^m a_n$ is compound interest on the earlier payments foregone. A_m is a sinking fund which grows each year by the current payment plus interest on accrued payments. So the tax liability deferred each year grows at compound interest, and the taxpayer does not abate the tax by deferring realization.

It might seem now that the tax on deferred land income is also a tax on the interest earned by deferral of use. But it definitely is not so, and it is important to understand why not, both to clarify the present point and for all analysis of the fascinating relationships of rent and interest. So far in this paper we have skirted the second matter, which is, however, central to any analysis of tax shifting.

Consider one year's rent, a_1, due at the end of year zero. Suppose the landowner defers it. He is plowing it back into his land-use plan. At the end of year *m* he realizes it at compound interest, and it is worth $a_1 (1+i)^m$.

The tax on it, *T*, also grows at compound interest. Had it been taxed at the end of year zero, $T_1 = t \cdot a_1$; being taxed at the end of year *m*, $T_m = t \cdot a_1 (1+i)^m$, so $T_m = T_1 (1+i)^m$.

But if we were taxing interest, T_m would have to be greater than $T_1 (1+i)^m$, to cut into *i*. When $T_m = T_1 (1+i)^m$ we are letting the landowner earn the gross-of-tax rate return on his investment in deferral of land rent. We just aren't letting him earn any more than that. But we are not taxing interest.

This explains the L. C. Gray example of minerals conservation with which we opened our Introduction. The miner who defers extraction is foregoing, and thereby investing, current rent to gain enhanced future rent. A tax on the pure rent income is intertemporally neutral because the after-tax rent grows over time at the same percentage as the full rent.[49]

[49] For modern treatments of Gray's principle see Orris Herfindahl, "Depletion and Economic Theory" [*17*]; and William Vickrey, "Economic Criteria for Optimum Rates

So the part of the income tax that falls on land rent is intertemporally neutral. But let there be a tax on interest, so $r < i$, and there is a premium on deferring realization of land rents, just as there is on other deferrals of tax liability. Any deferral that yields at the rate *i* now yields the investor more than *r*, the after-tax yield on alternative investments. So landowners alter their use plans toward the future until they reach a new equilibrium.

Referring back to equation (17) since $a = A_m \dfrac{i}{(1+i)^m - 1}$ then $a < A_m \dfrac{r}{(1+r)^m - 1}$. It now requires a higher annuity, a′, to be as attractive to taxpayers as A_m, and lower and later deferred rents that were submarginal now become interesting for landowners.

A good way to perceive this, a way that is equivalent to the use of calculus, is to think of how to maximize *a* when A_m is a positive function of *m*. *a* reaches its maximum in the year when the percentage increase of numerator and denominator in (17) are equal, which could be phrased "when the elasticity of the ratio equals one." The percentage increase of the denominator is positively related to *i* or *r*, whichever is used; and for large values of *m* becomes virtually equal to *i* or *r*. The year when unit elasticity is reached using *i*, the elasticity using *r* is still greater than one, because $r < i$. So at the after-tax rate, *r*, the taxpayer maximizes *a* by choosing longer cycles. In general, all later rents gain lustre relative to earlier ones, so all land-use plans are re-timed towards the future.

The lowering of *r* below *i* lightens the tax burden on the landowner who defers rent in three ways:

— A_m converts to a higher annuity at *r* than at *i*. (A_m remains the same by the assumption of no tax shifting.)

— the annuity value rises as A_m is deferred to $(m + x)$ in response to the lower rate of return.

— the annuity is capitalized into land value at *r* instead of *i*. Since $r = i(1 - t)$, and the annuity falls by less than the factor $(1 - t)$ due to deferral of A_m to $(m + x)$, the capital value of land will actually rise—a little capital gain on top of everything else!

But what if the tax on capital is shifted, so that $r = i_b$ (recall that i_b is the base rate of return in the absence of taxes)? In general the shifting will be to land, if the tax jurisdiction is small, because then wage rates,

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of Depletion" [39]. Both appear in Mason Gaffney (editor) *Extractive Resources and Taxation* [14]. The editor in his Conclusion then seeks to expand the principle to account for durable investments in mining improvements.

interest rates, material costs, and product prices are parameters exogenously set, and land may be treated as the residual claimant in the simple old manner of classical theory. Then the value A_m, the periodic land rent, becomes smaller by the amount necessary to absorb the tax; and site value, *S*, drops in the same proportion.

But this drop in land rent tends to retard the maturity of investments on the land. Timber, for example, is financially mature when its yearly growth increment, *g'*, is no longer enough to cover interest on the sum of its salvage or stumpage value, *g*, plus the site value, *S*. If site value is lower, and all other parameters remain the same, harvest comes later.[50] As a secondary effect, this will somewhat abate the drop of site value, reflecting the value of tax avoidance.

The essence of the matter may be grasped from the equation relating rate of return to site value. If we require a tree to yield a return on the land it uses, as well as the depreciable costs, the return is defined by equation (18).

$$(1+i)^m = \frac{R_m + S}{C_o + S} \tag{18}$$

After a tax, fully shifted to *S*:

$$(1+i)^m = \frac{R_m + S - t\,(R_m - C_o)}{C + S} \tag{19}$$

It requires a lower value of *S* to satisfy (19) than (18), so the marginal growth of R_m that was just enough to pay the carrying costs on R_m and *S* is now superabundant, and enough to carry the tree a few years longer.

Another, but equivalent, approach is to solve for *S* and maximize it:

$$S = \frac{R_m - t\,(R_m - C_o) - C_o\,(1+i)^m}{(1+i)^m - 1} \tag{19a}$$

Deducting taxes from the numerator increases its percentage growth rate and defers the date of *m* at which *S* is maximized.

So a tax on interest income, whether or not shifted, tends to favor time-patterns of land use that emphasize future over present realization of taxable rent income. The present paper only scratches the surface of the relationships between interest income and rent. We regard this as of first priority for extended treatment in a sequel. But to hold the present paper within bounds, we close the matter here.

A fourth way that land achieves tax exemption is by its close association with the production of Wicksell's "rent-goods," perdurable invest-

[50] This is based on the Faustmann formula of classical forestry economics. For an extended treatment of this point see M. Gaffney, *Concepts of Financial Maturity of Timber* [13].

ments in land development which take on some of the character of land itself, and whose life span is so long that for most practical purposes they may be treated as permanent. These include cuts and fills, some kinds of grading, draining, damming, etc. Professor Martin Bailey has taken fills in shallow water to represent the genus, and we borrow his example [2].

To begin, these investments produce land substitutes. Anything that raises the price of land tends to divert investment into land substitutes. The first three biases above tend to raise land prices and thus to stimulate the production of these land substitutes.

Any permanent fill whose cost may be written off, however slowly, finally achieves complete exemption from income tax, following the reasoning already expounded. Thus the after-tax yearly rate of return, r, for fill-type investments is made higher than for shorter ones yielding the same pretax rate of return, i. "Grading" is part of the land investment and non-depreciable, but many other investments of this type may be written off quite legally. Those that are not depreciated are prorated among the lots and written off as lots are sold—a sort of depletion allowance for land developers—so that land development firms often make their taxable profit entirely on the last few lots sold, deferring taxes to the very end of the sales operation. This kind of tax advantage is hard to come by in enterprises that produce in an endless stream.

But all that is disequilibrating and leads to shifting. The premium on fill returns draws investors into fills until the r's are equalized on all investments. The beneficiary of shifting is then the owner of land under shallow water. The price of such land, whose supply is limited and inelastic, rises to absorb the premium on fill returns.

Some of the premium might conceivably be shifted forward to land users in lower rents and sale prices. However, filled land is not a differentiated commodity but a perfect substitute for naturally dry land, so the shifting forward, if any, is trifling compared to the shifting backward (in this case "downward!") to the owners of sites under shallow water, which are scarce and differentiated. The capital frozen in fill-type investments is permanently preempted from alternative uses on superior land, some of which land is thus withdrawn from use. The net result probably is to reduce the effective land supply.

Sometimes the "fill" is financed not by landowners as individuals but by landowners collectively, organized in that syndicate of landowners known as municipal government. Now we are speaking of "public" works. This subsidy takes the form of the exemption of municipal bonds from federal income tax, so landowners can sell them for a better price and plan more long-lived investments, coupled with the deductibility of local taxes by which landowners pay off these bonds—a double subsidy when one considers that bond service includes repayment of principal faster than the works depreciate.[51] If the works are federal, there are no increased local taxes at all, and the longevity of investments is calculated at interest rates far below the market, sometimes zero. This advantage goes into enhancing land values.

This gives us an insight into shifting that applies over the whole range of topics we have covered. The specific beneficiary of the premium on longevity is the owner of those lands which are better suited to long investments. The specific sufferer is the owner of land on which short investments are better. That is as far as partial analysis can take us. The wider effects are those of retarding the turnover and replacement of a nation's capital, which shifts the whole burden from property to labor, following Wicksell's analysis. To Wicksell we add that slowing replacement also means piling up limited capital on fewer sites which are cleared and renewed less often, enhancing the bargaining position of land relative to labor.[52] The ultimate victim is in general labor.

A fifth means by which land benefits from tax bias is through that pervading institution, the rule of prescription. Submarginal land, whose tenure is often uncertain, is subject to capture by virtue of occupancy and use. No one would use submarginal land, ideally. But people will use it if both (a) they expect it to become rentable in the future, and (b) present use establishes future ownership. The appropriative doctrine of water law in the 17 Western states is a splendid example of the rule of prescription.

The result is to cause investors to develop and use resources while they are still submarginal. They suffer early losses, many of them in the guise of expensable current costs, in order to establish their history of use. The payoff on this investment is the effective ownership of the resource in the future, when it will bear rent.

Our income tax system, with its bias to longevity, puts a special premium on this kind of land acquisition. The "purchase price" of land—the early

[51] Who else gets to deduct repayment of principal at all?

[52] One might think that these subsidies to land development would in the aggregate result in more land development, eventuating in an artificial abundance of land, shifting the tax burden to landowners in lower rents. But that would be to assume a limitless supply of capital. In fact, the more capital we sink into developing submarginal land, the less remains to improve and fructify naturally superior land, and to complement labor in enterprises where capital cycles faster. In a nutshell, capital complements labor by turning over, which requires labor, and complements land by standing still, which requires land, so slow turnover favors land over labor. *Cf.* footnotes 5, 20.

losses—is fully deductible, much of it immediately as current expense. The payoff—the ownership of title to the appreciated resource—is not taxable at all unless or until sold. Thus the premature use of submarginal resources, which would be uneconomical enough in the absence of any taxes, receives an added stimulus from the income tax.

This kind of investment motivation, even in its pure form, is much more widespread than one would guess from the silence it has evoked. Minerals exploration, acquisition of television frequencies (often with preclusive or preemptive overtones), and premature extension of utility lines to capture developing territory are obvious examples.

But when we extend the concept a bit, the generality of it becomes remarkable. Wicksell once noted that: "because of the local character of the firm and its market," . . . "the large enterprise has an actual monopoly simply because it comes first on the scene, and this monopoly may be as good as a monopoly which is legally established." Competition by a second firm "would only lead to the ruin of both." [*41,* 131].

Now look at retailers jockeying for position around every growing city, to appreciate the man's prescience. Where there is only room for one store of a kind in an area, to be there first is to win a sort of franchise or prescriptive right to the territory.

There is also the zoning matter. The more offensive a land use is to its neighbors, the more important for the firm to establish the use early and establish a history of noise, air pollution, heavy traffic, garish signs, apartments, or whatever, long before a municipality begins zoning. Thus submarginal gasoline stations, for example, sprout up at every crossroads in suburbia and exurbia in one of the greatest urban land speculations in history by the largest corporations in the world, the international major oil companies. The early losses are expensable, the future preferential zoning is tax-free. Land is the vehicle by which the gains are secured, and the income tax is the supercharger on the motor.

Once one sees the pattern, the examples are legion, and every reader can supply his own. "Possession is nine points of the law," "grandfather clause," "vested interest," "sooner," "racing for position," "right of customary usage," "rule of capture," "seniority," "adverse possession," "squatter's rights," "historical base period," "residence requirement," "proving a claim," "finders keepers," "old-law tenements," "prior appropriation," "prescriptive right," "captive market," "a defensive position," "goodwill," "spheres of influence," 'franchise," "service area" are familiar phrases betraying the uneconomic favor that society has always granted to prior position. Under the income tax this favor has risen greatly in relative value.

Summarizing, we find a market bias in favor of land, because of its longevity; because it does not turn over; because it may in fact be written off; because it appreciates; because its rent may be deferred; because it may be enhanced by investment of the most durable kinds; and because it may be captured, and/or its value to the individual owner enhanced, by absorbing early losses.

This bias has implications for distribution, allocation, and macroeconomics. Distributionally, the lower effective rate on land means higher rates are imposed on labor and capital. Allocationally, the high price of land motivates diversion of capital to land substitutes, both private and public, whose longevity is extreme; and the favor given these investments adds to the motivation. Macroeconomically, much capital is destroyed by the losses taken to secure prescriptive rights to land, and that which remains has a replacement rate far slower than would be optimal.

(*Continued*)

Resources for the Future, Inc.
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Children's Plight in Developing Countries

"EVERY HALF MINUTE, 100 children are born in developing countries. Twenty of them will die within the year. Of the 80 who survive, 60 will have no access to modern medical care during their childhood. An equal number will suffer from malnutrition during their crucial early years, with the possibility of irreversible physical and mental damage. Their chances of dying early will be 20 to 40 times higher than if they lived in Europe or North America.

"Of those who live to school age, only a little more than half will ever set foot in a classroom, and less than 4 out of 10 of those who do will complete the elementary grades."

These few blunt facts might be called portents of the "State of the World for the Year 2000," for they are from a recent report of the UN Secretary-General, U Thant. He didn't have too add that today's children are tomorrow's adults.

The United Nations Children's Fund is the agency of the UN family charged with special concern for the children of the world. UNICEF has just decided to try to double—within the next five years—the assistance it is now providing 112 developing countries to help their children. It has taken the Children's Fund 24 years to reach its present income level, yet its sense of urgency is so great that UNICEF hopes to do twice as much by 1975. [From the U.S. Committee for UNICEF.]

Tax-Induced Slow Turnover of Capital, V

By MASON GAFFNEY

VI

Summary

TO SUMMARIZE the entire paper, we find that excise and income taxation in their present forms tend to bias investors to longevity. We divide assets into four classes: appreciating, constant-valued, depreciating, and land. We find a bias to longevity within each class. Among classes, we find a bias for appreciating assets and land.

As a general policy we recommend that the income tax be modified so as to tax appreciation and deduct depreciation at the times when they accrue. We note that this modification makes the income tax, insofar as it falls on property income, much like the property tax. We note that the neutrality is impaired by shifting; and the only part of the income tax that may be made perfectly neutral is the part that falls on land income.

Our definition of income, if correct, opens a fascinating legal point. If the income tax, properly construed, is a property tax, then the 16th Amendment may authorize Congress to tax property free of the crippling rule of apportionment among states by population. The 16th Amendment authorizes taxation of "incomes from whatever source derived." The realization doctrine is not in the Amendment, but rests on the shaky case of Eisner v. Macomber (1920) [*12*]. Harold Somers has compiled several opinions suggesting the vulnerability of the doctrine. [*32*, 143–44]. As economics, the decision is clearly a primitive, nothing worthy of awe for its substance but only for the sheltered interests that would rally behind it.

The last 15 years may have witnessed a cyclical resurgence of the property tax, but the last 50 have seen a secular displacement of it by income and excise taxes. "Tax sharing" proposals keep nudging us along the same route. The result is a sloughing of ancient tax burdens from property to labor. To redress the balance it would help to give the income tax more of the character of a property tax.

The decision would be made by lawyers and judges. But they would solicit the professional advice of modern economists on modern economic concepts and definitions of income. What counsel would they receive?

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APPENDIX I

By William Vickrey, Matthew Gaffney, Jr.
and Joseph Holzinger*

Proof that effective after-tax rate of return rises with life of investment (point-input point-output case), when gain at maturity is subject to a tax at rate $\underline{t} \in (0, 1)$.

Notation is the same as in the text, except that continuous interest is used and r and i are used for the continuous interest rates corresponding to the annual rates designated by r and i in the text. This is done simply to facilitate recognition. $i > 0$; $m > 0$.

$$e^{rm} = (1 - t)e^{im} + t \equiv f(m) \tag{1}$$

$$f'(m) = (1 - t)ie^{im} \tag{2}$$

$$rm = \ln f(m)$$

$$\frac{dr}{dm} = \frac{1}{m}\frac{f'(m)}{f(m)} - \frac{1}{m^2} \ln f(m) = \frac{1}{m^2}\left[\frac{ime^{im}}{\frac{f(m)}{1 - t}} - \ln f(m)\right] \tag{3}$$

Since $\frac{1}{m^2} > 0$, it suffices to show right hand factor of (3) is positive.

Let $u \equiv e^{im}$, then $im = \ln u$

Let $s \equiv \frac{t}{1 - t}$

From (1), $\frac{f(m)}{1 - t} = e^{im} + \frac{t}{1 - t} = u + s$

$$\ln f(m) = \ln (1 - t) + \ln (u + s) \tag{4}$$

Now the right hand factor of (3) is defined as:

$$g(u) = \frac{u \ln u}{u + s} - \ln(1 - t) - \ln(u + s) \tag{5}$$

$$g(1) = 0$$

If $g'(u) > 0$ for $u > 1$, then $g(u) > 0$ for $u > 1$ and $\therefore$ for $m > 0$.

$$g'(u) = \frac{(u + s)\,[\ln u + 1] - u \ln u}{(u + s)^2} - 0 - \frac{1}{u + s}$$

$$= \frac{s \ln u}{(u + s)^2} > 0 \text{ for } u > 1. \qquad \text{Q.E.D.}$$

* Credits are difficult to assign. There was an earlier proof by M. Consigny, superseded by Vickrey's more direct proof. This was simplified by Matthew Gaffney, Jr., with advice from Ralph Krause. A final simplifying substitution was contributed by Joseph Holzinger, and the present proof is his.

Appendix II

By William Vickrey and Michele Consigny*

Proof that an income tax using true depreciation is intertemporally neutral

Let $A(x)$ be a (continuous) cash or service stream bought for $C(0)$, 0 being the time of purchase and x the time of payment, m being the date of maturity or final payment. Let $P(x)$ be the present value at time 0 of a payment of \$1 at time x. The instantaneous short term rate of interest at time x is then $h(x) = -\frac{1}{P}\frac{dP}{dx}$. (The annual rate of interest is $i = e^h - 1$.) $C(y)$, the value at time y of the remaining payments from y to m, is then given by $P(y) \cdot C(y) = \int_y^m P(x) \cdot A(x)\, dx$. (1)

The depreciation in capital value at time y is then obtained from (1) by differentiating with respect to y:

$P\frac{dC}{dy} + C\frac{dP}{dy} = -P(y) \cdot A(y)$, and by solving for the depreciation, $\frac{dC}{dy}$ we get $D(y) = -\frac{dC}{dy} = A(y) + \frac{C}{P}\frac{dp}{dy} = A - hC$ (2)

Now let a tax be imposed at a rate $t(y)$ on the net income after depreciation $Y = A - D$, so that the tax is $t(y)\,[A(y) - D(y)]$ and the net receipts after tax are then $N = A - t(A-D) = A - thC$. Then there exists a private (2a) discount function $R(y)$, such that for any asset with a stream of payments $A(y)$, the current value of the asset can be obtained equally from discounting the gross payments A with the public discount function P, or the net proceeds N

* Again, credit is hard to allocate precisely. Miss Consigny first formulated the problem and proved the theorem. Professor Vickrey greatly shortened and generalized the proof and brought it to its present form. A third proof by Matthew P. Gaffney, Jr., might equally well have been presented.

with the private discount function R: $\int_0^m PA\, dy = \int_0^m RN\, dy$.

The private discount function R will be related to P and t by the equation

$$-\frac{1}{R}\frac{dR}{dy} = r = h(1 - t) = -(1 - t)\frac{1}{P}\frac{dP}{dy} \qquad (3)$$

where P, R, t, and h are all functions of y, h being the public rate of discount and r being the private rate of discount. $P(0) = R(0) = 1$.

We have $\int_0^m R(y)\, N(y)\, dy$

$$= \int_0^m R(y)\,[A(y) - t(y)\, h(y)\, C(y)]\, dy \text{ [using (2a)]} \qquad (4)$$

$$= \int_0^m R(y)\,[A(y) - t(y)\, h(y) \int_y^m \frac{P(x)}{P(y)} A(x)\, dx]\, dy, \qquad (5)$$

[using (1)]

$$= \int_0^m R(y)\, A(y)\, dy - \int_{y=0}^m \int_{x=y}^m \frac{t(y)\, h(y)\, R(y)}{P(y)}$$

$$P(x)\, A(x)\, dx\, dy \qquad (6)$$

which becomes, by inverting the order of integration

$$= \int_0^m R(y)\, A(y)\, dy - \int_{x=0}^m \int_{y=0}^x \frac{t\ (y)\, h(y)\, R(y)}{P(y)}$$

$$dy\, P(x)\, A(x)\, dx. \qquad (7)$$

From (3), we have $ht = \frac{1}{R}\frac{dR}{dy} + h = \frac{1}{R}\frac{dR}{dy} - \frac{1}{P}\frac{dP}{dy}$ (8)

so that $\frac{t(y)\, h(y)\, R(y)}{P(y)}\, dy = \frac{1}{P}\, dR - \frac{R}{P^2}\, dP = d(\frac{R}{P})$, so (9)

that (7) becomes

$$\int_0^m R(y)\, A(y)\, dy - \int_0^m [\frac{R(y)}{P(y)}]\Big|_{y=0}^{x} P(x)\, A(x)\, dx \qquad (10)$$

$$= \int_0^m R(x)\, A(x)\, dx - \int_0^m [\frac{R(x)}{P(x)} - 1]\, P(x)\, A(x)\, dx$$

$$= \int_0^m [R(x)\, A(x) - R(x)\, A(x) + P(x)\, A(x)]\, dx$$

$$= \int_0^m P(x)\, A(x)\, dx = C(0).$$

Q.E.D.

[53] *Errata:* In "Tax-Induced Slow Turnover of Capital, II," p. 181, n. 14, the equation should read:

$$m = \frac{ln\ (1-t)}{ln\ \left[\frac{1+i(1-t)}{1+i}\right]}$$

On p. 187, line 18, for [shifting] "would push i up to a new level, i" read "would push i up to a new level, i." And read in line 31 ". . . the premium of short i over long i. . . ." And read p. 188, line 15 ". . . the fact that i. . . ." And read p. 195, line 29 "Capital must now earn i. . . ." And on p. 196 read line 6 ". . . to earn i before taxes." And read line 7 "at the higher rate of interest, i. . . ." And in *ibid.*, III, on p. 283, line 8, read $a(1+i)^{-1}$ as $a(1+i)^{-1}$.

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The Quality of Existence on Welfare

The Diary of A. N.: The Story of the House on West 104th Street. By Julius Horwitz. New York: Coward–McCann, Inc., 1970, 220 pp., $5.95.

JULIUS HORWITZ SPENT eight years as a welfare caseworker and as consultant to the majority leader of the New York State Senate on problems of social welfare. Out of his intimate knowledge of the life experiences of welfare clients, out of his experience with the working and malfunctioning of the welfare system, and out of piles of case notes and records of interviews with hundreds of children, black and white, second or third generation wards of the system, he has written this sociological novel which deserves a place beside the works of Victor Hugo and Upton Sinclair.

The book, presented as the diary of a 15-year-old black girl setting down her experiences and observations, is a savage attack on a welfare system which, instead of providing equal opportunity, offers its beneficiaries just enough of a dole to keep them alive in a life style of continuing degradation. The book lets the facts of life on Manhattan's upper West Side make their own argument. This contributes to its powerful impact.

At the end A. N. gets caught up in one of the anti-poverty programs intended to break the cycle of dependency. Will she make it? The social scientist-turned-novelist so successfully involves the reader by the artifices of the story teller that the reader hopes so.

Julius Horwitz's previous book, *The W.A.S.P.*, was pronounced "the best American novel published in England in 1968." Surely the present one will win accolades, not only from general readers but from social