Groundwater Utilization and Tax Policy

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SINCE the early 1950's, groundwater has been used to expand irrigation in the arid and semiarid regions of the United States. Present irrigation from groundwater supplies is concentrated in the western states, but some irrigation from groundwater supplies is found in the more humid parts of the nation. Although statistics are not readily available with which to estimate precise acreage irrigated from groundwater supplies, the groundwater resource appears to have become an important resource to agriculture, both in terms of expanding production of the drier climates and in terms of supplementing precipitation in other areas. In some of the arid and semiarid regions, groundwater is the most limiting economic resource in that groundwater is not present in sufficient quantity to permit irrigation of the available land resource. However, further exploration may result in the discovery of new groundwater deposits which would increase the physical quantity of the resource both in the vicinity of present irrigated areas and in areas heretofore not irrigated.

The discovery, development, and use of groundwater by irrigated agriculture has, in effect, resulted in an increase in productive capital. The overburden formerly classified as "dryland" cropland or "dryland" grassland can be shifted into irrigated cropland, or the underlying groundwater can be pumped and transported to other sites and put to several different uses, including irrigation. The purpose of this paper is to present discussion pertaining to major issues regarding effects of taxation upon the use and ultimate value of groundwater as a capital resource. The discussion will be centered around property taxes, as opposed to income, sales, or capital gains taxes. The form of the property tax under consideration is the ad valorem tax applied to assessed resource value.

Nature and Significance of the Groundwater Resource

In general, groundwater is classified as one of the natural resources; that is, most groundwater resources exist independently of man's activities. However, in some areas of California, groundwater aquifers are being used to store and transmit water which has been diverted from surface sources. The character of these groundwater resources is different from that ordinarily associated with a natural resource, since the overt actions of man are involved. In cases of this kind, water transfer costs, water price, and taxes may become involved in the single terminology of taxes. However, this situation does not affect the generalized conceptualization

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of taxing policy, since direct aquifer operation costs and water prices presumably can be measured and hence separated for purposes of taxation.

Groundwater deposits range from those that are classified as stock resources to those that can be classified as flow resources. Groundwater deposits having natural periodic recharge equal to or greater than periodic withdrawal are considered as flow resources. Aquifers to which natural periodic recharge is less than periodic withdrawal are stock resources. The water deposit of the Southern High Plains of western Texas and eastern New Mexico is a stock resource in that there is not adequate recharge in relation to present withdrawals to prevent exhaustion within the foreseeable future.[1] The groundwater deposit in the Mesilla Valley near Las Cruces, New Mexico, has a source of recharge (the Rio Grande River and the network of irrigation canals which divert river water to the valley farmland) and thus this groundwater deposit has characteristics of a flow resource.

The different types of water deposits present different questions with regard to groundwater resource use and taxing policy. The flow resource should be utilized periodically (annually) to the extent that marginal cost equals marginal revenue; otherwise the economic value of the unused flows will be lost. On the other hand, a resource in storage, such as water in a nonrecharging aquifer, is available for use at a later production period and presents conservation questions about intertemporal allocation, given irrigation production prices and costs. The level and the form of the taxes upon groundwater affect the level of water resource use in the different production periods.

A significant factor which contributes to the importance of the economic allocation of groundwater resources is that a significant quantity of these resources is located in the sparsely populated counties of the arid and semiarid regions of the country. Because of the increasing cost of local government, from the standpoint of both the increased costs per unit of service and the increased quantities of services supplied, these local governments have a tendency to increase property taxes on farmlands and the associated water resources [2, p. 85].

The economies of rural areas depend upon use of land and water resources for employment, investment, and consumption. The effects of taxation upon groundwater use and the length of life of exhaustible groundwater reserves is significant to the present level of local area farm income, to local area economic activity, and to future local area economic growth. In addition, there are broader regional and national economic implications, since local areas contribute to national economic welfare and look

[1] Various estimates have been made pertaining to the time of exhaustion of the aquifer. Under present annual use rates, some parts of the aquifer will be depleted within the next 20 years; other parts will be depleted in 50 to 60 years [5].

to the national Congress for assistance in development of local area groundwater resources and resources associated with groundwater. The ultimate responsibility for any adjustments to use of the groundwater resources of an area and especially for areas in which groundwater will be exhausted will be borne by the state and national governments, either directly through investments in replacement resources or indirectly through the social cost of relocating and re-employing resources complementary to groundwater.

Tax Policy Issues

In order to approach questions of policy, the major goals and objectives must be known. Insofar as groundwater resource use is concerned, the public apparently has adopted goals similar to goals pertaining to other resources: that is, that development and use are desirable, that profit maximization is the objective, and that consumer and producer sovereignty shall be allowed to prevail. The groundwater resource is viewed as productive capital and will be utilized as a part of the collective wealth from which the community can benefit, through taxing either the current income derived from the use of the resource or the capital value of the resource.

Since groundwater is a natural resource, conservation questions arise. In an economic sense, conservation pertains to the time of use; and insofar as present goals seem to be concerned, the objective is to maximize present worth of the income stream produced by the resource, given market conditions and institutions. The manner of taxing and the amount of the taxes have a bearing on the rate of use of wasting our exhaustible resources, such as nonrecharging groundwater deposits.

The use to which resources are put is a major tax policy issue. Most tax legislation pertaining to the land resource includes terminology to the effect that the resource will be taxed as if it were put to the highest and best use. Presumably the same attitude is directed toward the groundwater resource. The attempt to direct resource allocation "en masse" through "highest and best use" clauses results in the protection of the taxing agency and does not necessarily result in optimum economic allocation, since optimum allocation can be made only by each individual resource user on the basis of applicable prices and technical conditions. "Highest and best use" is at best some kind of average which most likely fits no single individual but which is applied to all individuals.

Present Approach to Taxing Groundwater

In practically all cases, groundwater rights reside with the land overlying them, even though in most of the western states the appropriation as opposed to the riparian doctrine of water law is followed. In general, the water right is identifiable as a part of the land associated with it and therefore is classified as productive property in the form of irrigated land and is subject to property taxation by local and state governments and other local political subdivisions. The usual tax applied is an ad valorem tax on appraised value of the land resource, which in reality is two separate resources—land and water. Appraised value of land ranges from something called "fair market value" to estimates of capitalized net earnings plus other elements of expected appreciation or anticipated depreciation of future value. However, as a result of different viewpoints with respect both to time preference for income and to risk—that is, as a result of differences in the capitalization rates among the buyers and sellers—sales price value and capitalized earnings may be quite different.

Appraisal method for taxing purposes varies among the different states and also among the local administrative entities which levy and collect the taxes. The methods range from simple surveys of recent sales records to complete analyses of income earnings. The expected future income streams are based on historic yield and price data, on current yield and price data, or on expected future yield and price data. The appropriate estimate of present worth of future income streams is based on expected future technical input-output relationships and expected future prices; however, trends of past prices, yields, and costs are no doubt used rather heavily in making estimates of present worth of future income streams.

The nature of the expected future income from a producing asset, such as irrigation water, is of major importance in estimating the capitalized value of the asset, for taxing as well as for asset-trading purposes. Appraisal firms and local tax assessors have appraised land irrigated from exhaustible groundwater aquifers, for tax purposes, as if the water supply were endless and the income from irrigation water would never be expected to cease, when in fact the end of the water supply could easily be foreseen.[2] In 1967, in Curry County, New Mexico, present estimated net income to land and irrigation water was capitalized into perpetuity. The best available estimates showed that in some sections of the county the water supply would support the net income stream used in the calculation for only 10 years, and in no subarea of the county would the water supply support the net income stream of the calculation for more than 35 years. Thus, the capitalized values on which taxes were to be collected was in error by the amount of the difference in present worth of a future net income stream held constant at the 1967 level and the present worth of a declining future annual net income stream. A given ad valorem property tax placed on an erroneously high capitalized net income stream results in a higher tax than would have been the case had the tax base been correctly evaluated.

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[2] *The Farm and Ranch Owners Association of Curry County, New Mexico,* v. *The Commissioners of Curry County, New Mexico,* Clovis, New Mexico, May 1968.

In addition to property taxes on the basic land and water resources, state laws permit the levying of an ad valorem property tax on irrigation equipment such as sprinkler systems. Usually these types of equipment are installed either to permit the irrigation of land which cannot be watered by other, less capital-intensive irrigation techniques or to decrease the quantity of water input per unit output. Such investments are a form of capital substitutions for the groundwater resource.

Effects of Alternative Taxes upon Allocation of Groundwater Resources

The effects of alternative taxes upon resource allocation, the level of resource employment, and the level of output have been discussed by economists in the past. Contemporary writers have explored tax topics in light of present economic structure and present competition for resources. The eminent S. V. Ciriacy-Wantrup has devoted considerable attention to the effects of alternative taxes upon natural resource conservation [4]. Raleigh Barlowe [1, 2], Roland Renné [6], and others have also given attention to the tax question in relation to natural resource use. Writers of texts on economic theory deal with the influence of taxes upon resource use, output, and pricing. The relevant theoretical concepts applicable to analysis of effects of alternative taxes upon groundwater use are summarized below.

In cases where property taxes are placed on groundwater resources in the form of an ad valorem tax on the capitalized expected future earnings of irrigated land, the tendency will be to cause owners to attempt to redistribute use of exhaustible groundwater resources in the direction of the present [3, Chap. 13]. The reason for this intertemporal resource allocation is to avoid recurring property taxes on future net incomes by reducing the number of future periods in which income will be received. The forward shift will be practiced as long as discounted savings in taxes exceed the decrease in present worth of future net revenues resulting from shifting groundwater use forward in time. The final outcome of an accelerated groundwater use policy designed to avoid taxes is the exhaustion of the reserves and a shift in land use back to dryland more quickly than would have been the case under zero property taxes on the water resource or the use of a tax which varies with water use, that is, a tax per unit of groundwater pumped.

The per-unit resource input tax is an annual variable cost which tends to discourage annual resource use since it shifts the annual resource supply curve upward. A per-unit input tax means that unit resource cost is higher for each level of use and total annual tax varies with quantity used. Thus, for given demand situations the per-unit input tax reduces annual use whereas an equivalent ad valorem tax based on the value of the resource results in greater resource use. In the former case, the annual supply curve is shifted upward by the amount of the tax. In the latter case, the annual demand curve is shifted upward by the difference in discounted tax savings per unit and discounted reductions in present worth of future income, as a result of using an additional unit of resources in year i as opposed to waiting until some later year (year $i + t$). The greater the tax savings, the greater the shift in the annual demand curve; but because of declining marginal productivity from additional units of resource used in time period i, the shift in the annual demand curve is larger at low levels of use in period i than at high levels.

The form in which taxes are levied affects the intertemporal allocation of groundwater, the value of the resource (measured in terms of present worth), and the size and distribution of the "induced" and "stemming" effects upon local economies. These latter effects are of direct concern to local taxing authorities since the economies resulting from groundwater resource use will likely be organized and planned as if the groundwater resource were expected to last forever. Thus, tax authority may indirectly influence the ultimate size of the economy associated with groundwater use by influencing the annual rate of use of the groundwater resource.

The irrigation-associated economy is itself an object of property taxation and as such can be considered an asset to tax-supported entities. Annual ad valorem property taxes on agricultural marketing firms, agricultural input supply firms, and wholesale and retail firms are presently levied on the basis of either undepreciated construction and installation costs or a combination of undepreciated investments and annual net earnings. The generalized tax policy must, of necessity, be designed to treat the separate ownership entities equitably whether taxes are levied on the basis of services rendered or on the basis of ability to pay; but account should be taken of the extended effects of taxes placed upon basic resources such as groundwater.

The form of the tax will either hasten or delay the time at which local economic adjustment to a disappearing water supply must be made, by the manner in which the tax influences the rate of use of the basic resource. Other things being equal, a per-unit resource use tax results in a lower annual use rate than an annual lump sum ad valorem property tax. Although a lower annual use rate of groundwater results in a smaller effect upon the general economy (in terms of investments in property to service irrigated agriculture) than the general economic investments resulting from a more rapid use rate under fixed annual property taxes, the latter effect will be shorter-lived and probably will not be designed so as to be completely depreciated or used at the time of exhaustion of the groundwater supply. Not only will the tax base decrease when groundwater is exhausted, but also the adjustment process may include the abandonment of a significant quantity of productive capital in the service industries, especially in the smaller rural communities, where opportunity to shift into other uses is limited.

Needed Policy Measures

Both the private and the public interests would be served better if specific policies were formulated and applied to the taxing of groundwater resources per se. The present method, which treats groundwater as a part of the land resource to which it is attached, encourages a more rapid annual use rate in order to avoid taxes which may in fact be land taxes, and thus contributes to malallocation of groundwater deposits. One of the first measures to be considered is the recognition of exhaustible groundwater deposits as resources separate and apart from the land. Taxes could then be applied directly to the water resource on the basis of water resource value in production (present worth of future net earnings from water). Separation of groundwater from the land resource would have the added advantage of removing the influence of the speculative increment associated with the land resource from the assessed value of the water resource. This is particularly important in states where market value is used as the basis of tax assessment. In such cases, the confounding of land and water values may lead to higher taxes on water than the earning value of water would indicate, since in most such cases the market value of land contains certain locational, esthetic, and speculative elements which do not necessarily apply to the water resource.

The time of use (conservation) of water[3] could be guided to some extent by placing the tax on water on a variable basis so that taxes need not be paid unless actual use is made of the water. Although a variable tax would not necessarily reduce the annual rate of use of exhaustible water deposits, such a tax would not stimulate a more rapid rate of use, since the total tax paid could not be reduced under a variable tax as it could under a fixed annual tax.

The administration of a variable tax on the water resource would necessitate measuring the amount of water used each season, a task which is somewhat easier than measuring the amount of water in storage, as is now required in order to make realistic tax assessment of irrigated land. The amount of water used per unit of time can be measured by sampling wells for well output or by correlation of well output with energy input to the pumps. The measurement of groundwater in storage is extremely difficult and costly. A large number of test wells are needed from which to measure aquifer thickness, yield of the aquifer, and well output, in order to estimate total quantity of recoverable water. The latter cannot be done very accurately in most cases; thus, the length of time over which to cap-

[3] Conservation is the deferral of use of exhaustible resources [4, Chap. 4].

italize net earnings in order to estimate present value of the resource is subject to a large amount of error. Consequently, a tax based on the resulting assessed value would be subject to significant error. Shifting to a tax per unit of water used would serve to eliminate this source of error.

In cases where taxing is not shifted to a per-unit tax, the present method of taxing could be improved to distribute the tax burden among water and other forms of capital more equitably (that is, to reduce the present tax load borne by water) if the policy of assessment were changed to assess only on the basis of present worth of the future annnual net income stream as opposed to assessment on the basis of present worth of the current annual net income capitalized into perpetuity (Fig. 1). Future annual net income from exhaustible groundwater is expected to decline as a result of increased pumping costs as the water table is lowered. Since there are fairly good substitutes for groundwater, in the form of surface water and unused land in the more humid regions, it does not appear that a reduction in groundwater supplies will result in upward pressures on groundwater values through increased prices of products produced from groundwater. Thus, the increased pumping costs will not likely be offset by corresponding increases in gross revenue from irrigated agriculture, and the expected future net income per unit of groundwater use will decline. Assessment for tax purposes on the basis of capitalization of present net income into perpetuity is in error by the capitalized value of the differences between the future annual net income stream and the assumed constant annual net income stream (Fig. 1). In order to estimate accurately the present worth of groundwater deposits, there must be accurate and complete information about the present quantity of water in storage, the cost of pumping over the course of time, future technical input–output relationships, and future prices. The major tax policy objective should be a valuation of groundwater resources consistent with taxa-

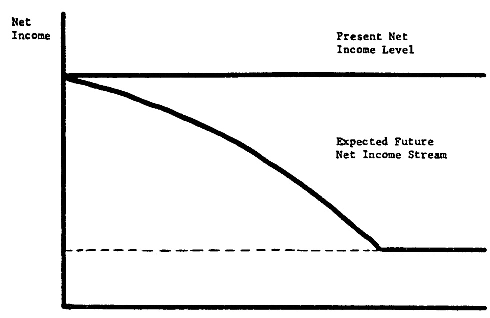

Figure 1. Nature of expected future net income stream from exhaustible groundwater supplies

tion of other resources. If taxes are to be levied on the basis of present worth of the resources, then accurate estimates of present worth of the groundwater resource should be sought.

Tax incentives could be used to encourage investments in water-saving capital items such as irrigation sprinkler systems and recirculating systems for cooling water. The present practice in the irrigated areas is to tax these types of inputs just as tractors, farm machinery, buildings, and pumps are taxed, even though such investments represent an attempt to reduce the quantity of water per unit of output and extend the life of exhaustible groundwater supplies. In order to avoid or reduce property taxes on water-substituting inputs, either the owners do not make the investment or, once the investment is made, the incentive is to still speed up further the rate of annual water use and either fail to replace such equipment when its useful life is ended or proceed to salvage the remaining useful investment when the groundwater is exhausted. Such tax incentives could range from zero property taxes on groundwater-substituting inputs to property tax credits and accelerated depreciation schedules.

Summary

The groundwater resource is identified as a part of the land resource for taxing purposes. The application of fixed annual taxes to groundwater of the type used in taxing land tends to shift the use of exhaustible groundwater deposits forward in time. A specific policy which treats groundwater as an individual resource is needed in order to permit taxing so as to enhance rather than reduce the economic value of groundwater resources. The type of tax indicated is a tax per unit value of water used as opposed to a fixed annual tax based on the total value of the resource if the tax is to be neutral insofar as water allocation is concerned.

The adoption of tax incentives applicable to water-substituting capital investments would be expected to contribute to prolonging the useful life of exhaustible groundwater aquifers. Such measures would be expected to benefit local economies dependent upon groundwater resources through increased local investments in the short run, through extension of the useful life of the water supply, or through a larger total output from water and the increased capital input.

References

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Discussion: Economics of Stock Natural Resource Use

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Whoever planned this session apparently anticipated that these three papers would relate in a unique way that would permit a single discussant. If so, the plans seem to have gone awry. About the only thing the papers have in common is that they deal with "stock" resources, and even here, Dr. Grubb's water aquifer, mistakenly I think, is treated as a flow resource if the rate of replenishment exceeds the rate of discharge. In general, the level of theoretical abstraction as well as the substantive issues treated in the three papers are highly disparate. Notwithstanding, in my opinion, all the authors have taken reasonable approaches to their respective subjects. I do not think it would be especially fruitful to compare or relate the papers to each other; rather, I will discuss each one on its own merits (or demerits).

Let me begin with the scholarly paper written by Dr. Brewer. The title suggests that economic, technologic, and policy issues will be treated. Almost all the substantive material in the paper deals with technologic considerations, which, however, are analyzed from an economic point of view and suggest some policy implications. In fact, Brewer's decision to focus mainly on technologic factors was wise, since other economic problems of optimal rates of extraction of a stock resource, the scale of optimal investment, and relationships between price paths and the rate of interest have been thoroughly discussed by Gaffney, Scott, Herfindahl, and Vickrey in the recent volume to which Dr. Brewer referred [MASON GAFFNEY, ed., *Extractive Resources and Taxation*, Madison, University of Wisconsin Press, 1967]. Brewer's paper is a welcome supplement to that volume because he considers a set of issues not treated in that book—namely, how technological advance at various levels of exploitation and utilization of stock resources impinges on resource owners.

His notion that problems of pollution and environmental quality constitute a special case of the stock resource problem is an exciting new concept that should yield fruitful results.

I appreciate the careful way in which Brewer sets up his model for a

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