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by

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SOIL DEPLETION AND LAND RENT

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This paper attempts to define land rent net of soil depletion. The paper is an outgrowth of a larger study[1] of the meaning and function of land rent, and is not represented as more than a subspecialized monograph focused on its fragment of the wider topic. Some economists will challenge one or more of its implicit postulates, but it offers only an introductory gesture at their defense, as that would otherwise constitute a separate subject. The paper does sow, where germane, some wild oats, hopefully germinable, on issues in conservation, tax policy, and mineral depletion, but only as *obiter dicta.*

In the last few years, economists' interest in land rent and land values has reversed a long downtrend and shown a lusty new vigor. As recently as 1953 it was possible to write of "The Declining Economic Importance of Agricultural Land."[2] Since then, the value of farm real estate in forty-eight states, as estimated by the Economic Research Service of the United States Department of Agriculture, has risen from 97 billion dollars to 155 billion dollars, or about 58 per cent, in spite of real estate taxes having risen to some one and one-half billion dollars yearly, and mortgage rates having risen to over 6 per cent. The percentage of "real estate" which is "land"—or at least is not "buildings"—has risen to 74 per cent. Since 1953, the mean annual increment to farm real estate values, 5 billion dollars, has equalled roughly 30-40 per cent of net income of farm operators. Since then, it has become widely recognized that the vested interest of farm landholders in values sustained by farm programs is a major obstacle to rational readjustment of obsolete farm programs. Since then, the Soil Bank programs have demonstrated that an annual outlay of about 700 million dollars, for bare land alone, was enough to entice only 28 million acres into retirement, or 8 per cent of our cropland area, suggesting that the imputed rental value of land not retired may be enough to absorb the lion's share of net farm income. Since then it has been rediscovered that high land prices are a prime barrier to entry of young men into farming.

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1. M. M. Gaffney, *Ground Rent and the Allocation of Land among Firms*, in Rent Theory, Problems and Practices (Miller ed., North Central Land Tenure Research Committee 1962) (Mo. Research Bulletin No. 810).

2. T. Schultz, The Economic Organization of Agriculture, ch. 8 (McGraw-Hill 1953).

A shower of scholarly works has accompanied the resurgence of land rents and prices.[3]

It is no longer necessary to emphasize, therefore, the importance of agricultural land. There is no longer any question that there is such a thing, that it is extremely valuable, takes a large share of farm income, and plays a vital role in human affairs.

If land and rent are topical, they are also of enduring significance to economics. It is net land rent, not contract rent, that determines the allocation of land at the margins between farms. It is land rent that helps determine the optimal allocation of land between present and future uses, and is thus a vital element in determining replacement policy:[4] replacement of buildings, orchards, machines, terraces, pastures, livestock, timber and other capital items. It is land rent that perdures, extending into the indefinite future, and is capitalized into land values so high that the investor ordinarily can expect to receive only a return on his investment, not a return of it. It is the enchancement of land rent, and of land values capitalized from it, that provides a main rationale for outlays on public works projects that improve lands (as what projects do not?), whereby ground rent helps

3. Hawtrey, *Production Functions and Land—A New Approach*, 70 Economic J. 114 (1960); D. R. Denman & V. F. Stewart, Farm Rents (George Allen and Unwin 1959); Bellerby, *Gross and Net Farm Rent in the United Kingdom*, J. of the Proceedings of the Agricultural Economics Soc'y 356 (1954); Whetham, *Rent and Agricultural Price Review*, 68 Economic J. 605 (1958); Stigler, *Ricardo and the 93% Labor Theory of Value*, 48 Am. Econ. Rev. 355 (1958); Samuelson, *A Modern Treatment of the Ricardian Economy*, 73 Q. J. Econ. 217 (1959); Johnson, *Allocation of Agricultural Income*, 30 J. of Farm Economics 724 (1948); Ruttan & Stout, *Regional Differences in Factor Shares in American Agriculture*, 42 J. of Farm Economics 52 (1960); J. S. Keiper, E. Kurnow, C. D. Clark & H. H. Segal, Theory and Measurement of Rent (Chilton 1961); Mishan, *Rent as a Measure of Welfare Change*, 49 Am. Econ. Rev. 386 (1959); W. Vickrey, *General and Specific Financing of Urban Services*, in Conference on Public Expenditure Decisions in the Urban Community (Resources for the Future, Inc. 1962); Aandahl, Scholter, & Murray, *Economic Rating of Soils for Tax Assessment*, 36 J. of Farm Economics 483 (1954).

4. It is I believe a lapse in several recent works on replacement policy to have overlooked this. *E.g.*, Faris, *Analytical Techniques used in Determining the Optimum Replacement Pattern*, 42 J .of Farm Economics 755 (1960). Professor Faris's difficulties with his critics, Professors Winder and Trant [*Comments* on Faris, *Determining the Optimum Replacement Pattern*, 43 J. of Farm Economics 939 (1961)] stem from his overlooking the role of land rent in replacement policy, and their failure, in turn, to have any impact on Professor Faris' thinking might well be attributed to the devious exposition (of their quite correct conclusions) necessitated by their forbearance from using any term so concrete as "land." Other recent studies are by F. A. Lutz & D. C. Hague, The Theory of Capital (MacMillan 1961); V. L. Smith, Investment and Production (Harvard Univ. Press 1961). For the writer's position on the question, see M. M. Gaffney, Concepts of Financial Maturity of Timber and Other Assets (N.C. State College Dept. of Agricultural Economics Information Series No. 62, 1957, 1960); M. M. Gaffney, *Land and Rent in Welfare Economics*, in Land Economics Research (Ackerman, Clawson & Harris ed., Resources for the Future, Inc. 1962).

guide the allocation of developmental resources. It is, finally, land rent which, if we can cleanly distinguish it from other distributive shares, constitutes probably an ideal tax base, and certainly a very practicable one, in a world increasingly in need of ideal and practicable tax bases.

A major barrier to useful applications of the land rent concept, however, has ever been the problem of imputation. The anti-imputationists, who are always with us, point out that you cannot unscramble an omelette. One may concede the point, but yet wonder if we can't still tell the omelette from the frying pan.

The distinction of urban sites from buildings is fairly clear cut. Site value is what would remain after a good fire. Farm soils, on the other hand, provide good sport for the "omelette school," for here parts of the frying pan appear to merge with the omelette. Farm soils are not only amended by and mixed with man-made nutrients, but some of them, and some parts of all of them, appear to lack the distinctly longer life-expectancy, and potentiality of salvage and re-use, that so clearly distinguishes sites from buildings, and frying pans from omelettes.

The "omelette school" may revel, therefore, in the difficulties facing economists who seek means to impute returns to specific inputs used in conjunction with soil, and to soil itself. The difficulties are undeniable, affording easy debaters' points for the captious. The substantive formidability of the difficulties, however, is largely a function of the economist's will to overcome them constructively. I suggest the effort is well warranted.

It is true of any situation, indeed, that the finer we can break down its elements, and their individual workings, the more effective control we can exercise, for private and public ends. Some private ends of rent imputation are these: Imputation is essential for optimal combination of inputs; for economical allocation of land among farms, or between one's farm and the Soil Bank; for optimal timing of replacement; for rent determination. On the public level, imputation is essential to tax policy, conservation policy, analysis of true net social capital formation, administration of public lands, and benefit-cost analysis of public works (where much of the benefit appears as enhanced rents). These ends seem adequate to motivate economists to scour their frying pans,[5] and, where the omelette defies conventional detergents, to synthesize more specific ones. That is the object of this paper.

5. Bracing ourselves for the inevitable wit who will ask if we are not rather falling out of those frying pans into the fire.

I
FOUR ECONOMIC CATEGORIES FOR SOIL ANALYSIS

Land rent is an income, corresponding to a flow of services from a durable resource. Rent is analogous to the legal concept of usufruct, the right to the income of an estate without impairment of its substance. Land rent is net of depletion of virgin fertility, for depletion constitutes sale of the substance of the resource, and the corresponding payment is not income but a transfer, the liquidation or amortization of a fund, comparable to sale of title to part of the land itself. Of course, rent is also net of depreciation and obsolescence of improvements on and in the ground; and among improvements we must include artificial fertility.

Some writers have seemed to fail to deduct depletion when reckoning rent. Thus Bunce writes that, under exploitation, "the net income accruing to the land will be higher than it would be when fertility has to be maintained."[6] Again, federal law forbids farmers' deducting soil depletion from taxable income. Yet, again, keepers of the national income accounts deduct nothing for soil depletion. Are they thus tending to overstate aggregate farm income, and to overstate net farm capital formation by a yet larger percentage? It may be that part of what we call "net capital formation," and impute to thrift, is rather the metamorphosis of natural geological fund resources into man-made capital, through liquidation and reinvestment. Or is the proper depletion charge too small to warrant the trouble of finding it?

It is easy to say we should acknowledge soil depletion with some charge. But the problem of distinguishing income, or rent, from depletion is not simple. What is the proper depletion allowance when a farmer liquidates soil fertility? And there is another question: is the true income, net of depletion, that imputes to exhaustible but unexhausted soil fertility, properly rent, or is it classical "interest"? Is is, like rent, an income imputable to natural and social forces—Marshall's "public value" of land—exogenous to the individual atomistic landholder? Or is it, like interest, the reward of an owner's past restraint in sparing the soil, and a socially functional incentive for him to conserve it in the future? To unravel these knotty topics it is useful to define at least four separate aspects of virgin soil fertility, distinguishing the four on the basis of economic concepts and criteria.

6. A. C. Bunce, The Economics of Soil Conservation 45 (Iowa State College Press 1942). We will see that Bunce was not entirely wrong.

Prevailing soils terminology, like that in so many disciplines, reflects a conceptual framework developed by natural scientists for their purposes, and not oriented toward economic problems and distinctions. It is therefore legitimate for economists to develop their own categories where necessary to analyze the economic aspects of soil.

I assume my readers are conversant with the fund-flow distinction. The first soil category I propose is the pure flow resource, that is, the enduring matrix of the ground, with its location, subsoil and drainage, macro-relief, climate, and those nutrients which, like iron, are present in such abundance, relative to prospective withdrawals, as to be inexhaustible.[7]

The matrix is not changeless, for nature is still dynamic and may impair or improve it. Even man might conceivably destroy a matrix, if he deliberately and wantonly set out to do so. Non-farm earthmoving like strip mining or road cuts may destroy a matrix. The matrix is however, "indestructible" in this important sense: it maintains itself without human aid, and despite human neglect and abuse incident to farm operations.

The economic value of the matrix is not insusceptible to human influence. The physical matrix is humanly indestructible in the sense explained above, but the economic value of a location—part of the matrix concept—is very much the product of surrounding human activities, public and private. But the location value is only negligibly the product of the activities of the atomistic individual landholder as such. It is rather the sum of the spillover effects, or external economies, received from surrounding human activities.

The second category is a degree less permanent. It is the "conservable flow" element of soil, that which it is possible, but not economical, to destroy in production. More positively, the "conservable flow" element is that which it is economical to take pains to conserve, because it is expected to yield future incomes whose present value exceeds the present value of conservation costs.[8] At the core, this category is as enduring as the matrix, and its income, net of conservation costs, is part of ground rent. At the fringes, its income is still rent, but is subject to change of classification as economic parameters change, and therefore to some uncertainty at all times, since these parameters are mostly forecasts of future prices and costs. I would

7. An infinite fund is similar to a perpetual flow.

8. Current liquidation value is included among these costs, because generally that is nothing more than the obviation of current conservation cost.

dispute, however, anyone alleging the concept therefore to be useless, for there is hardly to be found an economic concept without comparable penumbra problems.

The third category comprises the "revolving fund" of soil nutrients. These leave the soil and the site, embodied in crops and livestock, but are economical to replace or renew. This class is best likened to an inventory.

The fourth category is the "expendable surplus." It includes finite fund resources, which yield a liquidation value but are not economical to renew or replace. It also includes redundant flow resources that are not economical to conserve, and which yield a "liquidation value" in the sense of obviating conservation costs. For an oversimplified example, if a uniform topsoil is sixty inches deep, and plant roots can use only forty inches, then twenty inches is expendable surplus. The top twenty inches does not increase yields, but has the value of obviating conservation costs as it is allowed to erode off.

The proportion of soil value in each of the four categories varies greatly with the individual soil. Alluvial bottom, renewed by periodic flood and aeolian deposits, is largely permanent and resistant to abuse. On the other hand, thin erosive steep soils in zones of torrential rains or drought and windstorm have little permanent use value.

The proportion also changes with price and cost parameters. When land is cheap, much topsoil seems "expendable" that later becomes "conservable." Thus at today's high land prices (assuming them to continue), the exploitive practices of 1940 and 1950 are no longer appropriate: a great deal of "expendable" soil has become "con-

9. "Conservable," that is, in the prevailing opinion of the market. The market may be quite wrong in its outlook. Objectively, however, that judgment can only be passed *ex post*. To give the categories objective boundaries, *ex ante*, we must use the predominant forecast implicit in the market prices. That does not prevent individuals from disagreeing with the market—they can couch their dissent in terms of what physical soil quantities are conservable and expendable, and whether they choose to buy or sell at market prices.

The present situation is blurred by the fact that high land prices are in some (unknown) part the *result* of the growth of the belief that modern developments obviate many costly conservation practices previously believed necessary for sustained output. That is, modern thinking (whether or not correct) has enlarged the matrix and reduced the conservable, flow, and that has increased land rents and values. Thus, a lesser interest in conservation is contemporaneous with higher land values, but as cause, not effect.

High land values will stimulate conservation effort if (1) they impute to the conservable element of the soil; (2) they derive from expectations of the remote as well as the near future; and (3) they do not trap many farmers in low-equity positions that force liquidation.

servable."[9] Again, when fertilizer is cheaper, more of the soil becomes replaceable, and less soil is expendable; likewise, less soil is conservable.

The proportions also tend to change over time. There is a tendency for expendable virgin surpluses to be expended, and the remainder to approach zero, but the tendency plods far behind changes in demand and technology. There is always some expendable soil. Around growing cities, soil destined for urbanization becomes largely expendable. And whenever falling farm prices are anticipated there is an extra premium on current over future output that shifts some soil to the expendable class.

The proportions also depend on location. An erosive soil in a prime location might be economical to conserve because to expend it would be to lose the future use of the valuable site. The same soil on a remote site might be expendable.

Objective definition and measurement of rent in relation to soil fertility has been hindered by the penchant of some debaters to throw all soils into one of our categories. There are the soils fundamentalists and Malthusians, to whom most soils are irreplaceable and who object to regarding much of them as permanent, or replaceable, or—perish the myopic thought—expendable! Then there is the private property fundamentalist who gives nature little credit: all honor to the sturdy pioneers who created Heaven and earth from primordial chaos, or at the very least wrested earth from the elements, like Dutch polders from the North Sea. To this fundamentalist, soil fertility is largely man-made, hence renewable by man like the revolving fund of an inventory.

Ricardo is often accused of fundamentalism in describing soil as "indestructible." He may be more the victim of a hasty turn of phrase than a true extremist. Operationally, the most extreme "indestructible" position is held by those who say the least about it, but by their silence implicitly assume indestructibility. These are the production economists who arrive at this or that optimal combination of inputs without heed to different rates of soil loss associated with different input combinations. To them we should add "The Explainers" of farm tenancy, who tell us how a young farmer can rent more assets than he can borrow, but are silent about what havoc he may wreak on those rented soil assets. It is hardly necessary to add that some farmers have behaved as though all soils are expendable, to be looted and left languishing as quickly as possible.

The four categories of soil suggested here let us acknowledge the existence of soil elements answering to all the extreme assumptions, but permit us to balance out the picture and analyze the diversity of individual soils. Let us then look a little closer at the four categories.

II
THE MATRIX

The matrix is the perdurable base of the soil. We have seen that it is indestructible by the neglect and abuse incident to farm operations. What elements does it comprehend? First is the site, or extension plus location relative to markets and sources of complementary inputs. Access to hard-surface roads is a large element in farm land values. Access to water is paramount in arid states. Next is the climate holding sway over that site, important for its own sake and also as a major soil-building agent. Then is the macro-relief; the underlying rock from which the soil is formed, or the mantle of till or loess where those are the source of the soil, or the complex of conditions that cause alluvium or loess to be deposited currently.

Another important element of the matrix is the subsoil, especially as it affects drainage. "Crop production is as dependent on the subsoil as on the surface layer."[10] Below that lies the parent material with its balance of nutrient and perhaps toxic elements. The upper layer of parent material is usually under attack by soil-forming chemical and physical processes. Soil formation is a continuous process, with a moving profile cutting down continually into parent material.[11]

Below the parent material may be aquifers whose capacity to receive, store, and release water is of great value to farm operations on the surface, especially in this age of cheap rural power and turbine pumps.

We have mentioned that inexhaustible funds of common mineral nutrients are in effect perpetual flows, hence part of the perdurable matrix. The same may be said of layers of topsoil that are clearly redundant, for example some valley soils that are over thirty feet deep. In general, topsoil below plant root levels is trapped in un-

10. H. H. Krusekopf, in *Missouri* 29 (Gist ed., Curators of the Univ. of Missouri 1950).

11. C. Kellogg, The Soils that Support Us 46 (Macmillan 1941). "Moderate geologic erosion gradually removes the leached surface layers, but it permits the formation of a deep soil profile whose nutrient supply is constantly replenished from the unleached parent material beneath." H. Kohnke & A. Bertrand, Soil Conservation 50 (McGraw-Hill 1959).

productive cold storage. The loss of top inches lets roots penetrate deeper and use the idle lower layers, and so such loss hardly warrants much of a depletion charge until the roots approach bottom.

Even then the loss is not an unmixed evil, for the deep root penetration accelerates soil-building processes that convert subsoil to topsoil; but by that time soil value would have crossed the threshold beyond which it pays us to take some heed of soil loss, even if we still countenance it, and redundant topsoil would properly be classed as expendable surplus, and some depletion charged as it leaves us. The "threshold" is reconsidered below under the treatment of expendable surplus.

The several elements of the matrix determine not only much of a soil's productivity and versatility, but also its responsiveness to management and the duration of its response to soil amendments and other improvements. There is a tendency in some quarters to credit management with the entire net increase of output from this or that worthy improvement, but management only exploits potentialities latent in the land. The same amendment to a poorer matrix might last only half the time and give only one-third the increase, so the better matrix must receive due credit for its contribution to the joint product.

The matrix is probably more important than the other three soil categories. Were that not so we would find little use for soil maps, or Soil Conservation Service land-use capability tables, nor would we find a corn, wheat, or cotton belt. Soils are the product of massive, prolonged, and transcendent natural forces not lightly overborne, for better or worse, by man's efforts. "Soils then do not wear out," wrote Charles Kellogg, "in the sense that an automobile wears out. They may become poorer . . . as a result of improper management. . . . But usually they can be brought back to a good state whenever men know what to do and want to do it."[12] Throughout history until recent times the major restorative treatment given to tired land has been simply to let it rest, fallow, so its natural regenerative powers might catch up with man's withdrawals. On the other hand, Kellogg advises us that our "wornout" Eastern soils never were of much value, and that those built up by men easily decline, when neglected, to their original state.[13]

Next let us examine those elements of soil which it is possible, if

12. Kellogg, *op. cit. supra* note 11, at 271. *cf.* Q. Lindsey, *A Procedure for the Equitable Assessment of Nebraska Farm Land*, Nebraska Agricultural Experiment Sta. Bull. 410 (1950).

13. Kellogg, *op. cit. supra*, note 11, at 263.

not always economical, to destroy by neglect and abuse incident to farm operations. We have three categories of these: the "conservable flow" element, which is destructible, but whose emplaced value exceeds its liquidation value; the "revolving fund" element which it is economical to deplete and then replace or renew; and the "expendable surplus" which it pays to liquidate, but not to renew.

III
THE CONSERVABLE FLOW

The "conservable flow" element of virgin soil fertility is that which it takes some pains to keep in its original state, but is worth those pains because they are less than the cost of replacement and less than the present value of future income from the element. An example of conservable flow would be a rather thin surface layer of superior exogenous soil—loess, or glacial till—underlain by an inferior country rock. In all soils, a good share of virgin soil texture—the friability, and capacity to receive, store, and release moisture and nutrients—would also ordinarily be a conservable flow element, for texture may be maintained at some cost in the form of outlay or foregone gain, or both, but will deteriorate without such sacrifices. Virgin humus, a component of soil texture, may be a conservable flow element—its distinction from the revolving fund elements is discussed later.

The concept of "conservable flow" affords an important by-product, which is a distinctive and objective meaning for the chameleon-word "conservation." "Conservation" is effort effectively devoted to reduce the loss of virgin flow resources that may be, but need not be, deteriorated by use. The definition may be given normative content, without loss of objectivity, by limiting it to virgin flow-resource endowments whose emplaced value exceeds their liquidation value, and which are therefore worth conserving. Liquidation of such conservable flows is properly described as "irreversible" loss, not because the soil cannot be rebuilt, but because it can never be rebuilt so cheaply as the cost of conserving the virgin soil.[14]

Some readers will doubtless wonder if "conservation," so defined, differs significantly from the "maintenance" of old buildings and other man-made products. In the short run there is clearly a parallel,

14. The definition might also be broadened to include retarding the depletion of geological funds, and made normative by defining optimal rates of depletion. In either case, "conservation" is given a unique application to virgin endowments, not to man-made resources.

just as there is a short-run analogy between land rent and quasi-rent attaching to buildings. In the long run, however, I believe the differences are profound.

The differences rest on the natural origin of virgin soil in contrast to the human origin of buildings. The word "conserve" is peculiarly fitted to natural gifts whose supply is fixed beyond human control, which man can husband and develop, but not reproduce.[15] The word is also peculiarly fitted to resources that can be kept indefinitely. Being a natural product, soil is intrinsically able to sustain itself in perpetuity without human agency—that is how nature came to leave it to us in the first place. Conservation measures consist in merely forbearing from interfering with that natural perpetuity, or in compensating for man's threats to it.

Building maintenance, on the other hand, is ineluctably only a delaying action. All structures, all human products, are something of an affront to the elements, which gnaw at them continually so that they ultimately decompose.

> Something there is that doesn't love a wall,
> That sends the frozen-ground-swell under it,
> And spills the upper boulders in the sun;
> ——— ——— The gaps I mean,
> No one has seen them made or heard them made,
> But at spring mending-time we find them there. [Frost, "Mending Wall."]

Virgin soil, in contrast, is already the product of long decomposition. It has long since reached the angle of repose, and a chemistry of stability to match. True, parts of the soil itself are in a process of slow decomposition, but it is a selective sort of decomposition, the most refractory and terminal stages of decomposition which have resisted the buffeting of nature so successfully as usually to have reached a natural equilibrium with increments of fresh undecomposed material from the matrix and atmosphere and vegetation.

Thus structures deteriorate with time, which nature uses to undermine the work of man; soils deteriorate with use, whereby man undermines the work of nature. Maintenance is man's struggle against time and nature; conservation is his struggle against use, and himself. Maintenance is also sometimes a struggle against man, for structures may deteriorate with use, or abuse, as well as time. But conservation

15. He may contrive partial substitutes for superior resource A; but he does so by developing other natural resources, B, C, D . . . etc.

is not a struggle against time. On the contrary, time works toward conservation, since time lets Nature work to restore the *status quo ante hominem*, a status of no structures but of virgin soils.

Probably a primary reason why many economists have been tempted to blur any distinctions between natural funds [like erosive soil] and artifacts [like buildings] is that our inherited intellectual equipment, the traditional fund-flow dichotomy, is too limited. Specifically, it is ambiguous in its classification of assets that depreciate with time rather than use. Are buildings flow resources or fund resources? Like funds, they are finite in time; but like flows, they yield services as a function of time. If we have only two classes, fund and flow, we lump buildings and exhaustible nutrients together because of their similarities, ignoring their differences. The solution is a third class, for assets that undergo time-depreciation. Let us call them "flowing funds," (or "finite flows").

Land does not as a rule undergo time-depreciation, and does not fall in the class of "flowing funds." The permanent elements are flow resources; the expendable elements are fund resources. The only element of land value that may be regarded as subject to time-depreciation in any widespread way is the value attributable to spillover benefits from nearby artifacts; but this depreciation is derived from that of artifacts and is not inherent in the physical properties of land. In most areas it is offset by maintenance and replacement of the artifacts.

The difference between conservation and maintenance may be exemplified by an example from among conservation practices. Consider a terrace designed and built to conserve soil. The terrace structure may last twenty years with maintenance, before depreciation, otters, and obsolescence prescribe a new one. But the soil that the terrace has conserved is still in place, still usable, still conservable by a new terrace. Maintenance of structures merely postpones their inevitable depreciation; conservation of soil can stop depletion altogether, or at least reduce it to the rate of natural replacement.

One practical consequence is immediately evident: conservation investments look much further into the future than do ordinary maintenance investments. A higher outlay is warranted to conserve a given future income stream in perpetuity than merely to maintain it for a few years.

Some other distinctions are worth noting. Virgin soil being a natural resource, human contributions are generally sharply set apart from it. Structures being man-made, maintenance is a continuation of the original building process, often indistinguishable from it. Only parts of an old structure are literally maintained; many are replaced outright and the building rebuilt piece by piece, like the storied indestructible axe that had lasted for fifty years with only six new heads and twenty handles. A building that is "conserved" for generations is more accurately described as a slowly revolving fund, and more truly likened to the revolving fund element of soil fertility, than it is likened to virgin soil conserved by man.

Other parts of an old structure, that do endure, are often buttressed, shored up, covered over, and so on, so they are replaced functionally if not physically. Materials fatigue and warp, rot and molder, crack and settle, corrode and burn, fade and peel, so maintenance grows ever costlier as time exacts its inexorable toll. Soil conservation, in contrast, is much the same task today that it was 3000 years ago, or whenever man first drove his herds to graze on the land, and has no prospect of being terminated by demolition for renewal.

Time also imposes obsolescence on structures, for artifacts are in competition with an endless outpouring of more modern ones on other sites, and challengers for their own sites to which they generally become less and less appropriate as a dynamic society evolves. Soils, by contrast, are not generally subject to Schumpeter's "gale of creative destruction" from new products. Perhaps they might be so subject had nature been stingier, so that man was continually employed in pulverizing rock with guano and raking it out on alkali flats to create most of his soil supplies; and insofar as soils are artificial they do resemble other artifacts, and obsolesce, as well as depreciate, like them. But nature has supplied us with such an abundance of virgin soil, of such stable and conservable qualities, that for the most part it is more economical to conserve the old than create new, and obsolescence is generally a negligible factor. As to "demolition" of obsolete soils, it is practically unheard of. If an old soil is to be replaced by new, it is almost always done by amending the old, not scraping it off and beginning fresh. Obsolete structures, on the other hand, can rarely be mingled with new ones. They are torn down and the ground cleared for a new start.

There are man-made soils, of course, and most soils contain some "revolving fund" elements supplied by man. But such artificial soils and soil elements are generally out of balance with their natural environment and therefore unstable. Virgin soil is largely the product of the local matrix and climate; these are basic determinants which work ceaselessly to reduce all interloping alien elements to the likeness of the virgin soil. Artificial soils, and amendments in soils, are therefore depreciable, like structures, with time, and of course they also are vulnerable to obsolescence.

Virgin soil, then, is genuinely a unique resource, differing significantly from artifacts, even its closest substitutes. And conservation of virgin soils differs significantly from maintenance of artifacts, enough so, surely, to warrant a separate entry in the dictionary of economics.

Returning, now, to the meaning of "rent," all the above bears on the question. The net income imputable to conservable flow elements of the soil, above conservation costs, is part of ground rent. Looking to the past, virgin soil is by origin a natural endowment, like the matrix. Looking to the future, the conservable flow element of virgin soil, while destructible, is not economical to destroy. It does have a liquidation value, unlike the matrix, but the liquidation value is by definition always less then the emplaced value. And so the conservable flow has the same long life expectancy as the matrix, assuming an institutional environment which imposes or permits of economic decisions. The net rent of the conservable flow element of virgin soil is reduced by conservation costs; but there remains, except in marginal cases, a surplus over conservation cost, which surplus is part of rent. As such it is a gift of nature, subject to all the generalizations economists make about rent, including its peculiar suitability for taxation.

Some readers may object to that line of reasoning, saying that the conservable flow elements of soil are really human contributions: man has abstained from liquidating them in the past, and requires incentives to ensure future forbearance.

That objection must fall, however, because the liquidation value the landholder denies himself never exceeds the emplaced value he chooses instead. His contribution is simply to allocate the soil to its most lucrative use over time. He abstains only from shedding his own blood.

The point is quite clear when the landholder's choice is between alternatives at the same point of time, or over the same period. An urban landholder, for example, who devotes a site to the highest commercial use thereby sacrifices many less remunerative alternative uses, but the maximum commercial rent, all of it, is no less the ground rent. For the essence of ground rent is not the excess over some alternative use, or opportunity cost—that is a different and, I believe, undefinable[16] usage of the word "rent," which we will henceforth differentiate with the name "transfer-rent." The essence of ground rent is the excess of gross yield over the human contribution, that is, the non-land inputs.

The conserving landholder's sacrifice of quick liquidation values from virgin soil is the sacrifice of an uneconomical time-distribution of future revenues. The optimal time-distribution of future net revenues from the land yields a rent which is no less completely ground rent on account of the possibility of choosing less-than-optimal time-distributions.

An operational test of whether a payment for the use of matrix and soil is properly "rent" is whether the landholder would, in the long run, fail to supply the resource, or would withdraw it once supplied, if the full latent rent were charged to him as a periodic lump sum, a function of time uncontingent on his allocative decisions. Natural origin is of the essence here: the prospect of such a tax or charge would deter anyone from creating the tax base initially, but nature has already created virgin soil. Conservability is also of the essence: a landholder faced with the prospect of uncontingent rent charges would not be moved to liquidate conservable flow elements of the soil, since he would thereby simply lower his income, the tax being uncontingent on conservation and therefore not declining in result of depletion.

Such a tax would, if anything, sharpen his incentives to adopt optimal conservation practices. For the tax puts him in a high-leverage position, analogous to that of a stockholder in a heavily bonded corporation. The percentage rise in his net income from making right decisions is much higher than when he has no fixed charges to meet.

That conclusion presumes that abandonment is not a possibility. In practice that means that the landholder has some appreciable equity in the total bundle of real estate. Tenure institutions, and/or cyclical situations, that permit men to hold tenure with little equity, in soils with a high proportion of conservable flow elements, pose the danger of liquidation followed by abandonment to creditors, landlords, or taxing agencies—let us borrow a term from the law of entail and lump the last group as "remaindermen." In such situations, it behooves the private or public remainderman to recognize that conservable flow elements are destructible, and their income, for the duration of the situation, should not be treated like the ground rent

16. Indeed, such a usage would lead to a negative rent whenever land is misallocated, which is often.

of the truly indestructible matrix. But it also behooves social philosophers to recognize the abnormal crisis aspect of such pathological situations, and not treat them as the standard norm.

Abandonment situations can be minimized by intelligent social policy. They have arisen historically largely in the backwash of some of our more extreme land booms, when over-extended debtors were left without equity; on lands which had been farmed exploitively and not much improved; where improvements were subject to heavy taxes, along with the land; and in jurisdictions which winked at prolonged tax delinquencies and endless legal delays in foreclosure proceedings. This is not the place to go into public policies, other than to assert that effective policies are feasible to preclude anyone from reaping the benefits of soil liquidation without bearing the costs—the absence of such policies is indeed virtually the absence of law and order. Assuming such policies to be in effect, the income of conservable flow elements of virgin soil is part of ground rent.

Some readers will still object to regarding incomes from conservable flow elements as rent, on the grounds that they are rather fruits of the landlord's good judgment. If the landholder gets no credit for forbearance, perhaps he should get credit for decision-making.

Where the disclosure of outcomes is immediate, it is hard to allow much to a landholder for allocating land to its best use, which requires only that he distinquish higher from lower numbers of dollars. But where disclosure of outcomes is deferred, as with conservation decisions which involve time-distribution of future costs and revenues, allocation involves judgment, forecasting, risk-bearing, and therefore a higher input of management.

Those inputs are sometimes identified as the source of rent, on the grounds that the land alone could yield nothing. That, however, is rather a primitive fallacy of the "omelette school." Rent is never a value that the land yields without human help, but is rather the yield in excess of the human input. The valuation of managerial inputs involving judgment is trickier than pricing elementary labor inputs, but that such imputation occurs is manifest in the salaries of hired managers; that it leaves the total product unexhausted is manifest in the prices paid for raw land.

As to productive risk-taking, I would suggest that that is not a function of the landholder as such, but of the investor as such, meaning by "investor" the one who carries the financing of current output. He may or may not be the same individual who carries the land title, because deferment of liquidation is the special province and function of capital, not land. Risk-taking is economic shock-absorption. Only funds can absorb economic shocks. Land is largely a flow resource, and land as such is hired from day to day and paid a steady periodic hire by the risk-taker as such.

IV

THE REVOLVING FUND

Now let us turn to the third element of virgin soil fertility, the "revolving fund." It is that element which is not economical to conserve, but is economical to replace or renew with materials imported from offsite. It is like an inventory. Examples of revolving funds are the scarce nutrients nitrogen, potassium, phosphorus, and calcium, which are removed from the site, embodied in crops and livestock, or leached off in the productive process, then replaced commercially. Another revolving fund is ground water in areas like the San Joaquin Valley in California, where water is pumped down, but is also rechargeable by human hand. Ground water in the high plains of west Texas, on the other hand, is not a revolving fund resource but an expendable surplus, because there is no economical source of recharge.

Revolving funds are largely a feature of commercial agriculture, in which crops are exported from their sites so that nutrients are not entirely replaced by the closed cycles of natural conditions, and so must be imported. Closed natural cycles are not "revolving" of funds, as the phrase is used here. Some readers might wonder if there is any meaningful distinction between these closed natural cycles and the revolving fund process. I believe there is, and it is important for the definition of rent because (a) the income imputable to revolving funds is not part of rent, and (b) the important soil element humus moves in a natural cycle but is largely a conservable flow resource. Let us elaborate.

Humus is derived from surface organic matter. Minerals circulate from humus to crops to humus. But the circulation is vertical, that is on-site, as opposed to the horizontal or offsite circulation of revolving funds.

Why is that distinction important? Because the humus circulation is self-sustaining, like other conservable flow elements without human interposition. Humus differs from them in being a living process as much as a static structure, but it is a permanent and stable process, a sort of perpetual motion machine bequeathed by nature, which man can control, and in which man can participate without destroying.

It might be thought that when man intercedes in the natural cycle, by controlling surface culture, humus would become a revolving fund, as the term is used here. But it retains more of the attributes of a conservable flow. The humus still feeds the crops, which are controlled but not nourished by man. The humus is not withdrawn and then replaced exogenously. It feeds the crops that then renew it, in a continuous integral process. Humus cannot usually be withdrawn and then replaced, economically: without humus, poor crops; with poor crops, little humus-increment. To a degree, humus reserves can be drawn down for later recharge. But on the whole, the mechanism must be kept in continuous operation, for liquidation is not reversible except at a much advanced cost. Those are traits of what we have called the conservable flow elements of virgin soil, not the revolving fund.

Humus can of course be liquidated without replacement, which puts some of it in the "expendable surplus" category.

The income imputable to revolving funds in the soil is not part of ground rent, but the return to an improvement to the site, quite analogous to a return on the capital tied up in stores of silage. After the initial depletion, each decision to reinvest is an independent one which requires its incentive and represents a sacrifice of human alternatives.

There is an interesting point of similarity between revolving funds and the matrix, in respect to interest rates and tax rates. Because of their high time-rate of turnover, the gross return from revolving funds is largely amortization, net income being a small part only. As with all funds that turn over quickly, the supply is not very elastic either to interest rates, or to *ad valorem* general property tax rates, these burdens being low relative to the total amortization value. If, therefore, *ad valorem* tax assessments should be raised in result of soil amendments, it would be much less discouraging than is the *ad valorem* tax on structures, or timber, which pay the tax many times before they are amortized. In respect to property-tax-elasticity of supply, revolving funds are a little like the completely inelastic matrix and conservable flow elements. In respect to a turnover or sales tax, on the other hand, they are quite elastic because of the frequency with which they pass through the market place. So while one might argue that the return to revolving funds somewhat resembles true rent in one instance, it is far removed in the second, and in general cannot be treated as rent.

As to the liquidation of the initial endowment, that is of course amortization, not income. There is a further value to consider, the appreciation of the virgin fund before liquidation, which is income and a form of rent. That question, however, we defer to the discussion of expendable surpluses, which we now take up.

V

THE EXPENDABLE SURPLUS

Expendable surplus elements are those whose liquidation value exceeds their emplaced value, or is expected to in the foreseeable future;[17] and which are not economical to replace when expended.

Expendable surplus might seem at the farthest remove from the perdurable matrix. And at the core, the two concepts are indeed sharply different. But the line between them is not easy to draw. We have noted that some soil elements, like iron, are so abundant and inexhaustible as to constitute part of the permanent matrix, an infinite fund being tantamount to a perpetual flow. Expendable surpluses are not infinite funds, but they are often very large ones, whose emplaced value is very low, per unit, and hardly perceptible.

An expendable surplus is a finite fund which grows small enough, relative to demand, so that the emplaced value of a year's withdrawals enters over the threshold of our perception. That threshold is inevitably an arbitrary line—let us suggest the line where emplaced value surpasses 3% of liquidation value. More generally, it would be that emplaced value which was great enough to warrant a manager's beginning to bestir himself, or make some cultural adaptations, to decelerate the losses.

Fortunately for the definition of rent, the element of arbitrariness in defining the threshold line has no large effect on what is rent and what is not. When the fund is "infinite," the imputed return is all income, all rent. When the fund becomes finite, a depletion charge is in order, but at first that charge is very small, and the excess of imputed yield over depletion allowance is still rent.

Some readers might object to that analysis on the grounds that the depletion allowance should be equal to the liquidation value, or at least next year's liquidation value discounted back over just one year.

17. There is an optimal rate at which to deplete, so a surplus is expended over a long period. Just how much will ultimately be expended is uncertain today. Fortunately, this element of fuzziness does not significantly affect the division of receipts between income and depletion, as we will see.

But that procedure strikes this writer as being seriously in error. For next year's liquidation is not sacrificed by this year's withdrawal from the finite fund; only the terminal liquidation is sacrificed, far in the future. If, for example, a soil has a fifty-year fund of calcium, the withdrawal of year one does not sacrifice the withdrawal of year two, but of year fifty. The emplaced value, which equals the depletion charge, is the liquidation value expected in year fifty discounted back over fifty years to the present. That is all one can net off as depletion allowance. The rest is income: land rent.

If I may offer a homely analogy, the toothpaste one squeezes from the tube tonight does not constitute a sacrifice of tomorrow night's supply. One rather rolls up the end of the tube, which may be likened to the exhaustion date of the fund resource, and brings it nearer to the orifice, which represents the present. It is next month's supply which is sacrificed, and if toothpaste tubes lasted long enough for compound interest to be perceptible, the depletion value would fall below the liquidation value.

If one objected that the sum of all depletion allowances would then fail to exhaust the initial cost, the answer would be No, it is rather that the sum of liquidation values would exceed the initial cost, the excess being an income, the return on the investment carried over time. So with geological funds: their present values fall well below the sum of their future liquidation values, the difference being compound interest on the present values of the quantities destined for withdrawal in each future year. That excess is a species of income that the unexhausted fund earns over time, and I believe we state it correctly by using a depletion allowance equal to the discounted value of the most remote future liquidation receipt. I also believe we are generally correct to identify that excess as part of land rent.[18]

The extended implications of that simple conclusion in relation to mines and oil reserves should be exciting. If the conclusion is valid, oil depletion allowances as presently reckoned are even more of an outrage than we already know them to be for other reasons, and should approach liquidation values only when oil reserves approach exhaustion. Oil and mines are able to bear much higher taxes, both income and *ad valorem*, than is currently believed. But we are overstepping the bounds of this brief paper, and will close that toothpaste tube until a sequel.

18. *Cf.* E. Bohm-Bawerk, Positive Theory of Capital 335 (Libertarian Press 1959).

CONCLUSION

The upshot is that depletion of virgin fertility, or the possibility of it, does not ordinarily detract much from ground rent. Matrix income is all rent. So is conservable flow income, only net of conservation costs. Revolving funds supplied by man yield gross incomes that are not rent, but largely amortization, with a small net income that is not rent either, but the yield on an investment of man-made capital. Expendable surpluses yield liquidation values from which only a small depletion charge, based on remote future liquidation, is properly deductable, so that their liquidation yields are largely a species of rent income.

Only when the economic exhaustion of a geologic fund is imminent does the depletion element loom larger than the income element. In this case, modifications of private and public policies that acknowledge the replacement of income by depletion are appropriate. For example, the gradual or partial replacement of *ad valorem* by severance taxes would make sense as exhaustion approaches. But the need for such policies in some times and places should not blind us to the general prevalence of conditions where exhaustion is not imminent, and the returns to landholders are true rent, a form of net income.[19]

19. *Cf.* J. R. Commons, *A Progressive Tax on Bare Land Value*, 37 Pol. Sci. Q. 41 (1922); L. C. Gray, *Rent under the Assumption of Exhaustibility*, 28 Q. J. Econ. 466 (1914).