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PART III. Natural Resource Economics, 1946-75

The division of labor among the authors was as follows: Maurice Kelso prepared the first section; Herbert Stoevener wrote the portion of the review dealing with outdoor recreation; Joe Stevens prepared the final section; and Emery Castle wrote the remainder of the review and coordinated the review effort generally. Each author participated in the planning, and each read and made contributions to all parts of the review.

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Natural Resource Economics, 1946-75

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As this portion of the literature review developed, its scope became considerably broader than that originally envisaged by the authors and perhaps even by the planning committee. The authors had originally intended to confine their treatment of resource economics largely to the work of those agricultural economists who have written about resource economics. As the review unfolded, however, it became apparent that a balanced treatment would be impossible if this approach was followed. For one thing, agricultural economists have not contributed directly in a significant way to the underlying economic theory upon which resource economists draw, and, in addition, general economists have done important applied work on a number of topics covered in this review. Consequently, even though the major thrust of the review remains the contribution of agricultural economists to resource economics, writings of general economists and others are drawn upon where necessary to provide a theoretical base or a balanced treatment of applied work.

Even with this expanded coverage, certain areas of resource economics are not adequately treated in this review. Forestry and mineral economics are examples. It did not seem practical to open up these areas, given the fact that agricultural economists have not been major contributors to these areas.

The authors wish to issue a disclaimer here. It has never been our intention to utilize this review to attempt to establish natural resource economics as a subdiscipline distinct from agricultural economics or economics proper. Such an attempt would be a mistake for at least two reasons. First, the tools of

resource economists are not unique. The review itself makes clear that resource economists must rely upon the underlying economic theory if they expect to make progress in applied studies. Indeed, it might be argued that one of the reasons for the productivity of resource economists in recent years has been their utilization of economic theory. Second, resource economics is an applied field. As such, it should not be isolated from world events or from developments in closely related fields. To isolate resource economics from agricultural economics generally, and from agricultural policy and rural community development issues in particular, would be to lose the advantage of cross-fertilization. Just as people working on resource economics can benefit from contact with those in other specializations, so can those in other specializations learn from resource economics. One of the lessons to be learned from resource economics literature is the value that comes from contact with those working in the parent discipline, other applied workers, *and* workers in other disciplines.

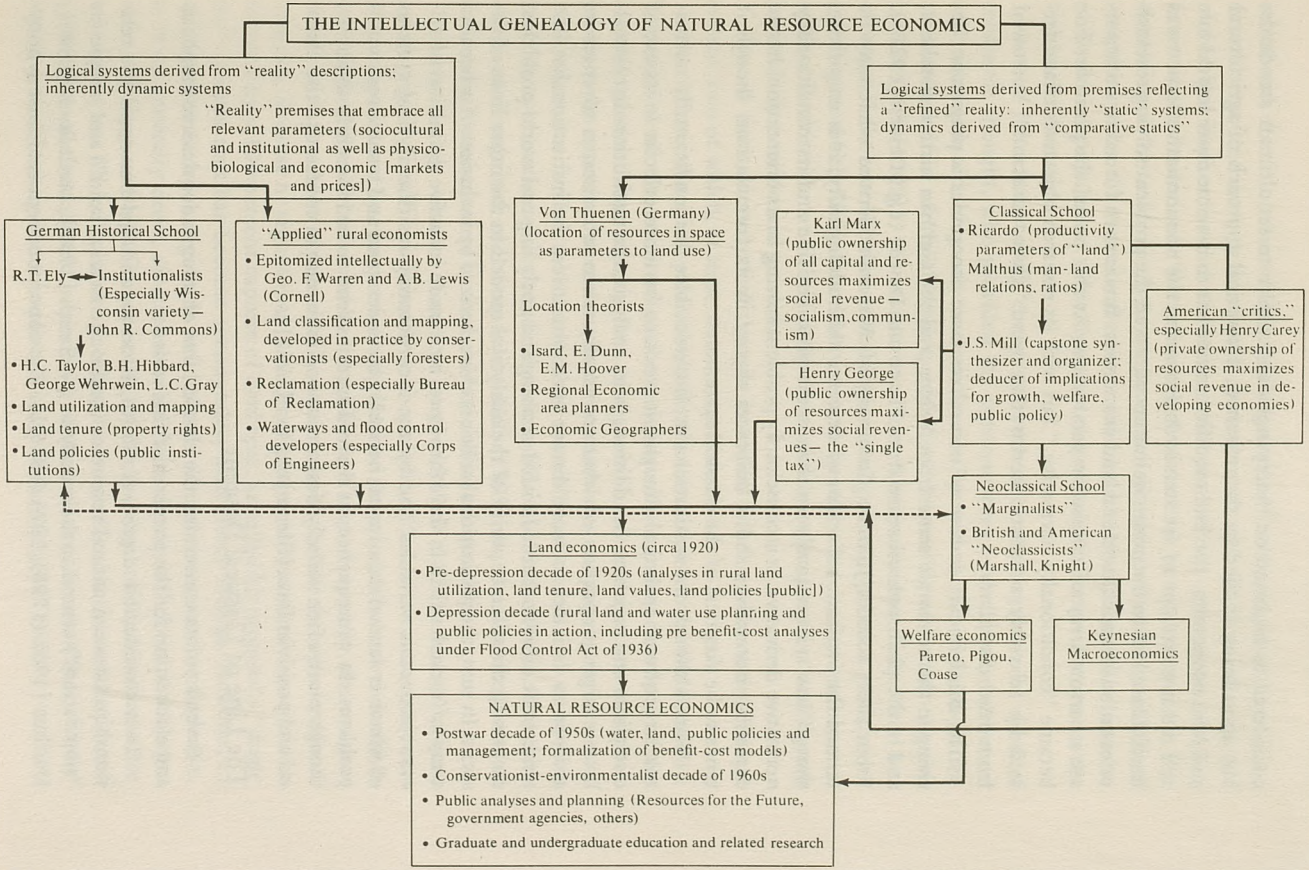
The Intellectual Genealogy of Natural Resource Economics

The content of the post-World War II literature in natural resource economics has been much influenced by its intellectual history. In this section we briefly trace the genealogy of natural resource economics and its emergence as a subfield with a recognizable body of analytical doctrine. This treatment demonstrates that natural resource economics emerged both from within and from without the agricultural area of intellectual concern.

The genealogy divides into three broad but distinguishable lines of descent, all of which merged during the 1920s and resulted in the appearance of land economics as a subdiscipline within agricultural economics.[1] Later, after further descent, natural resource economics evolved.

One of these lines was rationalistic, descending through classical, neoclassical, marginalist, and welfare theory. This line of descent may be referred to as the *classical line.* Methodologically, it is characterized as a structure of deductive, logical systems derived from specified ends and factual premises. It is largely nonnormatively predictive (though it may be made to be narrowly normative by specification of narrowly economic goals such as maximized income or welfare); neither is it in its pure exposition oriented to problem solving, though it may be in its narrowly normative phase, in which case it becomes normatively predictive. Systems derived from the classical line tend to be elegantly precise in statement but static in nature, their dynamic expression usually being in the form of comparative statics.

The second line of descent, positivistic in nature and originating in the British Baconian-Pearsonian positivism of natural science and in statistics, may be referred to as the *positivist line.* Methodologically, it is empirical, inductive, and nonnormatively predictive. In its purest form, the positivist line was not


THE INTELLECTUAL GENEALOGY OF NATURAL RESOURCE ECONOMICS
Logical systems derived from "reality" descriptions; inherently dynamic systems
"Reality" premises that embrace all relevant parameters (sociocultural and institutional as well as physico-biological and economic [markets and prices])
Logical systems derived from premises reflecting a "refined" reality: inherently "static" systems; dynamics derived from "comparative statics"
German Historical School
R.T. Ely
Institutionalists (Especially Wisconsin variety—John R. Commons)
• H.C. Taylor, B.H. Hibbard, George Wehrwein, L.C. Gray
• Land utilization and mapping
• Land tenure (property rights)
• Land policies (public institutions)
"Applied" rural economists
• Epitomized intellectually by Geo. F. Warren and A.B. Lewis (Cornell)
• Land classification and mapping, developed in practice by conservationists (especially foresters)
• Reclamation (especially Bureau of Reclamation)
• Waterways and flood control developers (especially Corps of Engineers)
Von Thuenen (Germany) (location of resources in space as parameters to land use)
Location theorists
• Isard, E. Dunn, E.M. Hoover
• Regional Economic area planners
• Economic Geographers
Karl Marx (public ownership of all capital and resources maximizes social revenue—socialism, communism)
Henry George (public ownership of resources maximizes social revenues—the "single tax")
Classical School
• Ricardo (productivity parameters of "land") Malthus (man-land relations, ratios)
• J.S. Mill (capstone synthesizer and organizer; deducer of implications for growth, welfare, public policy)
American "critics," especially Henry Carey (private ownership of resources maximizes social revenue in developing economies)
Neoclassical School
• "Marginalists"
• British and American "Neoclassicists" (Marshall, Knight)
Land economics (circa 1920)
• Pre-depression decade of 1920s (analyses in rural land utilization, land tenure, land values, land policies [public])
• Depression decade (rural land and water use planning and public policies in action, including pre benefit-cost analyses under Flood Control Act of 1936)
Welfare economics
Pareto, Pigou, Coase
Keynesian Macroeconomics
NATURAL RESOURCE ECONOMICS
• Postwar decade of 1950s (water, land, public policies and management; formalization of benefit-cost models)
• Conservationist-environmentalist decade of 1960s
• Public analyses and planning (Resources for the Future, government agencies, others)
• Graduate and undergraduate education and related research

considered to be based on theory nor did it aspire to set ultimate standards; but upon being applied to the reasoned, theoretical approach of agricultural and land economics, the line modified somewhat to become more logical but still did not attempt to set standards. However, the nonnormative stance was itself diluted when the positivist line encountered the problem-solving research orientation in agricultural and land economics. It was then forced to incorporate a narrow array of normative parameters. At this point, the positivist line became "conditionally normative," but with its research objectives characterized by relatively simplistic norms that were "given constants" borrowed from other disciplines.

The third line of descent of natural resource economics is pragmatic, deriving in the economic sense from Veblen and the German historical school, and in the philosophical sense from Pierce and Dewey (e.g., Dewey [1927]). From these sources John R. Commons of Wisconsin derived what may be termed the *institutionalist line* of descent. Methodologically, it is empiricist, though less systematically so than is the positivist line and its conditionally normative derivative. It is consciously problem solving in its orientation, hence explicitly normative, and it embraces theory in its formulations though it tends to be skeptical of the classical system.

Thus, although the institutionalist line resembles the conditionally normative structure of analytical thought, it tends to be more eclectic in its use of disciplines and variables. In addition, in its analysis, the institutionalist line allows a larger proportion of what are usually taken as constants to enter its analysis as variables to more distant ends. Moreover, the institutionalist line tends to be more concerned with describing and analyzing real world problems, eschewing the abstract purity of the analytical models in the other lines of descent. In sum, the institutionalist line is characterized by inclusion of a broader array of variables than in the other lines, by a more inclusive definition of relevant economic variables, and by the incorporation in its analytical systems of whatever factual data appear necessary to understand and resolve real world problems. In consequence, its derived systems tend to be inherently dynamic, though more often verbally descriptive and imprecise in contrast to the classical and positivist lines (Glenn Johnson [1962]).

The Line of Classical Descent

Several points concerning the classical line of inheritance deserve emphasis and elaboration for the purposes of this review.

To a considerable degree, A. Smith, Ricardo, and Malthus made the relationships between natural resources (under the rubric "land") and people (as "population") central to their analyses (A. Smith [1937], McCulloch [1846], Malthus [1965 (1798), 1974 (1836)]). The concept of rent is almost synony-

mous with Ricardo; that of "diminishing welfare" stemming from increasing natural resource scarcity is equally synonymous with Malthus. Ricardo explored the implications of the differential productivity parameters of land, from which he derived "Ricardian rent" and which he made central to the dynamics of his macroanalysis of the economic system. Malthus introduced into the system the "man-land ratio," which related the differential dynamics of land and population. This dynamic macroanalysis is now known as the Malthusian Doctrine.

It was John Stuart Mill, the great synthesizer and organizer of classical economic thought, who provided the capstone work to the classical structure and who deduced, elegantly and with verbal precision, the implications for economic welfare of "land" and "population" interacting with other relevant factors (Mill [1909]). His treatment of the "stationary state," the "iron law of wages," the race between technological change and population growth, the significance of the distinctions between the quantity and quality attributes of welfare in this race, and the implications of private property in "land" were particularly notable and prescient.

Several lines of analytical thought branched off from the main classical stream, two of which, at least, deserve mention here.

The American critics, particularly Henry Carey, questioned the Ricardian formulation of the unidirectional expansion of occupancy onto land of decreasing productivity, arguing that occupancy in developing economies often moves in the opposite direction as wealth accumulates and population increases. The Americans further said that private ownership of land in such economies leads to maximization of the social revenue (Carey [1965, 1967]). This criticism was recognized and accepted by Mill [1909], but he dismissed it as of little overall consequence in the land-population relationship.

Henry George—also an American—argued [1929 (1879)] that (1) private ownership of "land" is inherently monopolistic, (2) rent is an economic surplus not generated by entrepreneurship (derived directly from classical thought), and (3) land should be owned by the public or, if owned privately, the rent generated by it should be captured in its entirety by the public through a confiscatory tax. Because he argued that that cost of government a century ago could be covered by a 100 percent capture of land rent, he called his proposal a "single tax"—a term that has become synonymous with Henry George. However, to characterize George's argument as a polemic on taxation or on one single tax, as is so generally done, diverts attention from the central point of his argument. Of far greater significance in the intellectual descent of natural resource economics was his focus on the peculiar character of land in the socioeconomic system, the socioeconomic importance of the land tenure institution, and the equity and efficiency issues implicit in the private capture of rent.

Henry Carey's thought was more in tune with the conventional wisdom of a frontier America than was George's, and, in consequence, his conceptualization of the problem dominated thinking on natural resource policy almost to the present time. That of Henry George was submerged, surviving almost solely as an interesting aberration in intellectual history. However, many analysts and polemicists have recently rediscovered what George argued a century ago regarding land ownership and the private capture of economic rent. The mainstream of the classical descent from Mill[2] continued into the "neoclassical" school, epitomized by Marshall, the "marginalists," the British and American neoclassicists, Keynesian macroeconomics, and welfare economics. To many, this line, especially in its theory of the firm, is the core of natural resource economics thinking, and to a considerable degree it is, especially in its conditionally normative derivative described above.

Another approach in the classical tradition, but originating in Germany rather than in England or America, was that of J. H. von Thuenen in *Der Isolierte Staat* [1830]. He elaborated the factor of *location in space* and its bearing on the sorting and arranging of land uses. Although it is unclear whether, or to what extent, he was influenced by the writing of the classicists, his analysis was clearly within the intellectual and methodological formulation of classical economics. His writing seems to have had little influence on later mainline developments of classical and neoclassical economics; nevertheless, it did stimulate an extensive literature of "location economics." This literature was extensively elaborated by a group of German economists who surfaced in the main stream of economic though in America in the mid-twentieth century through the works of E. M. Hoover [1948], Walter Isard [1956], and Edgar S. Dunn, Jr. [1954]. The work of several economic geographers, regional analysts, and area planners is relevant here also.

The Line of Positivist Descent

Probably the earliest analyst in the positivist line of descent to surface in the United States in the emerging land economics phase of natural resource economics was George F. Warren of Cornell University. Warren's thinking was not influenced greatly either by the classical or the institutionalist lines but was a spin-off from the British positivism in the natural sciences that dominated agricultural natural science research of his day. He was a horticultural scientist by training and early experience. Through his concern for the economic adjustment problems confronting agriculture and rural land use in rural New York State, Warren evolved a program of research that, by focusing on the comparative profitability of real world farms, sought to locate geographically the lines of transition between classes of lands suitable for various kinds and intensities of farming and other forms of rural land use. Out of these con-

cerns, developed largely by and through his student, A. B. Lewis, came a program of land utilization research and an applied technique for land classification. The intellectual line of descent of this development was largely positivist. The research involved observing how assets were accumulated by farm entrepreneurs as a result of management decisions they took in pursuit of maximizing their profits. These observations were then related to their apparent geographical patternings and to the underlying productivities of the land. Thus Warren's program was logical-positivist and not closely related to the classical or institutionalist approaches, except that insofar as it did embrace theory, it was derived from the neoclassical theory of the firm.

Also in the positivist line of descent were several other groups who contributed to the stream though more clearly in the conditional normative methodological construct within positivism. These included the conservationists (especially American foresters of German intellectual training), the reclamationists (indigenous products of western irrigation development), and the waterways and flood control developers (especially those affiliated with the Army Corps of Engineers). These, too, were more akin to the classical line that eventuated into management and into land utilization and classification than they were to the institutionalist line discussed below.

The Line of Institutionalist Descent

The principal intellectual progenitor of land economics in the United States was R. T. Ely, a product of the classical tradition who was intellectually "hybridized" through study in Germany in the late nineteenth century during the heyday of the German historical school in economics. He gravitated to the University of Wisconsin near the inception of the conservation movement in the United States during the 1890s. Here he began a mutually stimulating association with President Van Hise, the conservationist president of the University of Wisconsin, and the emerging "institutionalist," particularly John R. Commons [1924, 1934] of the "Wisconsin school." This association led to Ely's concern with property and contract in the economic process and their applications to land and to industrial organization, especially monopolies and public utilities. Others in this tradition were Henry C. Taylor, Benjamin H. Hibbard, George C. Wehrwein, Lewis C. Gray, and the "Wisconsin tradition" that become known, *circa* 1920, as "land economics." Since its inception, the Wisconsin family has been primarily concerned with institutional factors in land economic analyses—property, public policy, and public action. It has been strongly oriented toward defining and solving real world problems. Thus it has been strongly normative. However, the ends (values) commonly built into the more conventional conditional normative models of other agricultural economic analysts have been frequently transformed, by the institutionalists

in their models, into variable means to yet more ultimate ends. This has been done to a greater degree than it has in the more conventional conditional normative models of other agricultural economic analysts. In addition, recommendations for group (usually public) action have been more generally the goals of the institutionalists' analyses than has been the case in most conditional normative analyses. The Wisconsin group's earliest studies dealt with problems of land tenure (especially of tenancy) in farming; it soon became involved in problems of the forest land cutovers in northern Wisconsin, seeking ways by which public action could guide their transition to settled agriculture and economic development through community planning, rural zoning, adult education, and credit reforms.

Two papers that are especially pertinent to the discussion of the institutionalist as compared with the conditional normative form of the empiricist lines are those by Parsons [1962] and Ottoson [1962].

The Emergence of Land Economics

Stemming from the intellectual concerns of Dr. W. J. Spillman, who then headed the Office of Farm Management in the U.S. Department of Agriculture, and under the intellectual aegis of Henry C. Taylor, and the participation, among others, of Ely, Gray, and O. E. Baker, the Division of Land Economics was organized in 1919 within the U.S. Department of Agriculture (USDA); L. C. Gray was head of the new division. The division was charged with the following five areas of research:

1. Land resources
   A. Classification
   B. Utilization
2. Land values
3. Land ownership and tenancy (land tenure)
4. Land settlement and colonization
5. Land policies.

Here the lines of descent are clearly apparent. The categories of land resources and land values are clearly descendants of the neoclassical, entrepreneurial-management line (market price line fused with the positivist line in its conditional normative form), whereas the categories of land tenure, land settlement and colonization, and land policies are clearly institutionalist in their genealogy. As expressed by Salter [1948, p. 18], the latter three categories "fit better into the terms of reference of the political economy group of agricultural economists than into the 'farm practice' group of farm management specialists." Intellectually within the new division, land resources and land values remained largely separate from land tenure, settlement and occupancy, and policy. Intellectual merging was still to come.

As described by Salter in the same book,

> . . . the division [soon] expanded [its] work to include studies of the forces affecting the nation's need for land and a determination of the national land requirements. Spurred by the establishment of a departmental Committee on Land Utilization . . . , the division prepared an extensive report on the national land utilization situation. This report [Gray, Baker, et al. (1924)], published in the 1923 [*Agriculture*] *Yearbook*, point in land policy thinking.
>
> The 1923 *Yearbook*, which carried the landmark report on the nation's land utilization situation, also contained a very comprehensive report on farm ownership and tenancy summarizing all of the findings of the many studies which had previously been made [Gray, Stewart, et al. (1924)]. But . . . whereas the land utilization report marks the beginning of an intense growth of interest in that subject, the land tenure report is more accurately described as marking the termination of an intensive period of research interest in that subject [p. 25].

As further elaborated by Salter:

> Although the outstanding development in agricultural economics in the twenties was the attention given to prices, price statistics, and marketing, nevertheless, farm management continued to receive the bulk of attention. . . . This solid core of interest in farm management had an influence on land economics in this period, however, and this effect came by way of investigations of type of farming.
>
> If the market mechanism could not be altered to give the farmer better and more stable prices, it might be possible to give farmers greater help in adjusting to forthcoming economic changes. The first requirement of this line of reasoning was that farmers should be provided with advance information on what to expect in the prices of products, services, and resources. . . . The second requirement was that farmers should be given general advice as to what kinds of farm organization and management adjustments might best meet the forecast conditions.
>
> A program intended to fill these needs was launched in 1926 and named the Outlook Program. As a part of it, F. F. Elliott in the Bureau of Agricultural Economics and economists at several state colleges proceeded to devise means of designating areas within which the systems of farming were sufficiently homogeneous that a determination could be made of the type of economic data needed in the area and of the farm management adjustments that might be applied.
>
> This development was important to land economics for two reasons. First it meant that farm management research now took on a geographical, mapping approach at a time when land economists were trying to develop methods of land classification and land utilization analysis for the purpose of recommending desirable uses of land. Secondly, it meant

> that men who might previously have limited their views to the line fences of particular farms now began to look at the farms of an area as a unit. This approach was capturing the imagination of land economists at the same time the farm management group first began to feel their way into the problems of typing farms and delineating type-of-farming areas [pp. 26-27].

Important names from this era were: in the Division of Land Economics—O. E. Baker, C. F. Clayton, L. J. Peet, W. A. Hartman (in land utilization and classification), E. H. Wiecking (in land values), and R. P. Teele (in western irrigation analyses); in the states—David Weeks (California), C. L. Stewart (Illinois), I. G. Davis (Connecticut), George F. Warren and A. B. Lewis (New York), and M. L. Wilson (Montana).

Although American agriculture had been mired in depression since soon after World War I, the entire country began its slide into deepening depression following 1929. The agricultural distress of the twenties led from expanding interest in land utilization and classification, and from type-of-farming geographic delineation, to the outlook described above, and finally in 1931 to a National Land Utilization Conference called by the Secretary of Agriculture *(Proceedings of the National Conference on Land Utilization [1932]).*

In land economics the deepening depression led to a resurgence of interest in the institutional aspects of land policy, land tenure, and planning. Submerged though it was during the 1920s, the institutionalist content of land economics broke its dormancy because of the need for planning, policy, and action. When M. L. Wilson and his associates in Montana discovered that the best management and organization of individual dry-land wheat farms that experts could devise in the spirit of the Outlook Program could not lift farm incomes to equitable and viable levels, they shifted their attention from the problems of individual farm firm managment operating within a given structure of institutions toward the design of changes in the existing and conventionally accepted structure of the institutions themselves. This led them into the problems of ownership and tenancy of dry-land farms, agricultural credit, and into agricultural price policy. This shift led to the "domestic allotment" plan and to the Agricultural Adjustment Act (AAA) of 1933. Wilson and his associates also became concerned with the problems of livestock ranches in the Great Plains, which operated in a hodgepodge of grazing-land ownerships. They devised and secured the adoption of the cooperative grazing district idea in Montana, which served as the prototype for the federal Taylor Act of 1934. This brought to an end the era of open, unregulated grazing on the federal public domain and brought instead the spread of grazing districts and the management of federal public domain grazing lands throughout the federal public lands states.

During the same period, Ely founded (in 1920) the Institute for Research in Land Economics and Public Utilities at the University of Wisconsin, where in 1924 he established *The Journal of Land and Public Utility Economics.* (The institute, with its journal, was moved in 1925 to Northwestern University. Retitled *Land Economics* when the institute was reestablished in Wisconsin, the journal is still published there.) The institute pressed into publication many studies on land economics topics and sponsored a number of research studies focusing on land tenure at a time when tenure, as a problem, was in eclipse in the USDA and the colleges. The institute also held both urban and rural land economics in a common bond. By the middle 1920s, there had been a considerable development in the area of city planning. In 1926, the institute published Harlean James's *Land Planning in the United States for City, State, and Nation,* in the concluding pages of which James remarked, "The principles of *city planning* which we are now applying to our urban communities are equally applicable to rural regions" (James [1926, p. 23]).

In the mid-1920s, the Federated Societies of Planning and Parks of Washington, D. C. organized the Joint Committee on Bases of Sound Land Policy [1929]. The committee was chaged with the task of exploring answers to two "vital questions: will our land area in the United States meet the demands of our future population? How are we to determine the best use of our land resources?" [p. xv]. Dr. George M. Peterson, then of the University of Minnesota (later Professor of Agricultural Economics at the University of California), was asked to prepare the committee's Report. The report was published in 1929 under the title *What about the Year 2000?* It analyzed available data on land uses from a national point of view, estimated the land resources of the continental United States, and attempted to forecast the principal surface uses of land for a predicted future population by the year 1950 and the year 2000. It concluded that "future land policies ought to be formulated in answer to the question: Should more land or particular tracts of land be used to produce commodities or can the land be put to better social advantage?" [p. 168]. It ended with a strong plea for land use planning, arguing that there were opportunities for promoting social progress by land use planning in different sections and from a national point of view.

At the University of Wisconsin, interest in the problems of the forest cutover lands of the Lake States was strong. It began with land utilization research in the cutover counties of northern Wisconsin, with public officials actually participating in the work. Data were collected in much less detail than in the more analytically elegant endeavors elsewhere. The information was combined by rough map correlations and, on this basis, public officials made recommendations for public action. After 1929, and as the depression deepened, the

problems of the cutovers became increasingly acute because of the rise of tax delinquencies and the movement of urban unemployed and displaced farmers onto cheap, isolated land in these counties.

> With the store of land use information that was on hand, with the public awareness that had been created by the county committees, and with legislative authority under a permissive 1929 law [authorizing rural zoning], in a relatively short time 25 Wisconsin counties enacted zoning ordinances that restricted farm settlement to designated areas. Previous to this time, zoning had been limited in its application to cities and some of their periphery areas. Harlean James' suggestion [quoted above] had become a fact [Salter (1948, pp. 24-31)].

Thus land economics entered the great depression with the two lines of investigation beginning to merge. Within the USDA, the institutionalist and the neoclassical-positivist approaches began to intertwine closely after 1933. A short but excellent summary of the land economics developments of the era between 1933 and the advent of World War II, when problems and interests of another sort shouldered resource issues aside, is contained in Salter's work [1948, pp. 27-35]. The Public Works Administration, the submarginal land purchase program, the Land Policy Section of the AAA, the National Planning Board, the National Resources Board, the National Resources Committee, the State Land Use Planning Program, the Resettlement Administration, the Land Utilization Division, and the Land Use Planning Section were all concerned with various aspects of land policy. See, for example, U.S. President's Committee on Farm Tenancy (U.S. National Resources Committee [1937]); U.S. National Resources Board [1935]; U.S. Great Plains Committee [1936]; U.S. Department of Agriculture [1941].

Land economics during the 1930's, especially among its protagonists within the Land Policy Section and the Division of Land Economics in the Bureau of Agricultural Economics, was instrumental in the initial formulation of operational conceptualizations of benefit-cost analysis of public investments in resource development. The Flood Control Act of 1936 specified: (1) that federal participation in flood control required that benefits to whomever they might accrue must be in excess of the estimated costs and (2) that the Department of Agriculture would be responsible for upstream flood *prevention* activities (watershed treatment) as alternatives to downstream flood *control* activities. Land economists within the Department of Agriculture were deeply involved in the operational task of implementing these directives and soon were brought together with representatives of the Bureau of Reclamation, the Army Corps of Engineers, and the Federal Power Commission to extend this operational conceptualization of benefit-cost analysis to flood control activities specifically

and to water resources planning and action generally. The fruits of these efforts surface soon after the end of World War II in the so-called Green Book, the Old Testament of the water planners' Bible. (U.S. Inter-Agency Committee on Water Resources [1958]).

Land economics as an integrated intellectual discipline was maturing. But just as it appeared that its maturity was at hand, even as with young men at a similar stage of emerging maturity, it was dragged into the holocaust of war and as a discipline was laid aside, not to emerge again until the return of peace and of concern with more mundane problems of living. During the period covered by this historical sketch, land economics emerged as a subdiscipline within agricultural economics, primarily because it concentrated on issues related to rural, renewable natural resource problems centered in farming, grazing, and forestry. Urban planning was still a thing apart except within the Institute of Land and Public Utility Economics. Not yet had problems emerged that centered in the rural-urban fringe, in regional planning, in air and water pollution, in rural-based recreation, or in water (except those related to irrigation with some broader references to flood control). However, some exploratory probing had occurred in several of these areas.

It was during the period since World War II that these and other broadening issues emerged. It was during this period and owing to the influence of this broadened range of problems that natural resource economics began to supplant land economics in the thinking and writing of analysts. The field of concern now broadened to include renewable ocean resources, nonrenewable resources generally, and nonrural peoples; it now embraced *all* of nature under the rubric "natural environment" and *all* segments and interests of society that were somehow related more or less closely to the use and conservation or depletion of the matrix of nature within which society's short-run and long-run welfare is embedded. "Natural resources economics" now became the distinguishing (defining) concept for the field of study. It became more of a subdiscipline within economics, even within social science, than within agricultural economics alone, wherein it had first emerged.

Two distinguishable methodological constructs are still visible in natural resources economics. One construct is conditional normative-positive and guided by theory, usually neoclassical, in which a wide array of relevant norms appear as exogenous constants. It is strongly oriented to mathematical modeling and quantitative operability. The other methodological construct is pragmatic institutionalism—also empiricist, also guided by theory but not so exclusively by neoclassicist theory—and includes a narrower array of goals that appear as given exogenous constants. More of what are exogenous goals in conditional normativism appear in institutionalism as variable endogenous means to fewer and more distant goals. That there are these disparate

methodological constructs in natural resource economics is not necessarily bad; they represent areas of specialization within the field as a whole, and they serve somewhat different purposes. What is important is that their differing relevance, roles, and significance be recognized and understood by their practitioners who desire equally to raise understanding of natural resource-based problems of social welfare and to serve as consultants to conscientious natural resource managers.

The Theoretical and Analytical Base of Natural Resource Economics

The Environment of the Post-World War II Period[3]

It is difficult, even for members of the agricultural economics profession who have been professionally active since World War II, to comprehend completely the changes that have occurred in our social environment since the war and to appreciate fully the impact of this changed environment on the thinking and activities of members of the profession. Not only is the social environment important to the thought of agricultural economists, it also establishes the conditions under which we work and creates the support for our work—because agricultural economics is an applied science. In the period immediately following World War II, the nation was experiencing inflation resulting from the increase in purchasing power and money supply during the war. The nation was also discovering that the peace was an uneasy one. All nations were adjusting to the reality of nuclear weapons. International tensions were a reality.

THE TRUMAN YEARS

In one sense, the Truman years were a transition period. During World War II, food production was of high priority. The demand for food continued strong after World War II until the early 1950s. Agricultural production became a weapon of cold war. Even so, by the outbreak of the Korean War, it became apparent that U.S. agriculture had a capacity to produce that would result in lower farm product prices unless international consumption could be increased. It was apparent that an agricultural technology had been created that was unlike that which had existed in the pre-World War II period.

The full impact of World War II monetary and fiscal policy was felt during the Truman years. Deficit financing had been used during the war, and a monetary policy had been followed that made it "easy" for the government to market its debt. The result was an increase in the capacity of the banking system to create credit. This credit was, in fact, created when the strong post-World War II consumer demand stimulated business activity. Inflation became

accepted as a way of life during this period. Not until 1951, however, was monetary policy divorced from fiscal policy. That is, monetary policy became more autonomous, and open market operations were no longer conducted in such a way as to minimize the cost of government borrowing.

In terms of land and resource economics, the Truman years had the following characteristics:

1. Our society was strongly orientated toward things technological and materialistic.The hardware of World War II and the postwar emphasis on consumer goods contributed to this environment. It was not surprising, therefore, that our relationship to natural resources was of a comparable nature. We talked of "controlling" floods and of "developing" land. The Corps of Engineers, the Bureau of Reclamation, and the Soil Conservation Service became "the" resource agencies.
2. Because of the monetary and fiscal policies followed, interest rates were low. This lengthened planning horizons—a situation that was favorable to long-term investments.
3. During most of the 1940s, Democrats controlled both the Congress and the Presidency. Government investment in resource development was a product of the policies of both the liberal and conservative wings of the party.

The so-called Green Book appeared during the Truman years (U.S. Agency Committee on Water Resources [1958]). This document was the product of an interagency group which had the assignment of developing criteria for the evaluation of government investment. It influenced subsequent government documents and the professional literature on the subject for the following two decades.

THE EISENHOWER YEARS

Dwight Eisenhower was president from January 1953 to January 1961, and the decade of the 1950s may be accurately labeled the Eisenhower decade. He was elected on the basis of promises to reverse the trend toward larger and stronger central government. After the election it was found that many of the problems could be met only by action of the federal government; international affairs and national defense were prime examples. Moreover, many of the people from whom Eisenhower drew political support benefited from numerous government programs. Included among these programs were various kinds of resource development activities that were sponsored and financed by the federal government.

The partnership concept was advanced as a response to this set of conditions because, on the one hand, it did not deny the need for resource development, but, on the other hand, it did diminish the relative importance of federal government. The consequence was a need to evaluate a new set of institutional

relationships. Thus the productivity of government investment and the impact of resource development on different interest groups became relevant topics for consideration.

The Eisenhower years were also characterized by (1) a growth in the federal budget, (2) a persistent, but a relatively slow, rate of inflation as compared with the period immediately after World War II and the latter part of the 1960s and the early 1970s, and (3) recurring problems of unemployment and slack in the economy.

Agricultural research fared well during this period. Although there were not dramatic increases in support for land and resource economics, those agricultural economists working in the land grant universities and the USDA shared in the general prosperity. Research and study were still respectable activities, even though the Eisenhower administration had a reputation for disdaining "eggheads" and intellectuals.

During the 1950s, a body of resource economics literature emerged that was nearly unanimously critical of public investment policies in natural resources. Partly in response to this, at the beginning of the Kennedy administration, an attempt was made to increase the role of economic analysis in the decision-making process of public investment in natural resources. Although this attempt largely failed, the intellectual basis for it can be traced to the resource economics literature of the 1950s. By the late 1960s and early 1970s, as this is being written, it might be argued that the critics of public investment policy have had their say, but it would be inaccurate to attribute this much influence to the literature. Competition for public funds and the environmental movement were the prime forces that caused a dramatic reversal in public natural resource policy, but the literature of resource economics provided an intellectual base and a rationale for some of the opposition.

One of the first substantial pieces of literature to appear in this tradition was Otto Eckstein's *Water Resource Development: The Economics of Project Evaluation* [1958]. Objective in tone, the book nevertheless found much to be lacking in the procedures of the action agencies when measured against the standards implicit in economics. Somewhat more strident, Edward F. Renshaw's *Toward Responsible Government* [1957] also appeared in the late 1950s. Krutilla and Eckstein brought forth *Multiple Purpose River Development* [1958], in which they concerned themselves with the economic efficiency, income distribution, and social costs of federal financing of public works projects. Roland N. McKean's *Efficiency in Government Through Systems Analysis with Emphasis on Water Resources Development* [1958] provided a direct link between the literature of resource economics and the application of economic concepts and operations research techniques to government operations in the following decade.

Although water resource policy dominated resource development policy during this period, it did not constitute the whole of it. There were developments and interest in soil conservation, public lands, and resource tenure. As will be noted later in the review, there were companion developments in the literature on these subjects. Perhaps one reason for the dominance of water resource development is that water development projects required substantial public funds. As a consequence, they were a favorite "pork barrel" for the politicians and a natural target for efficiency-oriented economists (Milliman [1962]).

THE KENNEDY-JOHNSON YEARS

Whereas the 1950s belonged to Eisenhower, the first three-fourths of the 1960s were dominated by the Democrats. John F. Kennedy was elected on promises of "getting the country moving." However, the emphasis placed by the new administration gave little more than a hint of the social upheavals that were to occur in the latter part of the decade. The administration continued to rely on a strong military as a tool of foreign policy. Science and scientific research were still "in." Even so, a major shift in political power was recognized. Urban problems received more attention, and agricultural policy was never an important issue in presidential compaigns during the 1960s except insofar as that policy affected the price of food.

Two innovations of the Kennedy administration did have considerable significance for resource economics. One was its approach to defense spending. McNamara, as secretary of defense, made use of the concepts of operations research and systems analysis in the management of defense spending. The principal intellectual base drawn upon by the department of defense was the work in systems analysis and cost effectiveness that had been pioneered by the Rand Corporation (Hitch and McKean [1960]). Some of these tools had been used for over a decade in natural resource evaluation and policy. Although not many resource economists found their way into defense evaluation, they can claim to have had some impact, and the resource economics type of analysis gained in prestige.

Another important impact of the Kennedy administration was its frontal assault on the process by which natural resource development projects were evaluated and authorized [(Castle, Kelso, and Gardner [1963]). President Kennedy's February 23, 1961, message to Congress on natural resources stated that he was instructing the budget director, in consultation with the departments and agencies concerned, to reevaluate standards for appraising the feasibility of water resource projects. In response to this directive, the Bureau of the Budget proceeded to establish a panel of independent consultants to advise them in this respect. The panel consisted of John Krutilla,

Maynard Hufschmidt, and Julius Margolis, with Stephen A. Marglin providing additional assistance (Hufschmidt, Krutilla, and Margolis, with Marglin [1961]). It became apparent that Congress was very concerned about this possible ascendancy of the Bureau of the Budget over the resource agencies, and a group of senators issued Senate Document 97 (U.S. Senate [1962]).[4] Senate Document 97 was a principles-and-standards statement that has influenced events to the present time. President Kennedy also stimulated legislation that resulted in the Water Resources Planning Act of 1961, which established a Water Resources Council and regional river basin commissions.

For the purpose of this review, the significance of the above events is twofold. First, the attitude of the Kennedy administration was to increase the role of reason and rationality in the evaluation of resource development projects, despite the fact that political power still rested with the complex of interests that favored traditional types of development. The Water Resources Council was not, and is not, a strong arm of the executive imposing its will on the agencies. On the contrary, it consists of agency members, and its influence on agencies has been minimal. Thus, in the final analysis, it was the Congress that issued Senate Document 97—not the executive branch.

The Kennedy years were also good years for researchers in natural resource economics. Modest funding was provided for the establishment of water resources research institutes on many campuses. Several agricultural economists became directors of these institutes. Engineering, biological sciences, and law were other disciplines represented among the institutes' directors. This association with engineering and other disciplines may have contributed to the general hospitality of resource economists to multidisciplinary approaches.

The 1960s was also a decade of massive government programs that strived to correct social ills. The principal focus was on the human agent, either individually or collectively. These programs tended to be directed toward the large cities and the centers of population. However, they had an impact on the agricultural economics profession generally and on resource economics in particular in that a need developed for human resource and community analysis. This development drew on the intellectual capital of resource economics and thus tended to compete with natural resource economics for the services of economists.

The environmental movement also was rekindled during the 1960s. No doubt much support for this resurgence of concern about environmental quality was part of the general dissatisfaction with the quality of life that developed during the 1960s (Castle [1972]). Although opinions differed on the extent to which economic analysis could deal with environmental problems, much of the literature of resource economics was relevant to environmental economics. Witness the analysis of conservation policy that commanded the

attention of resource economists for several decades. Although the recent literature on environmental economics has wrestled with the same problems, it has unfortunately been without full appreciation of the existing literature on conservation.

THE NIXON AND FORD ADMINISTRATIONS

History should be written from the perspective of time, and at the present writing we are too close in time to the administrations of Richard Nixon and Gerald Ford to provide that perspective. Nevertheless, it is appropriate to relate the main thrusts of these two administrations on the atmosphere within which resource economists must work.

The social unrest of the late 1960s prevailed during the presidential campaign of 1968. Richard Nixon was elected president by a small majority and confronted a Democratic Congress. The polar extremes in American politics were strengthened as a result of developments in the 1960s and early 1970s. Conservatism was manifested in the campaign of Barry Goldwater, the emergence of George Wallace, and certain policies of Richard Nixon. At the same time, the rise of George McGovern is evidence of the existence of support for a point of view at the other end of the political spectrum.

Gerald Ford continued to have the problem of obtaining support from a majority of people who are not members of the Republican Party. Concurrent with this is a Republican Party that apparently takes a more conservative stance than the people as a whole. Under these circumstances, unusual alliances form that affect the total social environment of which resource development forms one part.

Reference was made earlier to the growth of the environmental movement. The antithetic objectives of this movement, together with competition for governmental funds, have tended to reduce government investment in resource development. Other interrelated developments are worthy of mention in this connection. The specter of resource scarcity has arisen primarily in the energy and food areas. This has been accompanied by rapid inflation. In addition, unemployment and economic growth have reemerged as relevant economic issues.

Thus natural resource problems are currently being addressed within a new policy matrix, in which preservation of resources and conservation of environmental quality must be dealt with in the context of their impact on economic growth. Further, the issue of resource scarcity brings our attention back to fundamental issues of returns to investment in resources over time. The impact of pricing on natural resource use, nonstructural alternatives for resource development, and the relationship of the environment and the economy become current topics for investigation.

As one might expect from this explosion of public policy problems,

institutional support for resource economics has become increasingly fragmented. Agricultural resource economists no longer look to the USDA and agricultural experiment stations as their sole sources of support. The Department of the Interior, the Environmental Protection Agency, special commissions, various state agencies, and numerous foundations now sponsor such work. Consequently, it is becoming increasingly difficult to monitor the literature of the field, and subsequent synthesis of the literature will be increasingly difficult.

The Literature of the Period Immediately Following World War II

THE TRADITIONAL LAND ECONOMISTS

In 1947, Roland R. Renne's textbook *Land Economics* was first published. It seems appropriate to use this text as an indication of the state of the arts in the immediate post-World War II period. At that time, the terms resource economics or natural resource economics had not come into common usage in the profession. Land economics generally encompassed all economics concerned with natural resources. Renne recognized land economics as a subdiscipline within agricultural economics and said, "but the full scope of land economics is a distinct, applied field of the parent discipline—economics" (Renne [1958, p. 7]). Renne justified the special field for land economics on the grounds that land has unique characteristics which cause it to respond in special ways to price shifts and institutional changes. These unique features, according to Renne, are permanence and fixity in space. He argued that methods of using land and its share in the national income are sufficiently different from the other production factors to justify separate study. However, Renne's justification for land economics as a separate field of study rests largely on assertion; one searches in vain for a rigorous justification.

Renne's book has five parts. Part I is entitled "Background and Perspectives" and consists of an introduction. In Part II, "Principles of Land Utilization," one finds explicit reference to the parts of economic theory believed to be the most relevant to the study of land economics. But there is much more. The physical characteristics of land, land classification, and land appropriation (or the social processes affecting land) are all discussed. The principal economic problems to which economic theory is applied involve the demand and price for land and the determination of rent and the distribution of income. Part III is a discussion of the major uses of land—not only the traditional and expected land uses such as agricultural, forest, recreational, and urban, but also mineral resources, water resources (which were destined to occupy much attention from resource economists for the following three decades), and transportation. It is unfortunate that transportation did not become an integral part of the work of the resource economists who followed Renne. Part

IV is concerned with the problems that had been at the center of land economics from its inception—tenure and tenancy, valuation and credit, taxation and conservation. Part V is entitled "Planning and Control of Land Use." Central to this discussion is concern about social versus individual control of property.

If one can say that Renne's book was typical of land economics at that time, one has a base for judging the developments of the period immediately following. There seem to be three key elements in the traditional approach to land economics that grew out of the pre-World War II period: (1) The "land is different" argument, which meant it could not be lumped with capital, labor, or management as a factor of production. (2) Explicit recognition of the social institutions affecting the use of land and the distribution of income from land. Although the market was recognized as a social institution affecting land, the market did not occupy the sole attention of the immediate post-World War II land economists. (3) Explicit reference to economic theory. Renne's book showed familiarity with contemporary economic theory, even though its use in analysis of land economics problems was minimal. Neoclassical economic theory stemming from Hicks's *Value and Capital* [1946, 2nd ed.] in the late 1930s was utilized. The work of Robinson [1933] and Chamberlin [1928] on imperfect competition was also cited. While there is room, perhaps, for criticism with respect to the imaginative use of this body of theory, its use did provide a direct tie to economics. All these key elements were to be important in the further development of land and resource economics.

Another way of assessing the state of land economics research in the immediate postwar period is to review a paper given to the 1950 summer meetings of the American Farm Economics Association by E. H. Wiecking [1950]. The paper reflects a substantial amount of pragmatism and little doctrine. Six areas of opportunities for productive research are listed: (1) tenancy and ownership, (2) farm real estate values, (3) land and water utilization, (4) economics of conservation, (5) nonagricultural uses of rural lands and waters, and (6) water. With respect to water, three subareas were singled out as being of special importance at that time: inundated areas (the flooding of reservoir areas), protected areas, and benefit-cost analysis.

A research program organized around the above topics and sustained for a decade with competent researchers would have yielded much research of significant social usefulness. Yet if one appreciates the atmosphere of the times, it is not surprising that the imaginations of the younger economists were not captured by such a pragmatic approach. At the same meetings, Earl Heady and Glenn Johnson gave main papers on production economics (Heady [1950a]; Glenn Johnson [1950]).

Earl Heady [1950b] presented at the same meetings another paper entitled

"Some Fundamentals of Conservation Economics and Policy." This paper was reported to be an abridgment of several papers on the theory of conservation presented at the request of the North Central Farm Management Research Committee at the University of Chicago efficiency seminar. However, as this review documents below, the theoretical approach of the production economists was to have a greater impact on resource economics in the early part of the 1950s than would the pragmatic approach of the traditional land economists.

THE INFLUENCE OF THE PRODUCTION ECONOMISTS

Without question, one of the most significant developments in the immediate post-World War II period in agricultural economics is the emergence and influence of Earl Heady and Glenn Johnson. One is tempted to call both of them "production economists," except that, for reasons that are developed more fully in other review articles, Johnson might not be willing to have such a label applied to him and his work. Nevertheless, he and Heady dominated the literature and by their writing and teaching exerted an influence that extended far beyond the narrow definition of "production economics."

Heady and Johnson were able to attract as followers much of the young talent in the profession. Although many students of high quality went to Iowa State and Michigan State to study with Heady and Johnson, the influence of these two men went far beyond this in terms of direct and indirect impact on other institutions of higher learning and research organizations. This influenced the subsequent literature on resource economics in at least two ways. First, the treatment that production economics gave to problems of natural resource development tended to be dominated by microeconomics, oriented to the firm. Second, during the 1950s and 1960s, a significant number of agricultural economists trained as "production economists" turned to "resource economics" as their principal field of emphasis. In many instances, they discarded some of the points of view that were typical of production economists. However, the use of a formal theoretical framework together with emphasis on empirical work was carried over to resource economics by those whose basic training was in production economics.

Barlowe's textbook, *Land Resource Economics*, appeared in 1958. Even though Barlowe's previous orientation was largely in the traditional institutional approach of land economists, his textbook represented a serious attempt to bridge the gap between traditional land economics and the emerging use of microeconomic theory in agricultural economics at that time.

The influence of production economics on land and resource economics can also be observed in the organization of land economics work in the U.S. Department of Agriculture. As noted in the previous section, land economics work had been an important part of economics research in the USDA almost

from the beginning of economic research in that department. The specific field of research was first recognized in 1919 by the Land Economics Section in the Office of Farm Management and Fam Economics.

The Division of Land Economics was one of eleven divisions in the Bureau of Agricultural Economics after the creation of the bureau in 1919 and was continued until the bureau was abolished in 1953. Until 1945, economic planning was concentrated in the Bureau of Agricultural Economics (BAE).[5] In 1949, the Division of Land Economics consisted of the following sections: (1) Land Utilization, (2) Water Utilization, (3) Land Values, (4) Land Tenure, and (5) Land Problems. In addition, the field staff was grouped into those concerned with cooperative research with land grant colleges and those who dealt with river basin studies in cooperation with state and federal agencies.

In 1953, Secretary of Agriculture Ezra Taft Benson abolished the Bureau of Agricultural Economics and divided its functions between the Agricultural Research Service and the Agricultural Marketing Service. The work in land economics went to the Agricultural Research Service, with most of it placed under the Production Economics Research Branch. A Land and Water Section was established under the Production Economics Research Branch and was parallel to the Farming Efficiency Section, the Production Income and Costs Section, and the Agricultural Finance Section.

The 1953 reorganization is significant from several points of view. Production economics was then nearing its peak influence in the profession of agricultural economics. It was consistent with production economics theory that land and water would be part of the total field of production economics. No doubt the reorganization indicates the perceived importance of land and water problems at that point in time. Among other motivations, the Secretary undoubtedly wished to have control of the principal policy-making units in the Department of Agriculture. Reorganization may have been, at least in part, a way of accomplishing this objective. Regardless of motivation, the reorganization had the effect of diminishing land economics in the profession by making it a subset of production economics.[6]

Too much could be made, of course, of the distinction between production and land or resource economics. One receives the impression from Heady's classic book on production economics that resource economics is a subset of production economics [1952a]. Most resource economists would not, of course, wish to leave the impression that they have nothing to contribute to production economics. Yet there were and are differences between the two areas, and this review article is an appropriate place for some of these to be recorded.

In the immediate post-World War II period, Heady wrote several articles on leasing and tenure systems and conservation (Heady [1947, 1951, 1952b];

Heady and Scoville [1951]). Schickele [1941] and Gale Johnson [1950] also contributed to the literature on leasing systems. The rigorous application of neoclassical economic theory by Heady succeeded in opening up new vistas for subsequent development, although the basic framework for the work on leases may be found in a volume by Alfred Marshall [1920] . In many respects, the Marshallian system provided somewhat greater flexibility for analyzing tenure arrangements than did the Hicks framework, as applied by most agricultural economists. Gale Johnson [1950] noted that bargaining between landlord and tenant is multidimensional and involves household, as well as firm, relationships. As a consequence, conclusions reached by isolating the farm from the remainder of the enterprise may be erroneous.

Perhaps one of the clearest statements of Heady's views of land is found in his 1952 book:

> Land, as a factor of production, has no unique characteristics which should cause it to be set aside by itself in economic analysis. The principles defining the optimum use of land are those drawn from the more general production economics principles. From the standpoint of contemporary production economics or economic efficiency, land differs from other factors only in the sense that its opportunities are more restricted. Land can be shifted back and forth only between alternatives at 1 geographic location; capital, labor, and management can be transferred between production opportunities in different locations as well as a 1 particular point. Land differs from certain other factors in respect to legalistic and institutional characteristics. It can be purchased and sold in the United States and, in the form of "property," persons or groups have protected rights in the factor. In the case of labor and management resources, however, this private privilege is not permitted. The individual cannot be sold into bondage and firms cannot obtain the right to lease labor in perpetuity or the right to sell the human factor of production. The reader is aware, of course, that the institution of private property is permitted in the case of capital, and, in the not distant past, was widespread for labor in the form of slavery. Analysis which relates to institutions *per se* has come to be known as land economics. Most institutions do, however, have impacts which lend themselves to analysis via economic tools drawn from the basic principles of production, distribution, pricing, and consumption. No new principles unique for land can or need be formulated. The principles which are applicable have been set forth in previous chapters [of Heady's book] and have been applied to labor, management, and capital in its many forms, as well as to land.
>
> Land perhaps takes on unique importance only in respect to its use and allocation over time. Even here the tools of analysis and basic economic principles are identical with those which apply to any other pro-

> duction or resource use problems over time. Production always involves time as was emphasized in chapters dealing with uncertainty. Problems of production in time are only matters of degree when they relate to specific resources. In terms of our previous discussions of flow and stock resources, we know that services are given off from pasture forages for only a limited period of time; the alternatives over time are few. Grain, while subject to deterioration over a period of a few years, allows more choice over time than hay or pasture forage. Services from a tractor can be extended further into the future than can those for grain. All resources, except those which provide evanescent services, involve questions of investment and disinvestment, and the principles which guide choice for one resource are identical with those which provide the decision-making framework for other resources (Heady [1952a, pp. 763-764]).

This view of land was typical of that held by production economists at that time as well as for several succeeding years. With the benefit of subsequent developments, it is open to criticism on two counts. The viewpoint that institutions can be evaluated adequately by subjecting them to economic efficiency analysis is not acceptable to many social scientists. The problem is far more complex and may stem, in part, from an oversimplified view of the relationships of the individual to the group. Second, and this point will be developed in greater detail below, there is little recognition in the production economics literature of issues of interdependency that lead to externality problems. Although the work of Heady and his followers in production economics had an important and beneficial impact on the literature of resource economics, the hard questions at the center of land economics from the outset were virtually untouched by this approach. The failure to develop this line of investigation stemmed from an inadequate appreciation of the social problem. Now that the problem has been recognized and discussed in the literature, it is possible to observe that the principal tools of neoclassical economics are of value in analyzing the problem and in designing alternative institutions. The issues of external economies and diseconomies have long been part of the neoclassical and classical theory of economics (Friedman [1962]). The production economists' failure to perceive the existence of important social and empirical counterparts to these theoretical concepts not only limited their impact on resource and land economics but also flawed some of the work in production economics as applied to public policy. Certainly one could not accuse the production economists of being unfamiliar with this body of theory. The apparent underlying assumption was that problems of "the group" represented a simple extension of individual firm economics.

In the interest of maintaining perspective, however, it should be noted that there is a strong tradition in economics that does not attribute special impor-

tance to natural resources. In part, this stems from the neoclassical tradition; in part, it can be traced to the influence of Frank Knight on the neoclassical thinkers of his day. In his memoir article on Frank Knight, Patinkin says:

> The most distinctive part of Knight's theory course had to do with his theory of capital—and one cannot but be impressed by the modern flavor of what he taught here. First of all, Knight railed against the traditional classical "trinity of factors of production"—land, labor and capital. There was little in the productive process that Knight was willing to identify with "the original and indestructible forces of nature" that the classical economists had defined as "land." Agricultural land, too—emphasized Knight—had to be developed and maintained just like any other capital good. Similarly, the productive process of labor reflected primarily not "native qualities," but the artificial qualities which constituted human culture. Thus there is no basic distinction between most of the income received by labor and that received by capital. In the terminology of the more recent "Chicago school" associated with the names of T. W. Schultz, Gary Becker, and others (and I suspect that Knight had some direct or indirect influence on their thinking, too), Knight viewed most of labor income as returns to "human capital" and stressed the role of the family (both genetically and socially) in endowing its children with this capital. Thus Knight was not very far from classifying all of the factors of production under the one general title "capital" (Patinkin [1973, p. 794]).

When placing the work of the neoclassical production economists in perspective, it is important to note that resource economics is inherently and necessarily aggregative (and social) economics. In contrast, entrepreneurial economics has no need for a category called "land" or natural resources. It needs only capital and labor, including entrepreneurship.

THE FACTOR MARKET APPROACH

Another influence on the resource economics literature has stemmed from work at the University of Chicago on factor markets. It would be difficult to overestimate the impact of T. W. Schultz and associates on all areas of agricultural economics, including land and resource economics. In the immediate post-World War II period, there was substantial concern about economic development. Economists of Western countries attempted to be useful to policy makers who wished to stimulate economic development in the less-developed countries of the world.

T. W. Schultz was in the forefront of those who believed that much of the experience of the Western world could be applied in the developing areas. Drawing on University of Chicago research on capital and labor markets in U.S. agriculture, he posed hypotheses about economic development generally

[1953]. Although Schultz concentrated on capital and labor markets, he apparently was troubled by the role of land in economics. He noted the declining importance of agricultural land when subjected to the traditional measures of economic importance [1953]. Yet Schultz must not have been satisfied with either his evaluation of the role of land or that of others, as the following quotation seems to imply:

> The quantity of land, as it is commonly described, is such a heterogeneous aggregate as to have little or no economic meaning; and, very little has been done in applying economics to land. Where the capital formation of farmers is studied, investments and disinvestments in land are always left out; when factor markets are analyzed, the research on land stops with description: legal, social, and institutional arrangements are stressed while neglecting the economic aspect. Whereas the task is a difficult one, all too little has been done to measure land as an economic variable [1953, p. 145].

One may speculate that Schultz was influenced by the "Chicago tradition" that argued against a separate treatment for land. Yet Schultz may have also perceived numerous important economic problems in which land played a key role and did not wish to be among those who argued that land should continue to be aggregated with all other capital.

This desire may have motivated Schultz to develop his locational matrix theory of differential rates of economic development in rural areas [1951, 1953]. This hypothesis consisted of three parts designed to explain the uneven geographic process of economic development: (1) Econimic development occurs in a specific locational matrix; there may be one or more such matrices in a particular economy. This means that the process of economic development does not necessarily occur in the same way, at the same time, or at the same rate in different locations. (2) These locational matrices are primarily industrial-urban; as centers in which economic development occurs, they are not mainly in rural or farming areas, although some farming areas are situated more favorably than are others in relation to such centers. (3) The existing economic organization works best at or near the center of a particular matrix of economic development; and it also works best in those parts of agriculture situated favorably relative to such a center; and its works less satisfactorily in those parts of agriculture situated at the periphery of such a matrix.

This hypothesis stimulated a substantial amount of empirical work (Bachmura [1956], Bryant [1966], Nicholls [1961], Ruttan [1955], Sisler, [1959]). In the context of this review, three generalizations can be drawn from this research. First, the research was not done primarily by those who were known in the profession as land economists or resource economists. Perhaps because of this, this body of literature is not generally regarded as part of land or

resource economics—a situation that may have been unfortunate for resource economics, because, had greater concern been shown for such problems, resource economics would have a stronger tie with issues of economic development. Second, in spite of this, the body of literature does add to our knowledge and understanding of the process of economic development in industrialized societies. Third, although the literature has added to our knowledge, it is far from a complete explanation of the role of natural resources in economic development. Subtle interrelations between the attributes of natural resources and economic organizations need to be taken into account before a complete explanation can be advanced (Norman and Castle [1967]).

It would, however, be incorrect to leave the impression that resource economists were not concerned with regional growth and natural resources. Economists associated with Resources for the Future (RFF) gave attention to the general subject through an approach different from that of the Chicago group (Perloff et al. [1960], Perloff and Wingo [1961]). In a generally overlooked article, Krutilla [1955] developed a conceptual framework similar to one later utilized by Perloff and Wingo. Kelso applied the Perloff-Wingo analysis to the problem of economic growth of arid regions (Kelso [1970]). Nevertheless, neither the Norman-Castle [1967] elaboration of the location-matrix hypothesis nor the Kelso application spawned significant additional study or literature.

ECONOMICS OF CONSERVATION

In 1952, the University of California Press published *Resource Conservation: Economics and Policies* by Ciriacy-Wantrup. Abstract, systematic, and thorough, this book provides a conceptual approach rather than an operational guide to the understanding and solution of important social problems (Heady [1954], J. W. Wicks [1953]). A decade earlier, A. C. Bunce [1942] had published a book on the same subject. The work of Heady [1950b] and Heady and Scoville [1951] constituted the principal economic literature to that time on the economics of conservation. However, Ciriacy-Wantrup's book, although it has specific reference to conservation, has far broader application to resource economics generally. Special attention is given in this review to Ciriacy-Wantrup's book on the grounds that the book is still very timely, and resource economists would do well to consult it when wrestling with a range of problems, including problems of the environment as well as institutional obsolescence and change. Furthermore, it has provided a frame of reference for a substantial amount of research.

In the years immediately following publication of the book, Ciriacy-Wantrup penetrated more deeply into numerous subjects identified in the

book [1954, 1955a, 1955b, 1956a, 1959, 1961a, 1961b, 1961c]. In Ciriacy-Wantrup's view, conservation is concerned with the intertemporal distribution of resource use.

> More specifically, "conservation" and its logical corollary, but economic opposite, "depletion," are defined in terms of changes in the intertemporal distribution of use. In conservation, the redistribution of use is in the direction of the future; in depletion, in the direction of the present [1952, p. 51].

The advantages of such a definition are many. It provides an objective standard by which conservation can be judged. Some such device was necessary if conservation was to be made amenable to thorough economic analysis. While the definition could be applied in a historical context, it was developed to permit a decision maker to relate subsequent consequences of his or her decision to the present.

This definition of conservation, and the application of economic reasoning to it, gave Wantrup the tools for discussing both the private and the social economics of conservation. In his book one finds treatment of such subjects as irrationality, extra-market values, uncertainty, and habit patterns [1952, chap. 6].

Ciriacy-Wantrup's treatment of institutions is somewhat at variance with that of Commons [1924, 1934]. To Commons, institutions are collective action in the regulation of individual action; they arise out of social action for the purpose of achieving order. According to this approach, the structure of an institution consists of the procedural and relational rules of behavior developed by the institution itself in the process of its operation.

Ciriacy-Wantrup treated institutions as variables and brought them explicitly into the analytical framework of economics. Resource economists of the 1970s are following in this tradition. In this respect, he was at least two decades ahead of most workers in natural resource economics and agricultural economics.

Glenn Johnson wrote in 1962 that research in land economics represents three streams of thought. One is the rationalist stream that came to agricultural economics through classical and neoclassical economics. Another is the positivistic stream that came to agricultural economics through George Warren of the Cornell tradition. This approach stems from the work of Bacon and Pearson (Pearson [1900], Bowen [1963]). The third stream, according to Johnson, was the pragmatic approach represented by the institutionalists whose philosophic approach can be traced to John Dewey [1927]. The Wisconsin land economists, of course, were much influenced by their

great teacher, John R. Commons [1924, 1934]. Ciriacy-Wantrup utilized the contribution of each approach. Yet the basic framework of his book comes from neoclassical economics.

Ciriacy-Wantrup confined his analysis of institutions to economics, even though he was knowledgeable in the other social sciences, but he resisted the temptation to become so broad as to lose the thrust of analysis (Parsons [1962]). An outstanding example of Ciriacy-Wantrup's avoidance of this pitfall is found in his article on the concepts for a system of water rights [1956a]. It avoids the usual procedure in which process and substance are run together so that the unique contribution of economics in the analysis of social problems is lost. Parts II and III of Ciriacy-Wantrup's 1952 book are concerned with the private economics of conservation. Part II deals with the optimum state of conservation, Part III with topics that impinge on private conservation decisions. Included are (1) interest, time preference, and income; (2) uncertainty; (3) prices and price supports; (4) property; (5) tenancy; (6) credit; (7) taxation; (8) market form; and (9) economic instability. As mentioned above, institutions are not taken as a given, and their impact on conservation decisions is analyzed.

Ciriacy-Wantrup's private decision maker is recognized as being a theoretical construct or a "scientific fiction."[7] He views the "optimum state of conservation" as useful mainly to predict the direction of change rather than to describe accurately the way individual decision makers will behave.

In Parts IV and V of the same book, the social economics of conservation are treated. The three chapters of Part IV deal with conservation policy and social institutions, objectives and criteria of conservation policy, and a safe minimum standard of conservation. The principles of the latter chapter have been rediscovered numerous times in the recent literature on environmental economics, and many recent writers could profit from a reading of the chapter. Part V also consists of three chapters, concerned with the implementation of conservation policy. One chapter pertains to domestic tools of conservation policy, another deals with international tools, and the final chapter discusses coordination of conservation policy.

The Merging of the Economists and the Agricultural Economists

The work of Resources for the Future has had a significant influence on resource economists since it was established in 1952. Three kinds of influence have been apparent: (1) RFF's substantial contribution to the literature, with its very significant output of books, monographs, and journal articles from the RFF staff, has meant that agricultural economists who wished to be in the forefront had to master this substantial quantity of quality work. (2) RFF has augmented the financial resources available for re-

search in natural resource economics, enabling agricultural economists to receive RFF grants or to serve at various times on the RFF staff in Washington, D.C. (3) Through its Washington-based permanent staff, which has generally been a combination of agricultural economists and general economists, RFF has provided a link between agricultural economists and the economics profession generally. But apart from any interaction that may or may not have occurred in Washington, the literature resulting from the two groups forced the one to read the writings of the other.

The RFF work in resources is relatively comprehensive. It encompasses resource projections, water resource development, land problems and policies, economic growth relative to resource endowment, ocean fisheries, minerals, radio spectrum, outdoor recreation, and environmental economics. Several exceedingly capable economists contributed to this literature. In the past, these economists included, but were not limited to, Harold Barnett, Marion Clawson, Chandler Morse, Joe S. Bain, Harvey Perloff, Edgar Dunn, Robert Haveman, Robert Davis, Myrick Freeman III, John Krutilla, Anthony Fisher, Charles Howe, and Allen Kneese. They brought to the study of resource economics the rationale of classical economics and applied this framework skillfully and thoroughly.

The body of economic thought that has become known as modern welfare economics has been utilized heavily by many of these economists. The most obvious application of this body of theory is to benefit-cost analysis. Eckstein's book in 1958 was one of the first efforts to make this relationship explicit and systematic. Partly as a result of this application in resource economics and partly because of its use in agricultural policy, many graduate training programs in agricultural economics provide for systematic training in modern welfare economics.

One suspects that resource economics, and especially water resource economics, may have become an interesting place to apply the paradigms of economics if one wishes to be a follower of Kuhn [1970]. Some of the "puzzles" of welfare economics could be solved by attempting to apply the concepts to problems of resource economics. In this context, the works of Arrow [1966], Baumol [1968], Steiner [1959], Dorfman [1962], Marglin [1962, 1963], Hirshleifer and Milliman (Hirshleifer [1966], Hirshleifer, De Haven, and Milliman [1960], Milliman [1962]), Margolis [1955, 1957, 1959], Eckstein [1958], Krutilla [1961], Krutilla and Eckstein [1958], Haveman [1965], and Kneese [1962] provide examples. Preoccupation with solving the puzzles of a paradigm may partly explain economists' intense emphasis on problems of water resource development during the fifties and early sixties at the expense of other problems in the management of natural resources.

It is not surprising that the normative base of neoclassical economics

influenced the writings and set the moral tone for this literature. The majority of this literature is critical of government investment in natural resource development. The literature does, however, range from the highly moralistic book by Renshaw [1957] to the more balanced analysis represented by Krutilla [1961, 1966]. The prevailing tendency, at least in much of the literature of the fifties, was to view with horror and surprise the discovery that there were numerous examples of deviations from those conditions that would result in maximum economic efficiency. Hypotheses derived from broader formulations of social processes would not have led to these reactions. The motivations for government investment in natural resources are seldom solely those of maximizing national income or national economic efficiency. Benefit-cost analysis was developed as a means of preventing gross distortions in economic efficiency from such investment. Viewed in this way, a benefit-cost ratio of 1 or more becomes a necessary condition for investment. Many economists who wrote in the fifties tended to view the maximization of national income as the objective of government investment. As Hammond put it [1966, p. 221]:

> Benefit-cost analysis should be recognized for what it is—a useful way of roughly assessing the promise of a particular project, or comparing various ways of carrying out a project . . . and not taken for what it is not, nor can never be . . . a precision tool for attaining general economic efficiency.

Hammond earlier illustrated the above attitude by an examination of the problems of economic analysis as applied to water pollution control [1960].

Public Investment Criteria and Welfare Economics

For at least four decades, criteria for public investment in water resource development have foundered on the rock of making market and nonmarket values commensurable (Lynne, Castle, and Gibbs [1973]). In its narrowest conception, benefit-cost analysis is based upon the assumption that the relevant values can be reduced to monetary terms. Benefit-cost analysis originated as a pragmatic response to a legislative mandate, and it is not clear that Congress anticipated developments of the magnitude created by economists or that Congress believed that benefit-cost analysis could serve as both the necessary and the sufficient condition for project approval.

The Flood Control Act of 1936 contains the following language:

> It is hereby recognized that destructive floods . . . causing loss of life and property, including the erosion of lands and impairing . . . [of] navigation . . . and other channels of commerce . . . constitute a

> menace to national welfare, so that it is the sense of Congress that flood control on navigable waters . . . is a proper activity of the Federal Government in cooperation with States . . . [and] Federal Government should improve or participate in the improvement of navigable waters . . . for flood control purposes, *if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected* (*U.S. Statutes at Large* [1936, pp. 1570-1597; emphasis supplied]).

Nothing in the statement suggests that investment in flood control should be viewed as a means of maximizing national income. A more reasonable interpretation is that the Congress was proposing a simple test, a necessary condition, that projects should pass before being authorized, funded, and constructed.

This legislation and that which followed set bureaucratic processes in motion to develop procedures for the performance of this test. The Green Book, referred to earlier, was an interagency effort to develop a common approach to the problem of determining benefits and costs (U.S. Inter-Agency Committee on Water Resources [1958]).

The legislation that called for a simple test of economic viability turned out to be exceedingly naive. The matter then passed from the hands of legislators to bureaucratic and academic economists, and issues immediately arose with respect to placing market values on nonmarket resources. This in turn introduced opportunity cost concepts. Question of size and scale were introduced. When this happened, the criterion issue had to be addressed. How logical it was to carry over the optimization rules from economic theory and utilize the conditions for optimum welfare from welfare economists! This, of course, admitted only the criterion of maximizing national income. That is to say, a project would be justified if it could meet not only the test of benefits exceeding costs but also the sufficient condition of being superior, in national income terms, to all other possible unfunded investments, public and private.

The actual practice of economic evaluation was very different in several important respects from that advocated by most of the economists who were students of the subject. First, there was never agreement that all benefits could be reduced to dollar values. Natural resources legislation authorizing government investment in natural resources before and after 1936 made reference to multiple objectives.[8] In addition, all government instructions on economic evaluation subsequent to the Green Book have mentioned nonmarket considerations. In fact, there has been substantial evidence for some time that national income was not being maximized by public investment in natural resources; indeed, the evidence suggests that such investment probably has

decreased national income.[9] Yet there has been no ground swell of protest over public investment in natural resources for this reason.[10]

Many economists working in this field with benefit-cost analysis implicitly or explicitly used the efficiency model, not only as a tool of analysis but also as a policy norm. The result was that when it could be shown that a public investment did not add to national income, it was judged by economists to be "bad." In this context, benefit-cost analysis was used as the final answer rather than as an aid in the total decision-making process. Such a point of view, of course, was destined to failure in the political arena. First, legislators are not likely to surrender the opportunity for logrolling and filling the pork barrel to such abstract notions as "economic efficiency" or "maximizing national income" (Smith and Castle [1964, chap. 22]). Second, it has long been apparent that all valid national objectives cannot be reduced to a common denominator and measured in a single dimension such as national income.

The use of efficiency economics as a source of hypotheses about possible government intervention obtained increased support during the 1960s. Ciriacy-Wantrup had consistently argued in this vein [1955b]. In this view, benefit-cost analysis and quantification of economic variables was an aid to public decision making but not a substitute for it. In 1961, John Krutilla wrote a thoughtful article in the *Journal of Political Economy* that discussed the conditions under which benefit-cost analysis might be an unambiguous indicator of social welfare. He continued this line of thought in a 1966 article in the *National Resources Journal*. George Stigler's 1964 presidential address to the American Economic Association traced what economists have had to say about government intervention throughout the history of economic thought. He concluded by saying that only recently have economists acquired the measurement tools to provide empirical evidence on the questions they had been posing and answering (Stigler [1965]). Castle [1965] and Castle and Stoevener [1970] wrote articles in the same vein. With this approach, economic theory is utilized to establish the conditions under which government intervention may be justified. However, whether such intervention is, in fact, justified depends on more than *a priori* theorizing (Bator [1957, 1958]). At about the same time, Sargent [1960, 1964] illustrated differences in approach by the use of contemporary literature in land economics (Barlowe [1956], Timmons [1956], McPherson [1956]).

Externalities and Market Failure

The utilization of modern welfare economics as a basis for evaluating public investment no doubt provided an incentive for a closer study of welfare economic theory. Two discernible influences resulted. One was a growing realization of the normative nature of the theory itself; that is, its bias in

favor of the status quo and the difficulty, if not the impossibility, of determining an "optimum" distribution of income (Bator [1957, 1958]). The other was that welfare economics had much to say about natural resource problems that had not been exploited. As Solow said, "Good theory is usually trying to tell you something even if it is not the literal truth" [1974, p. 10].

According to modern welfare economics, there are essentially three reasons for market failure (Bator [1957, 1958], Castle [1965], Haveman [1973]). One reason pertains to the common property nature of some resources to be discussed later in this review. Another relates to the public goods nature of certain production processes. The third is the existence of externalities in production and consumption. The basic intellectual debt in this connection is to Pigou [1933].

The development of the literature on externalities has constituted one of the most rapidly growing areas of economic theory since World War II. Mishan, one of the major contributors to this theory, provided a literature review and an interpretative essay in the *Journal of Economic Literature* [1971]. Both Marshall [1920] and Friedman [1962] pointed out that a knowledge of firm-industry relationships was required in order to understand individual firm adjustments. Ciriacy-Wantrup's early writings contained thorough and explicit treatment of externality considerations [1952].

Failure to appreciate the implications of the basic externality literature significantly handicapped any economist in the analysis of the social problems of the 1960s and 1970s. Modern industrial societies have been characterized by large-scale production of relatively homogeneous products. This has required vast numbers of inputs and has depended on mass consumption. In the Western democracies, markets have generally been relied upon to define inputs and outputs, subject, of course, to governmental constraints. It is less clear how the communist countries have organized production and consumption. Nevertheless, it is apparent that not all the consequences of mass production and consumption have been foreseen and provided for. It is also obvious that if the costs of these external effects had been foreseen and internalized, the "progress" of the recent past would have been less rapid (Barkley and Seckler [1972]). The failure to recognize pecuniary externalities was one of the principal weaknesses of the linear programming work of production economists. The assumption that all firms could be treated as atomistic and that aggregate effects could be neglected is highly unrealistic when viewed retrospectively.

The production of vast quantities of industrial goods has created great demands on particular natural resources that are subject to markets. Recent increases in the prices of natural resources give testimony to this pecuniary

effect. Beyond this, the discharge of by-products of production into the environment, which might be ignored with small-scale production, has reached levels that cannot easily be ignored. This is especially true of societies that are becoming increasingly affluent and that can afford increased environmental quality. A larger population with increased income tends to make scarce both market and nonmarket goods that were previously abundant.

At least some of our economic progress has been the result of decisions that were not based on a full accounting of the social costs. To the extent that economists have supplied decision makers with information that has not reflected these costs, they must bear part of the responsibility.

Credit for early perception of the relationship of mass consumption to environmental issues must go to Galbraith [1958a, 1958b]. He pointed out that although the United States had but 10 percent of the population, since World War I our consumption of most materials has exceeded that of all humankind throughout all history prior to that conflict [1958a, pp. 89-90]. In the same article, he argued that conservationists should concern themselves not only with supply, waste, and substitutes but also with the question of appetite itself. Although this seems a bit quaint today, it did reflect a significant break with the prevailing mood at that time.

The problems that became apparent during the 1960s caused many Americans to question the objectives of modern industrial societies and the quality of their lives in such a society (Castle [1972]). Two economists who wrote a bestselling book that generally took a pessimistic view of the ability of a market system in an industrial society to solve the complex problems generated by such a system closed their volume as follows:

> In sum, in order to restore and maintain a high level of environmental quality, it is necessary to accept low rates of economic growth; and in order to ensure that everyone benefits by such a policy, it is necessary to provide a minimum income to people whether they work or not. . . .
>
> There is something compelling about the conviction that the stationary state offers great benefits to a society. The early Classicals primarily feared the stationary state; Mill welcomes it. The time has come when Mill's thinking should be reexamined. The stationary state offers the bounty of both man and nature. The great dread of the early Classicals may be the only hope of the moderns (Barkley and Seckler [1972, pp. 191-192]).

The resource economics work of the 1950s served to identify two major problem areas. These were "problems" in both a disciplinary and a social sense.[11] One major area of concern was the evaluation of nonmarket goods. The greatest elaboration of this research has occurred in connection with the valuation of outdoor recreation, and the development of this research is

traced in detail later in this review. However, it is the multiple objective issue that raises very fundamental questions about the measurement of the quality of life. The other major area of concern that emerged pertained to environmental quality.

Barkley and Seckler state that "a study of environmental problems is the study of the unintended consequences of choice" [1972, p. 185]. Economics is one of the few sciences that, as part of its basic theoretical framework, provides for the recognition of unintended consequences. With the exception of Ciriacy-Wantrup's book, however, none of the standard works in land resource economics made systematic use of such concepts as late as 1965 (Ciriacy-Wantrup [1952], Renne [1958], Barlowe [1958], Ely and Wehrwein [1940]). At that time, it was argued that a major part of land economics should be concerned with the systematic investigation of externalities as they arose from the use and management of natural resources (Castle [1965]). Such an approach allowed the study and development of institutions that might serve as alternatives to the market in situations where there is real or alleged market failure.

The Valuation of Nonmarket Goods

The existence of nonmarket goods and services resulting from the use of natural resources is one of the major problem areas of resource economics. Expressed in terms of a social problem, society has no automatic way of relating the output of the market economy to the nonmarket economy. Or, to put the matter a different way, there is no institution available that will ensure that resources are automatically allocated optimally between the two types of activity when they compete for the same resources. The problem is further complicated if interdependency exists between the two types of activity; that is, if the output is not independent and some type of intermediate production occurs (Castle [1972], Martin and Carter [1962], U.S. National Goals Research Staff [1970]).

The response to this problem has been to utilize the concept of consumer's surplus as a tool to approximate the value of the nonmarket good, while a competitive model is usually relied on to generate the values of market goods. This problem is especially troublesome when a common property resource is involved and where overinvestment may exist (Castle and Brown [1964]). It would appear that no satisfactory technique exists to compare total values of alternative market and nonmarket uses. It may be that the best that economic science can do at this point is to approximate values at the margin. If this can be done, it may then be possible to develop institutional devices that will permit incremental changes in resource allocation to be evaluated (Schmid [1967], Haveman [1967]).

Common Property Resources

The existence of common property resources is one of the most troublesome issues in resource management. The fishery, groundwater, petroleum deposits, and, to a certain extent, the range provide examples. Moreover, the mass production and consumption associated with industrialized societies have tended to move many more resources into this category. The atmosphere and open space are examples of natural resources that have become scarce because of the greater number of people and their level of consumption.

Perhaps the most complete statement of this theory has been in connection with the fishery. The seminal article in this field is that of H. Scott Gordon [1954]. Gordon starts with the assumption that as fishing effort expands, the catch of fish increases at a diminishing rate because of the effect of the catch upon the fish population. He goes on to note that, with sea fisheries, the natural resource is not private property; hence the rent is not capable of being appropriated by anyone. He defines the optimum degree of utilization of any particular fishing ground as that which maximizes the net economic yield.

From the above, it is deduced that some form of property right is essential to the optimum utilization of the ocean fishery. Gordon attempts to show that in the absence of such a property right, an equilibrium will be reached that represents greater fishing effort than is required for an optimum utilization. Reduced fishing effort and less investment in the fishery are needed to maximize economic rent. Gordon notes that he is arguing for maximizing the economic yield of a natural resource—not a privileged position, as in standary monopoly theory. He says the rent is a social surplus and is not due to artificial scarcity as would be the case with monopoly profit or rent.

Shortly thereafter, Anthony Scott argued for sole ownership as the route to appropriate fishery management [1955a]. He accepts Gordon's hypothesis that individual fishermen will enter the fishery until the average product of effort (the value of his catch) just covers the marginal cost of effort. He assumes that the individual owner would take into consideration the effect of his catch on future populations and future marginal costs. This, of course, is a long-run consideration and would not necessarily hold in the short run. Scott anticipated a possible difficulty with the sole ownership argument by assuming that such an owner is not a monopolist. The effect of this assumption is that the sole owner would not be influenced by the impact of his output on product prices. Scott concludes his article with a discussion of the conditions that would have to prevail elsewhere in the economy if sole ownership is to lead toward a social optimum. Scott's arguments on fisheries were generalized somewhat in his book which appeared later in the same year as

the above article [1955b]. In chapter 11, entitled "Conservation and Resource Tenure," Scott discusses soil resources, petroleum and forestry, as well as fisheries.

In 1965, Christy and Scott brought forth a significant volume on fisheries. This book is a comprehensive treatment of the economics of fisheries, including treatment of demand, productivity of the seas, supply, international law, objectives for fisheries management, and alternative arrangements for the future. Chapter 2 treats the characteristics of common property natural resources. In this book, the earlier arguments of Gordon and Scott are extended to show how a fishery resource will become depleted with unlimited entry. James Crutchfield is also a significant contributor to the common property literature. His contribution is not so much to the basic theory as it is to an extension of that theory to particular fisheries and to sport fishing (Crutchfield [1962], Crutchfield and Zellner [1967]).

Recent literature on common property resources has been quite extensive. However, only that pertaining to common property resources with the fishery as the dominant example is reviewed.[12] Two articles by Vernon Smith and one by Quirk and Vernon Smith generalized the basic theory advanced by Gordon and Scott (V. L. Smith [1969, 1972], Quirk and V. L. Smith [1969]). In a recent article, G. Brown showed that dynamic considerations may modify some of the earlier conclusions of Gordon, Scott, and V. L. Smith, which were based largely on static assumptions (G. Brown, Jr. [1974]). While empirical tests of dynamic models might be even more difficult than tests of static models, the policy conclusions derived from the models suggests that the traditional economic wisdom in this field is on somewhat shaky grounds.

Certain characteristics of common property literature are important in the context of this review. The literature does call attention to the role of property in decision making, which, in turn, leads one to considerations of institutions. Another characteristic is that the theory has proceeded in its development largely in the absence of empirical measurement. The empirical data that have been presented have been interpreted from the vantage point of the theory and do not in any sense provide a test of the theory. Policy recommendations for fishery management have been developed on the basis of these economic models, and the policy recommendations of biologists have been criticized from the same vantage point. Yet it is not clear that a dynamic formulation based on knowledge of the biological relationships and time preference would lead to the same conclusions (Brown [1974]).

Recent contributions have tended to focus more on empirical measurement and policy recommendations. O'Rourke explored the relationship between

the physical yield of the California trawl fishery and the economics of its operation [1971]. In a comment on O'Rourke's work, Cassidy argued that the policy objectives set forth by O'Rourke might be achieved by means other than government intervention (Cassidy [1973]). Cassidy focused primarily on the use of a monopolist to bring about the socially desired output. In a thoughtful reply to Cassidy, O'Rourke said, "Data may be more of a problem than my original article or Cassidy's comment might suggest" (O'Rourke [1973, p. 531]). O'Rourke went on to draw parallels between the returns to fishermen and returns in agriculture. He further stated:

> We are still a long way from being in a position to recommend fishery management solutions even where the problems of a fishery are adequately defined and the goals of management are unambiguously specified. Meantime, there is much we as economists can do to measure empirically how the resources used in various fisheries actually respond to economic and other forces, and in that light develop and evaluate beneficial management policies [p. 531].

The Rate of Discount

Perhaps no subject has been discussed so extensively by economists with so little consensus as the subject of the appropriate rate of discount for use in making decisions about investments to protect or develop natural resources. The present value criterion is, of course, dependent upon the discounting of future returns. But what rate of discount should be used? For private sector decisions, a consensus has been reached. However, for public sector decisions, there is no consensus and the controversy continues to rage. Yet the subject is important because the rate of discount used can have a significant effect on the economic viability of a project (Eckstein [1958]).

A competent treatment of alternative theoretical positions to that time may be found in Herfindahl and Kneese's *Economic Theory of Natural Resources* [1974]. There continue to be many unsettled questions, however, and there have been many contributions to the literature since then. The literature will undoubtedly continue to be in a developmental stage for some time. Agricultural economists have not been in the forefront of those who have contributed to this literature.

General economists have wrestled with at least two principal problems in conjunction with the discount rate. One area of concern pertains to the social rate of time preference that should be used for public investment. The focal point of this problem involves the allocation of resources between the public and the private sector. There is agreement that the opportunity cost of capital in the private sector is relevant to the public sector (social) discount rate. The point has also been established in the literature that an individual may

make personal decisions which, in that person's judgment, are not optimal from the standpoint of the group of which the person is a part. The existence of externalities is the reason for this divergence with Marglin [1963] usually being given credit for this line of argument. The Marglin line of argument has been used to justify a social rate of discount that would enhance a particular national objective as, for example, a particular rate of economic growth. Thus even in a world of perfectly functioning capital markets, there are arguments that tend to establish a range of possible rates, rather than a single point. In practice the opportunity cost of capital in the private sector would tend to establish an upper limit. The Marglin line of argument is used to justify a lower limit. However, precisely what this rate would be depends on the group objective that is to be maximized and the externalities that might be associated with present consumption.

But perfect capital markets do not exist. The distortions are many and come from numerous sources. Taxes are one obvious source, but others exist as well. Individual risk may be greater than group risk, institutional constraints on individual action may prevail (Herfindahl and Kneese [1974], Arrow and Lind [1970]), and the existence of inflation creates some nasty difficulties. Baumol [1968] gave suggestions for adjusting the private sector opportunity cost of capital to account for private sector capital market distortions.

One of the reasons there has been such a wide divergence of recommendations among economists is that different economists have varying ideas about the importance of various distortions. It is not surprising that different answers emerge when different "second best" conditions are established as a base for the analysis. (See, for example, Arrow and Kurz [1970]). Even if only an economic efficiency objective prevails, it is unclear how a social rate of discount might be estimated. The matter becomes even more "murky" if other social objectives are introduced.

The preceding discussion abstracts from the second issue that has assumed considerable contemporary importance—intergenerational equity (Page [1977]). Traditionally economists have tended to dismiss the intergenerational issue on the grounds that the next generation is likely to be richer than this one (Tullock [1964b]). Yet the issue cannot be disposed of so easily. It is not known that the tastes of succeeding generations will be the same as this one, and if options are foreclosed intergenerational welfare will not necessarily be maximized. Ferejohn and Page [1978] discussed whether discounting can be utilized to solve this problem. Ferejohn and Page approached intergenerational equity by symmetry conditions and axioms. They concluded that the discounting rule forces a dictatorship of the present generation and that if intergenerational equity is to be served, side conditions must be imposed that will constrain the discounting process.

In conclusion, then, there is not much agreement among economists regarding the appropriate discount rate. There is no agreement on a single rate appropriate for use in either the private or the public sector. The private opportunity cost of investment may provide an upper limit. A lower limit would be the return on relatively riskless investments, say, government bonds. This provides a broad range within which value judgments, economic efficiency, and political considerations can be brought to bear.[13]

Property Rights and Resource Tenure[14]

In the immediate post-World War II period, the influence in agricultural economics of traditional land economists declined. This is not to say that traditional land economists did not continue to be highly productive in their respective settings. Timmons at Iowa State, Raup at Minnesota, Barlowe at Michigan State, Penn at the University of Wisconsin, and Pine at Kansas State are examples of land economists who have continued to be active in research and teaching to this writing. In many instances, they turned their attention to economic development and land reform abroad and became influential in that environment. Within the USDA, land economists also continue to be productive on a variety of subjects. These include the late Mark Regan and two of Timmons's students, Gene Wunderlich and the late Walter Chryst.

Yet the interest of traditional land economists in property rights and resource tenure was not sustained as a major professional thrust. Production economists' work on the effect of tenure on efficiency of resource use has been mentioned. In addition, several researchers working with water became concerned with the economics of water rights (Ciriacy-Wantrup [1956a], Timmons, O'Byrne, and Frevert [1956], Trelease [1961, 1962]). Some of this work was undertaken in cooperation with scholars in water law, such as Wells Hutchins, Frank Trelease, and Harold Ellis (Hutchins and Steele [1957], Hutchins [1971], Trelease [1957], Ellis [1961]).

In the late 1950s, interest in the relationship of property and economics began to flourish outside agricultural economics. Publication of a new journal, *Journal of Law and Economics*, was initiated by the University of Chicago Law School. Volume III of that journal carries an article by R. H. Coase [1960] which provided an analytic base for the study of property rights and economic decisions.[15] This article draws on welfare economics and legal procedures in property rights litigation to examine how externalities are treated within the law. Coase demonstrates that a legal system is basic to the functioning of a market and that the definition of property within the law affects the results obtained from the market. Liability rules and transactions costs are integral parts of the analysis. In situations where transaction costs are high when the market is relied upon, a firm may develop to handle all transactions related to a particular external effect of exercising a property right. A firm

existing for the purpose of developing a shopping center provides an example. Government, of course, may enter the picture when transaction costs become very high. Randall summarized Coase's arguments as follows [1972c, pp. 25-26]:

1. External economies* are of a reciprocal nature: the affected party is harmed if the externality remains unmodified; the acting party is harmed if the generality of the externality is stopped by fiat; neither party has a monopoly on harm or immorality.
2. If property rights with respect to liability for damages are clearly specified, transferable, and rigidly enforced, under any given liability rule one or the other party will have an incentive to attempt to modify the externality by offering a "bribe" to induce the other party to behave differently.
3. The ensuing negotiations will result in an efficient solution.**
4. If transactions costs were zero, the solution achieved would be the same with respect to resource allocation and amount of externality, regardless of the liability rule in operation; only the distribution of income between the parties involved in the externality situation would be affected.
5. Therefore any assignment of liability rules, so long as these rights are completely specified, transferable and rigidly enforced, will lead to the same efficient resource allocation; equity considerations may be handled by judicious selection of liability rules or by any other appropriate income redistribution method.

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*An externality is said to exist whenever the utility of one or more individuals is dependent upon, among other things, one or more activities which are under the control of someone else. In the case of an external diseconomy, the affected party is adversely affected. Here I [Randall] confine my comments to one particular type of externality: that where modification of the externality could increase overall efficiency.

**Coase [1960, pp. 4-6]. All of the assumptions of perfect competition are required to ensure efficiency.

Demsetz extended the Coase analysis in a series of articles [1964, 1966, 1967]. Among his other conclusions, he found the solution of many problems may be arrived at by a more complete specification of property rights [1966, p. 64]. With Coase, he argues that an important task of economists is to compare the relative efficiency of government with various private sector arrangements in coping with transactions costs associated with internalizing externalities or side effects. He says that the traditional literature of welfare economics fails to take account of the fact that the provision of a market is itself a valuable and costly service. Demsetz also traces the implications of property rights for the management of common property resources. In addition,

he says that changes in knowledge over time result in changes in production functions, market values, and aspirations. These, in turn, change the harmful and beneficial side effects of the exercise of property rights. Property rights have to be adjusted to account for these changing side effects and new benefit-cost possibilities.

Not all the arguments of Coase and Demetz have been accepted. Mishan, Dolbear, Randall, and Kneese have expressed reservations in varying degrees on different points (Mishan [1971], Dolbear [1967], Randall [1972a, 1972b, 1972c], Kneese [1971]). It has been shown that the choice of liability rules does affect resource allocation when transactions costs are greater than zero, some consumers are involved, and capital is a scarce good. Further, the impact of changes in the distribution of income on resource allocation has generally been neglected.[16]

Bjork examined the relationship of private property and the general good [1969]. In his survey, he addresses some of the criticisms of Marx and capitalism. Bjork contends that the economic function of property under capitalism is in its assignment to increase output rather than just to distribute it. He believes the rationale for property need not depend on the morality of giving a person property in return for the incremental output of that person, but rather on the assumption that, in the absence of the incentive created by a social guarantee, increases in social output would not be forthcoming. Such a position leads to interesting speculation concerning the security of property rights when conditions change, causing external diseconomies to emerge from the exercise of private property rights.

Even allowing for these corrections, which are inevitable when a significant advance has been made, something quite fundamental may be involved here as far as resource economics is concerned.

1. The institution of property rights and resource tenure may well be a connecting link between traditional land economists back to Commons [1924, 1934] and modern resource economics, which is inextricably rooted in modern welfare economics. Furthermore, property rights can be related to externality theory, which is utilized extensively in all of resource economics (Castle [1965]). In fact, Cheung [1970] argued that the term "externality" should be abandoned and that the study of the existence or the absence of contracts should be substituted.
2. Changes in property rights are at the center of economic change. If Demsetz [1964] is correct that property right adjustments are associated with economic growth, changes in property rights may have great impact on economic growth.

3. Because property rights represent claims to future income they are of great importance to the distribution of income over time. Property rights will be under continued stress during periods of economic change. If nonmarket values like environmental quality become relatively more important, there may be pressure to shift some of the bundle of property rights to the public sector. This can range all the way from outright public ownership to placing constraints on the exercise of private rights in property. In either case the effect is to shift the distribution of income as well as to change the way resources are used.

This relation between property rights and the distribution of income leads one to the venerable concept of economic rent. The ability of a resource to command rent is a reflection of its scarcity. When a resource becomes relatively more scarce economic rent can be expected to increase and property rights may be adjusted, primarily for the purpose of affecting the distribution of income. The pursuit of income distribution objectives in the short run may be counterproductive in the long run because of supply response effects. Thus when a resource becomes more scarce, economic rent will increase if price rises reflect that increased scarcity. Yet property rights may be held in such a way that only a few are being enriched. Under these circumstances price rises may be prevented by political means. Such actions may permit the desired income objectives to be achieved in the short run. However, these lower prices may not provide encouragement for additional resource development or the development of substitutes. But because of the long time periods involved, citizens may have more difficulty appreciating the relationship between rent and supply response than they do between the price and the supply response for commodities.

While the advances enumerated above were being made in the theoretical literature, certain agricultural economists were keeping alive the traditional interest of the profession in property rights and resource tenure. Allan Schmid called attention to the role of institutions in explaining economic progress. Even though, in early writings on this subject he did not deal with property rights in as precise a way as he was to do later, property rights were referred to explicitly as an example of an important institution (Schmid [1963, 1965, 1972], Schmid and Shaffer [1964]). Wunderlich [1969] of the Economic Research Service, USDA not only contributed to the literature but also stimulated colleagues to think about the role of property in a systematic way. See also the introduction to Wunderlich and Gibson, eds., *Perspectives on Property* [1972].

The Farm Foundation and Its Influence on Resource Economics

The Farm Foundation of Chicago has had a profound influence on all of agricultural economics. Land economics was one of those fields of agricultural economics that was first supported by the foundation.[17] Regional committees sponsored by the foundation include the North Central Land Tenure Committee; Southeast Land Tenure Committee; Southwest Land Tenure Committee; Great Plains Committee on Tenure, Credit, and Land Values; and the Western Committees on Water and Range Resources. From the first four committees, an Interregional Land Tenure Committee was formed. A representative from the West has served for several years as a member of the Interregional Land Tenure Committee.

By following the work of the above committees, the writings of the committee members, and the conferences and workshops sponsored, it would be possible to account for a significant percentage of the work in resource economics contributed by agricultural economists. Some of the principal products of these committees will be enumerated here. Individual contributions to these group efforts will be referred to when particular topics are discussed. Some of the more notable efforts in this respect are the following:

1. *Modern Land Policy.* This book is a compendium of papers of the Land Economics Institute held at the University of Illinois (Halcrow et al. [1960]). The book provides an excellent record of the conventional wisdom on the land resource at that time, as well as approximating a Who's Who listing in the profession of land economics.
2. A year later, a symposium was held at Lincoln, Nebraska, on land economics research. This symposium was the culmination of planning by the Interregional Land Tenure Committee and was financially supported by the Farm Foundation and Resources for the Future. The resulting volume consisted of fifteen papers by the most respected scholars in land economics and related research fields working at that time in the agricultural economics profession (Ackerman, Clawson, and Harris [1962]).
3. In 1962, a symposium at Lincoln, Nebraska, on Land Use Policy and Problems in the United States marked the 100th anniversary of the signing of the Homestead Act. Again, financial support for the symposium and the printing of the proceedings came from Resources for the Future. The Interregional Land Tenure Committee assisted in the planning of the project (Ottoson, ed. [1963]).
4. In 1966, the Interregional Land Tenure Committee sponsored a book on research methodology and the scientific method as applied to land economics (Gibson, Hildreth, and Wunderlich, eds. [1966]). This book is general in application and would seem to have as much application to agricultural economics generally as it does to land economics.

5. In 1961, the Southeast Land Tenure Research Committee sponsored a symposium on watershed planning. A publication of the Iowa State University Press entitled *Economics of Watershed Planning* resulted (Tolley and Riggs [1961]).
6. In 1964, a book of readings entitled *Economics and Public Policy in Water Resource Development* was published by the Iowa State University Press (S. C. Smith and Castle [1964]). These readings had their genesis in the proceedings of the Water Resources Committee of the West (Western Agricultural Economics Research Council [1951, 1953-68]). Contributions were drawn from economists, lawyers, engineers, and political scientists. The early tone of this committee was established by western agricultural economists who had published on the economics of water prior to the formation of the committee. The work of Ciriacy-Wantrup, Kelso (Clark, Grant, and Kelso [1952]), and Huffman [1953] is notable in this respect.

Applied Resource Economics

The remainder of this review will be concerned mainly with applied work in resource economics and with the possible future evolution of resource economics. In view of the virtual explosion of literature on natural resource economics since the mid-1960s, some classification is necessary to permit discussion of this literature in an orderly fashion. The classification is quite traditional in many respects and emphasizes: (1) the resources themselves, (2) the social problems, and (3) the economic effects and consequences of decisions about resources.

Water Resource Economics

The economics of water resource development has continued to dominate the interest of resource economists during the past decade. A casual survey of the contents of the *American Journal of Agricultural Economics* during the past decade leads to the estimate that between 25 and 40 percent of the articles on natural resources are directly concerned with water resources development. However, the most rapidly growing areas of the literature is concerned with environmental economics—an area that tends to be divided between environmental problems created by agricultural production and those that tend to be resource-specific without particular concern with the pollution source.

PROJECT ANALYSIS AND WATER RESOURCE SYSTEMS

As noted earlier, much of the early analytic work on water resources was project oriented. Tolley, however, was not content to work only with aggregate output of projects and attempted to analyze in greater detail the planning requirements in watershed development [1958]. The river then became

the focal point for Tolley's subsequent work (Tolley and Hastings [1960]).

Reclamation projects and reclamation activity have been subjects of analysis by several agricultural economists and economists (Tolley [1959], Kimball and Castle [1963], Freeman [1966], Infanger and Butcher [1974]). After a time, *ex post* analysis of resource development projects became popular and was viewed as a technique for checking prediction against performance. In a sense, of course, such procedures are manifestly unfair. The period of time required for project approval made prediction exceedingly difficult. On the whole, however, most such criticism was responsible and probably led to improvement in agency practice. The work of Haveman deserves special recognition in this respect [1965, 1972].

One of the major advances toward systems analysis of projects and programs came with the publication of *Design of Water-Resource Systems,* a major product of the Harvard Water Program (Maass et al. [1962]). The following quotation from this book discusses that program:

> There have been three stages in the history of the Harvard Water Program: one year (1955-56) of exploration to determine whether or not a study should be undertaken in this field, and if so, what type of study it should be; three years (1956-57 to 1958-59) of combined training and research, during which senior employees of federal and state water-resource agencies came to Harvard to assist in the research and at the same time to prepare themselves for positions of greater responsibility in the public service; and one final year (1959-60) of research and writing (Maass et al. [1962, pp. 10-11]).

The resultant book reveals the interdisciplinary nature of the undertaking. Part I deals with objectives and concepts and draws on economics and political science. Part II treats methods and techniques, and simulation is introduced as a technique for planning river basin systems. Part III is concerned with governmental factors and is written by Arthur Maass, a political scientist. Not only did the volume introduce many new concepts and techniques into the water resource field, but it is also testimony to the ability of the modern university to combine research and education and to do interdisciplinary research.

The Harvard focus on specific projects and water systems has continued to characterize much water research, an approach that has resulted in the application of such research to problems of the developing world (Carruthers [1968], Cline [1973], McGaughey and Thorbecke [1972]). In 1973, the Agricultural Development Council (ADC) sponsored a course on land policy for the developing nations at the University of Wisconsin. The following year, a manuscript that represented the course content was brought forth under the guidance of A. M. Weisblat [1973]. Although this manuscript is unpublished, ADC has made it available to professional workers in the developing countries.

In addition, Price Gittinger prepared a guide to the use of economic tools in capital allocation [1972]. Other interesting extensions of project and systems analysis include the allocation and pricing of water as well as floodplain planning (Guise and Flinn [1970], J. C. Day [1973]).

REGIONAL ANALYSIS

Water has long been viewed as a tool for economic development. The availability of water in a physical sense may not be so important in this connection as the associated investment required to make the water available and to market the products that may result from water.

The transfer of water between regions has created conflicts in the right to water (Gardner and Fullerton [1968]). Although not typically stated in these terms, transfers have often had the effect of transferring income to a developing region. Economists typically have analyzed transfers from the standpoint of efficiency (Hartman and Seastone [1965, 1970], Howe and Easter [1971], Kelso and Martin [1971]). In the 1960s, the possibility of major water transfer projects attracted the attention of Resources for the Future, which commissioned Charles W. Howe to prepare a book on this subject (Howe and Easter [1971]). Howe recognized the regional and indirect effects of water transfer but did not give extensive coverage to the redistribution of wealth through fiscal policies that take small sums from many people through taxation and transfer the benefits of this capital formation to a few beneficiaries of water resource projects. Beattie et al. [1971] demonstrated this point by empirical investigations in the context of interregional water transfer. Back [1969] had earlier recognized and called specific attention to the redistribution consequences of water resource development. Stephen Smith's work is also significant in this connection, although he utilized more traditional institutional considerations in his study of the organizations and organizational arrangements in water (S. C. Smith [1950, 1956, 1960, 1961]).

The regional impact of water resource development and management was the principal focus of a major water resource economic research project at the University of Arizona in the late 1960s and the early part of the 1970s. Maurice M. Kelso and associates, financed in part by a grant from the Rockefeller Foundation, undertook to study the consequences of a declining groundwater resource (Kelso, Martin, and Mack [1973]). These researchers utilized different quantitative techniques to assess the impact of water availability on economic growth. The resulting empirical work was interpreted in the institutional setting of the Southwest. The results were controversial in that they called the value of the Central Arizona Project into question. As a consequence, the University of Arizona came under severe pressure from various interest groups in the Southwest because of the results of this research.

Undoubtedly the pressure stemmed from the income redistribution consequences of the project, even though the principal focus of the study was on economic efficiency.

In 1966 Joe S. Bain and associates took a different approach to regional water resource problems. In a study financed by Resources for the Future these researchers attempted to determine the comparative efficiency of public enterprise in developing a scarce natural resource (Bain, Caves, and Margolis [1966]). The approach represented a significant departure from earlier studies of water resource development because it utilized the framework and concepts of market structure analysis. Structure, conduct, and performance formed the major sections of the book (Castle [1967]).

Regional development has been advocated as a legitimate objective of water resource development. To the extent that national income is not increased, the accomplishment of regional objectives represents a transfer of income. In this sense, the regional objective is different from other nonmarket objectives such as environmental quality and the provision of outdoor recreation. In these instances, a product is produced that is capable of being enjoyed and utilized. The provision of nonmarket goods and services involve adding to the flow of goods and services. Even though difficult, it is theoretically possible to compare the value of these increases in the volume of goods and services with the sacrifices associated with making them available. With enhanced regional development, increased regional income is reflected directly in national income.

That is, if increased regional income is not at the expense of another region, it will be reflected in national income. Thus if national economic efficiency considerations are to be reflected, separate regional accounts are not necessary. On the other hand, if public investment projects are being used to redistribute income among regions, regional accounts are necessary to ascertain whether the project is meeting those objectives.

The multiple objective issue is the motivating force underlying recent changes in rules for evaluating public investment in natural resources (U.S. Water Resources Council [1973]). Some economists and political scientists have called for the calculation of trade-off ratios (Freeman [1969], Maass [1966], Major [1969, 1974], Kelso [1966, 1967, 1972], Kalter and Stevens [1971]). In their desire to develop new institutional mechanisms, it is possible that the conceptual basis for such calculations has been overreached (Castle and Youmans [1968, 1970], Lynne and Castle [1975], Freeman and Haveman [1970]). At least two conditions must be present before the calculations of trade-off ratios have validity (Lynne and Castle [1975]): (1) the objectives should be independent in production, and (2) the total amount of resources must be held constant as output is varied. Many of the trade-off ratios that

have been calculated involve movements between, rather than along, isocost curves. It seems conceptually possible that techniques might be developed for the calculation of satisfactory trade-offs. However, no really valid method has yet been put forward for use as an operational guide in formulating water resource development projects.

NATIONAL WATER POLICY

The relation of project evaluation to economic research (as that research improved and refined benefit-cost analysis) has already been discussed in this review. Early in the Kennedy administration, U.S. Senate Document 97 [1962] appeared. This document embodied the principles within which all federal agencies operated, and it drew upon the analytical framework in the Green Book (U.S. Inter-Agency Committee on Water Resources [1958]). Senate Document 97 specified that water quality, recreation, and wilderness are to be on a par with other uses of natural resources, further stipulating that national, regional, state, and local viewpoints should be considered fully. Although these considerations might suggest a marked departure from past practice, which concentrated heavily on market values that could be incorporated in benefit-cost analysis with the objective of enhancing national income, the fact of the matter was that very little of a fundamental nature was changed in practice (Castle, Kelso, and Gardner [1963]). Nevertheless, the document did open the door to certain developments that have modified current practice.

At about the same time, the Water Resources Council was established. Henry Caulfield became its first director and Harry Steele later joined the Council as economist. In the middle 1960s, the Council came under criticism from Congress because it insisted on implementing the discount rate provided for in Senate Document 97. As a result of this criticism, the Council was able to institute a review of the procedures by which projects were evaluated (Cobb [1973]).

The Water Resources Council appointed a special task force to develop a set of principles and standards for project evaluation. The resulting document provided for four accounts: (1) national income, (2) regional income, (3) environmental concerns, and (4) national well-being (U.S. Water Resources Council [1971]). The report was sent to the Council in 1969.

At the time of the report of the special task force, an interesting development occurred that illustrates a contrast in the way agricultural economists and economists view their discipline for policy purposes. When the report was issued, a group of economists developed a highly critical statement (Knetsch et al. [1969]). The thrust of the statement was that methodology relating the various accounts to national income had not been developed and, therefore, the nation might well be made worse off by using the proposed principles and

standards. A rebuttal statement was then issued, written largely by agricultural economists (Kalter et al. [1969]). Their analysis was more pragmatic, calling attention to the fact that benefit-cost analysis had not progressed to the point where it could be viewed as an unambiguous measure of national welfare. This pragmatism is illustrated further by a note of two agricultural economists to the effect that economic tests and objectives are inconsistent for the evaluation of reclamation projects (Bromley and Beattie [1973]).

Subsequent to this, additional articles appeared supporting the economists' earlier position and criticizing the notion of multiple accounts (Cicchetti et al. [1972, 1973]). Perhaps Haveman stated the counterposition best when evaluating the meaning of his *ex post* studies:

> These results generate serious questions concerning the direction of recent efforts to revise planning and evaluation procedures in the water resources area. These efforts have largely neglected the need to improve the evaluation of primary benefits and costs and have concentrated on including several non-efficiency impacts, such as income distribution, regional growth and secondary effects in the basic evaluation model. Surely knowledge of these non-efficiency effects is relevant to project appraisal and choice and information on them should be developed and presented to decision makers. However, given the serious shortfalls in the performance of *ex ante* benefit and cost estimation—an area where production functions are fairly well understood—the first order of business would seem to be improvement of these estimates before more esoteric impacts generated by linkages that are little understood are pushed full-blown into the basic *ex ante* evaluation model [1972, p. 111].

The controversy brought into the open certain issues that are quite fundamental in the use of economics to evaluate natural resource policy. The use of the efficiency framework as a basis for empirical investigation has made it quite clear that there has been substantial economic inefficiency associated with public investment in water resources development. Broadening the criteria that might be used to justify a project holds prospect of making that situation worse. Another view emphasizes that economic analysis should be an aid to decision making and not a substitute for it. To the extent that there are objectives other than economic efficiency, economic efficiency analysis may not be as relevant to the decision-making process as more broadly based investigations would be. Thus there was merit in the positions taken by each group.

Resource economists continued to be active in the development of the principles and standards statement which eventually emerged (U.S. Water Resources Council [1973]). Public hearings were held (U.S. Water Resources

Council [1971]) and the Water Resources Council arranged "tests" of nineteen projects to be conducted by agencies and university researchers (U.S. Water Resources Council [1970], Bromley et al. [1970], Kalter et al. [1970], Schmid and Ward [1970], Schramm and Burt [1970], Bromley, Schmid, and Lord [1971], U.S. Water Resources Council [1970]). This entire process reflects the involvement of resource economists in a major way in the development of this area of policy. The statement that emerged, of course, reflected political considerations as well as the input of agency personnel and resource economists.

In June of 1973, the U.S. National Water Commission made its report to the President and to the Congress of the United States [1973]. This was a comprehensive review of water policy in the United States. One way to measure the standing and influence of resource economists in the policy-making process is to record the involvement of resource economists in this effort not only in terms of staff input but also in terms of special studies made for the U.S. National Water Commission [1973]. Special studies performed for the commission included those by: Howe, Russell, et al. [1971], Thompson et al. [1971], Heady et al. [1971], Madsen et al. [1972], Lewis et al. [1971], Davis and Hanke [1971, 1973], Young et al. [1972], Burcher, Whittlesey, and Orsborn [1972], Allee and Ingram [1972], Schmid [1971], Fox [1971], Hogan [1972].

The development of the principles and standards statement and the report of the National Water Commission are evidence of resource economists' involvement in public policy, especially water policy (Cobb [1973]). Although it is not possible to measure the precise impact of particular research efforts, the availability of resource economists made possible direct involvement in the policy process. This availability was a direct function of a research tradition and a body of literature that could be utilized for this type of applied policy study.

GROUNDWATER

The economics of groundwater has long been of interest to resource economists. One of the early research efforts stemming from the Water Committee of the Western Agricultural Economics Research Council worked out comparisons of the institutional arrangements for groundwater management. The intellectual leader of this research effort was Ciriacy-Wantrup [1956a]. This work led to cooperation with lawyers in investigating such issues. Wells A. Hutchins (Hutchins [1942, 1971] Hutchins and Steele [1957]) and Frank Trelease [1957, 1961, 1962] were legal scholars who made significant contributions.

Concern with declining groundwater levels in Arizona was among the

stimuli that influenced Kelso to undertake the Rockefeller Foundation-financed study in Arizona (Kelso, Martin, and Mack [1973]). Snyder also did pioneering work in the economics of groundwater in the early 1950s [1954, 1955].

In the mid-1960s, Oscar Burt's interest was captured by the stock resource aspects of water. He did extensive research on the use of quantitative techniques in addressing problems of groundwater management [1964a, 1964b, 1966]. Burt's work can be considered pioneering research in the use and development of quantitative techniques. Additional extensions of groundwater research are found in Burt and Stauber [1971], Grubb [1968], Rogers and Smith [1970], and Cummings [1971].

Resource Scarcity and Demand-Supply Projections

Economists are frequently called upon to project resource needs and availability for some future time period. In recent years there have been numerous criticisms in the popular press about the self-fulfilling nature of these prophecies. When a government agency provides services on the basis of such projections, and then prices these services so that the market will be cleared, the planner may be said to be vindicated. However, in those instances where there have been systematic attempts to appraise the performance of those who project usage, the record has not been outstanding.

Regardless of the accuracy of these predictions and projections, there should be recognition of these efforts and the methodological issues involved in any balanced appraisal of the literature in resource economics. Examples of such projections can be found in U.S. Department of Agriculture (Barton and Rogers [1956]), U.S. President's Materials Policy Commission [1950], Landsberg, Fischman, and Fisher [1963], U.S. Department of Commerce [1972a, 1972b], and Harris and White [1971]. In 1960 and 1961, Ciriacy-Wantrup analyzed the methodological issues inherent in such projections [1960, 1961c]. Among other issues identified by Ciriacy-Wantrup was the fact that most such projections do not allow for the workings of the economic system. Substitution relationships in both consumption and production are assumed away. He raised a caution flag in the using of such projections as a basis for policy.

Of course, Ciriacy-Wantrup's essays did little to diminish the demand for such studies. Given that a demand exists, it is not surprising that economists would bring forth a supply to establish some type of equilibrium. Projections by federal and state agencies have continued to be made and presumably have been used in policy formation. In addition, able economists have undertaken major studies designed to address some of the methodological difficulties cited above. Ruttan's work [1965] in this connection won an outstanding

research award from the American Agricultural Economics Association. Heady and his associates have done ambitious projection studies for the National Water Commission (Heady et al. [1971], Madsen et al. [1972]). Each of these efforts deserves comment.

In his foreword to the Ruttan study, Krutilla wrote:

> The significance of this study lies more, perhaps, in the framework of the analysis than in the particular empirical results. There remains much room for more intensive analysis by individual scholars in the several water resource regions to further improve the quality of the estimates and increase the precision of the results (Ruttan [1965, p. vii]).

Ruttan utilized a productivity model to permit a comparison of current resource productivity and cost levels. A demand model and an equilibrium model were developed to facilitate projection of future farm output and factor level inputs. In Ruttan's words:

> The basic distinction between these two models—both of which build on the relationships utilized in the productivity model—lies in the determination of output growth in each region. In the demand model, the regional output levels are determined from outside the system, while in the equilibrium model they are determined simultaneously along with factor input levels [1965, p. 19].

Certainly the Ruttan approach is more consistent with our knowledge of the working of the economic system than the so-called requirements approach criticized both by Ruttan and by Ciriacy-Wantrup. In addition, the results are generally plausible to people knowledgeable about irrigated agriculture in the United States. However, in his review of Ruttan's book, Hoch [1967] noted three problems associated with this approach: (1) intraregional heterogeneity, (2) overaggregation, and (3) omission of variables. The omission of variables would appear to be especially important if the approach used by Ruttan were to be used to estimate the productivity of resources. Although it has long been established in statistical theory that if omitted variables are not independent of included variables, the estimated coefficients of the remaining variables will be biased, this principle has been neglected in much applied work. Beattie et al. [1971] reported a fourfold upward bias on the estimates of owned and rented land by omitting variables and comparing the results with those of a well-specified production function.

The work of Heady and associates for the National Water Commission represents a utilization of the models of U.S. agriculture that were developed at Iowa State University in the Center for Agricultural and Rural Development. Their research is an attempt to model the principal resource constraints

and production opportunities for each of the agricultural producing regions in the United States. Again, the model does provide for the substitution relationships in consumption and production that tend to be neglected in the "requirements" approach. The accuracy of the estimates of future productivity of water in agriculture is, of course, unknown. Nonetheless, there is little literature that reports on efforts made to test the accuracy of this type of research in estimating supply response under different conditions. Despite the size of the models that have been developed by Heady and associates, there are major variables that are exogenous to the models, such as the nonagricultural portion of the U.S. economy and world agricultural supply and demand conditions. The relative efficiency of irrigated agriculture and the more intensive management of humid areas in the year 2000, for example, will be much affected by the price and availability of fertilizer, fuel, and other purchased inputs, yet these variables are exogenous to the model. To the extent that these variables become subject to the working of economic forces exogenous to the models, model results are likely to be in error. And they will be in error for the same reason that the requirements approach is usually deficient —because the role and influences of economic processes have been neglected. This is true even though some economic relationships and processes have been incorporated; the relevant economic processes are too many and too complex to be captured in any such model.

Yet it would be unfortunate to conclude that work in the projection area has not advanced since World War II. The work of Ruttan and Heady and associates and the resulting criticisms have made workers in this area much more aware of the complexities inherent in such activities. Perhaps it will serve to stimulate economists who are advising policy makers to encourage the use of projections as indicators of direction of change rather than as precise estimates of change. The emphasis can then be placed on developing institutional devices to utilize additional information as it becomes available. In this connection, the speculations of Boulding [1966, pp. 3-4] on the human condition on a global scale are interesting.

In contrast to the methodology utilized in making projections, studies have been made of past trends and their causes. If the reasons for past trends can be isolated, it becomes possible to isolate the fundamental demand and supply considerations affecting the supply or supply price of a resource. If the causal variables can be identified, a basis exists for better anticipation of future developments.

A benchmark study in this tradition was published by Barnett and Morse [1963]. In it, the authors attempted to discover whether there was empirical evidence bearing on the long-run relative supply price of natural resource goods. The 1870-1960 period was chosen for the period of analysis. The con-

clusion was reached that, with the exception of forest output, there was no evidence that natural resources were becoming more scarce through 1957, at least as natural resource materials enter into the gross national product.

The Barnett and Morse work has served as a reference point for such studies to the present time. The hypothesis is an exceedingly difficult one to test, but indirect tests of the authors' partial indicators, and experience until the 1970s tended to support the authors' conclusions. The authors recognized that declining relative costs of natural resource goods did not necessarily mean that a better quality of life would result, because the natural resource goods that are not valued in the marketplace did not enter their analysis. Examples are space, outdoor recreation, air quality, and water quality.

In the 1970s, trends began to develop that raised a question about whether the conclusions reached by Barnett and Morse, which had been generally accepted by resource economists, were a valid basis for public policy. It became apparent that: (1) the market for many natural resource commodities was worldwide, (2) the commodities were related to natural resource availability, and (3) such commodities were becoming increasingly expensive. Many foodstuffs hitherto produced in surplus became more highly priced, scarce goods. Energy resources also became scarce, and those countries with oil were able to redistribute wealth significantly in their favor by acting in concert.

At the time these trends were occurring, several studies began appearing that suggest that the world is on the verge of real difficulty unless the present path of growth is modified (D. H. Meadows et al. [1972], D. L. Meadows and D. H. Meadows [1973], Forrester [1971]). In these studies, computer simulation models were developed to relate population, environmental quality, industrial growth, and economic activity on a global scale. The results suggest that economic growth will not be able to continue at the same rate in the future that it has in the past unless steps are taken to control population growth, reduce capital formation, recycle products, increase resource productivity, and reduce pollution emissions (Day and Koenig [1975]). Social scientists in general have been critical of the computer simulation studies on the grounds that assumptions regarding social and behavioral phenomena were naive (Kaysen [1972], Shubik [1972], Solow [1973]). However, generally speaking, economists have been highly critical of these efforts. Brandow [1974, p. 193] said, "The exercise is an abuse of a method that can be highly useful in appropriate circumstances." Solow [1973, p. 43] judged the models "worthless as science and as guides to public policy." In contrast, Day and Koenig [1974, 1975] took a somewhat more favorable view. They made a number of suggestions for improving the models but concluded that if the models stimulate debate on a very important question, their limitations will be forgiven.

Generalizations about such efforts and their critics are almost as hazardous as the original efforts themselves. Nevertheless, it is apparent that the efforts neglected the role of social institutions. Day and Koenig [1975] called attention to the failure of the models to provide for factor substitution and to incorporate the workings of the price system. This failure means that the predictions of the models should be viewed mainly as specifying some of the consequences of extrapolated growth. Yet in the final analysis, all such models are partial, and there is no way of knowing if what has been left out is likely to emerge as of great future importance.

Even so, economists would do well not to dismiss the results out of hand simply because of these obvious shortcomings. Day and Koenig [1974, 1975] were quite correct when they said there is no assurance the price system will maximize welfare between generations. As was seen in the section on the rate of discount, there is no assurance that the future will be discounted properly, either by the price system or by group decision making (Ferejohn and Page [1978]). It seems to be an act of faith to believe that the demand and supply relationships for technology will always be such as to ensure that natural resource availability will never be limiting to the welfare of humankind.

Range Resources

A Committee on the Economics of Range Use and Development was established in the Western Agricultural Economics Research Council by a grant from the Farm Foundation in the early 1950s. The range committee operated parallel to the water committee referred to earlier, but took a different approach and chose to emphasize individual ranch decision making and the technical problems of resource management rather than broader issues of resources policy. Consequently, the output of this committee will be reviewed in connection with the farm and ranch management literature. Policy issues were not ignored, however, and it is appropriate that the output of economists dealing with the policy aspects of public rangeland management be noted in this review. The leaders in this early work included Chester McCorkle, Chester Baker, John Hopkin, and M. L. Upchurch. M. M. Kelso [1952] was an even earlier contributor to the literature on range resources.

A paper given by John Hopkin [1956] to the annual meetings of the American Farm Economics Association provides a view of the state of knowledge in range resources at that time. The articles presents the production possibility and preference functions necessary to obtain an optimum solution in the use of rangeland. The difficulties of obtaining such functions are also outlined as are pragmatic policy guidelines. No doubt the article was based on many research conferences among economists and range management biological scientists for the purpose of designing the cooperative research needed to

yield such information. For in-depth discussion of the research problems associated with rangeland management and policy, the reader is referred to the reports of the Western Agricultural Economics Research Council, Committee on the Economics of Range Use and Development [1957, 1959, 1961a, 1962, 1963, 1964, 1965, 1966, 1967a, and 1969]. Report No. 11 [1969] of that series is a bibliography of range and ranch economics.

The resource of the public range is held and managed by the federal government, with the Bureau of Land Management and the Forest Service being the two principal agencies involved. These agencies "managed" these common property resources by issuing grazing permits based on location and feed supply of the rancher. Although charges were made for these permits, their value as resources was considerably greater than the charge that was made (Nelson, Castle, and Brown [1957]). Under such circumstances, it was not surprising there was substantial excess demand and deviation from an economically ideal use of the rangeland. This problem and suggested corrective measures has been the subject of substantial research. B. Delworth Gardner was among those who argued that transfer constraints were the source of considerable inefficiency [1962a, 1962b, 1963]. Richard J. McConnen utilized quantitative techniques to address the overgrazing issue. By simulating different patterns of use, he was able to predict the effect of such use on future returns. The range resource was viewed as a flow resource with interdependency of the flows over time (McConnen [1965]).

Writing more recently, Burt [1971] treated pasture and range investments from the vantage point of a dynamic investment model. He argued the problem could be viewed as one of complex replacement essentially unique to agriculture. The Burt approach was criticized by Bromley [1972] and W. E. Martin [1972]. The basis of their criticism focused largely on Burt's failure to include grazing as a variable and on the sparse data he utilized in his dynamic programming model (Burt [1972a, 1972b]). (The data used by Burt were drawn from secondary sources, and he depended heavily on an earlier article by Cotner [1963].) Stevens and Godfrey built on the earlier literature in analyzing the efficiency of public investment in range improvements [1972].

Environmental Economics

The field of environmental economics has emerged as an area of specialization in its own right. This review cannot do justice to this large body of literature. Early efforts on environmental economics by resource or agricultural economists are identified without extensive discussion.

Pioneering work was done by Allen Kneese of Resources for the Future. In 1962, Kneese wrote *Water Pollution: Economic Aspects and Research Needs* in which he skillfully utilized economic concepts in a study of water quality

institutions in Europe and introduced the concept of a basinwide firm as a technique for analyzing the economics of water quality. Ciriacy-Wantrup wrote that water quality was likely to become a more important social problem than water quantity [1961d]. In 1962, Stoevener and associates initiated a multidisciplinary study of water quality (Stoevener [1963, 1965], Stoevener et al. [1972]). Kneese [1964] followed his early work with a comprehensive treatment of regions, with particular reference to conditions in the United States.

Another group, largely agricultural economists, began to study the environmental impacts of pesticides. An early effort in this connection was the work of Headley and Lewis [1967]. Langham and Edwards also initiated research in this area [1969]. Edwards, Langham, and Headley [1970] collaborated on an article published in the *Natural Resources Journal.* More recent efforts include those of Hall and Norgaard [1973] and Farris and Sprott [1971].

The 1965 meetings of the American Agricultural Economics Association provided a session on agriculture and environmental quality. In addition to the paper by Langham and Edwards on pesticides [1969], papers of a more general nature were given by G. C. Taylor [1969] and Delphendahl [1969].

By the 1970s, public concern about the environment had resulted in policies that were affecting agricultural production in numerous ways (Carlson and Castle [1972]). This concern was reflected in the kinds of research performed in numerous locations (Jacobs and Timmons [1974]). By this time, research effort was being directed not only to investigation of specific pollution problems but also to broader policy issues, including problems of institutional design (Brewer [1971], Seagraves [1973, 1974], Bromley [1974], Randall [1974]). The theory proven to be the most relevant here is that of the neoclassical externality literature (Mishan [1971]). However, there is some question whether this theory is powerful enough to account for the aggregate effects of mass consumption and production. Ayres and Kneese [1969] attempted to provide a framework for addressing the aggregate effects of these activities. A general treatment of environmental issues is found in Kneese and Schultze [1975], and a book of readings has been prepared by R. Dorfman and N. S. Dorfman [1972]. Fisher and Peterson [1976] have supplied us with a review of the theoretical literature on environmental economics.

Economic Interdependence and Indirect Effects

One of the more intriguing questions related to resource development is the extent to which the consequences extend beyond the primary beneficiaries of a given project. The influence of indirect effects on the region and the national economy has been a subject of debate since the early history of resource economics. An explanation of the basic issues was prepared by Ciriacy-Wantrup

[1955a] and is reprinted as chapter 2 of S. C. Smith and Castle [1964]. Ciriacy-Wantrup concluded that secondary or indirect effects of resource development should not be included in project evaluation, although such effects were certainly relevant to repayment. Margolis was also an early contributor to this subject [1957].

The magnitude and impact of indirect effects have long been of general interest. Chambers of commerce and other indirect beneficiaries of resource development projects have been promoters of such projects and of government spending. There was much response to this interest, and attempts were made to measure these effects in a relatively straightforward manner (Kimball and Castle [1963], Holje, Huffman, and Kraenzel [1956]).

The adaptation of Leontief-type input-output analysis to the study of small areas provided a tool for assessing economic interdependence in a much more systematic way. Leaders in these efforts include Martin and Carter [1962], Jansma [1965], Jansma and Back [1965], Rao and Allee [1964], and Stoevener and Castle [1965]. This tool was adapted to numerous problems where linkages among sectors of the economy were important (Hartman [1965], Hartman and Seastone [1965], Bromley, Blanch, and Stoevener [1968], Kalter and Lord [1968], Jansma and Back [1965]).

The issue of whether indirect or secondary effects should be utilized in project evaluation hinges largely on whether there is unemployment or excess capacity in the economy. Kimball and Castle [1963] noted excess capacity in a rural economy prior to the establishment of an irrigation project. In 1968, a book by Haveman and Krutilla represented an ambitious effort to address this problem nationally and regionally. An *ex post* analysis of water resource development projects was undertaken with regional analysis made of impacts, the results of which had considerable potential significance for policy. The authors concluded that, for the period 1957-64, the opportunity costs imposed by public investments were significantly less than the money costs of such projects. The difference ranged from 5 to 30 percent less, depending on project type, the location of the construction site, and the market response functions. Resource development projects have long been viewed as an inferior way of counteracting cyclical unemployment because of the time required for authorization and construction. However, if excess capacity is a chronic condition of the economy, some of this criticism loses its force. It is interesting that there has been so much discussion on the theoretical basis for an appropriate rate of discount but that this important empirical finding has gone largely unnoticed.

Land Use and Integrated Resource Management

One of the more significant contemporary developments in the area of natural resource policy is the emphasis being placed on land use as a technique

for bringing about integrated natural resource planning and control. As this is being written, legislation is pending at the national level, and several states have passed legislation exerting greater social control over land use.

It is an open question whether this approach will satisfy or disappoint those who believe it is a key to many problems of balancing increased economic growth with the quality of life and the quality of the environment. To accomplish the quality objectives, there is little question but that some of those attributes of property rights that have traditionally been in the private domain will have to be transferred to the public.

How well prepared are resource economists to assist in the institutional modifications necessary to accomplish these social objectives? How well prepared are resource economists to evaluate greater land use control as a means of balancing economic growth with other social objectives? On the one hand, it is certainly apparent that they will not have exclusive jurisdiction over this area. Landscape architects, geographers, and experts in other disciplines are increasingly playing a role as "planners" for rural and urban development. On the other hand, it does appear that there are central economic questions that will need to be addressed if greater public control over land use is to occur (*Journal of Soil and Water Conservation* [1972]): articles by Castle and Rettig, Clawson, Cormack, Criley, Denning, Hillman and Martin, Kellogg, Kyl, Mendell, Ogden, and Timmons]. The legal issues are in much clearer focus than are the economic and political, though one can expect court decisions to reflect increasingly the public interest in land use (Bosselman and Callies [1972], Bosselman, Callies, and Banta [1973]).

One of the expressed concerns is the rate of conversion of land from rural to urban purposes. It is suspected that, if analyzed, this concern would cover other, more specific, issues. It may be that the urban sprawl is viewed as destroying open space as well as removing agricultural land from production. Agricultural land may be desired not so much for its own sake as for its contribution to future flexibility in land use. Furthermore, the rural and urban conflicts that tend to permeate a rapidly growing economy might be better addressed in the minds of some if land conversion could be better controlled.

On the other side of the ledger are the deeply ingrained private rights to land. Real property ownership is widely disseminated in our society, and its relative importance as an asset is probably inversely related to total supply of wealth (Castle [1978]). The consequence is that greater public control over land use may have severe political repercussions and may be regressive in effect (Godwin and Shepard [1974]).

The work of Marion Clawson is significant in this respect. After leaving the directorship of the Bureau of Land Management in the early 1950s, he joined the staff of Resources for the Future. In that capacity, he began researching

and writing about the prospective uses of land. He developed major areas of research related to federal lands and the recreational use of land. His original contribution to recreation research, which spawned substantial additional investigation, is elaborated later. Included among his work in the 1950s on federal lands were publications in 1951 and 1953. His continued interest in the federal lands led to collaboration with Burnell Held in 1957. This was followed in 1960 with a comprehensive effort on total land use in the United States (Clawson, Held, and Stoddard [1960]) and later by a work on the Bureau of Land Management (Clawson [1971a]). It is to be hoped that the existing group of resource economists will take advantage of the foundation laid by Clawson [1971b, 1972a]. See also Clawson [1960, 1961, 1962, 1963b, 1966, 1968] and Clawson and Held [1963].

In addition to the work of Clawson, there have been others who have investigated the issues and programs of land use (Snyder [1966]). Schmid [1968] prepared a book on rural-urban land conversion. However, rural-urban problems have usually been discussed in a broader, more general context (Back [1970], L. Taylor [1970], Snyder [1966]).

With respect to future directions for research in land use, it appears that at least three areas will require attention. One relates to income distribution and equity issues (Fitch and Stoevener [1977]). Real property ownership is so widespread that any policy significantly affecting the bundle of property rights is bound to have important distributive consequences. Another area relates to the issue of institutional design. New institutions may be required not only to accomplish the objectives of a changing society but also to protect private real property rights. Transferable development rights have been advanced as a solution to this problem. (Chanooshian and Norman [1973]). A third area with the potential of yielding much insight relates to space and distance. Historically, land use policies in the United States have been designed to overcome space and settle the countryside. The need now seems to be to reverse this trend. Rising energy costs may make the transportation of both people and goods relatively more expensive. At the same time, very little is known about people's preferences for space and spaciousness. Isolation is relative and is a utility to some and a disutility to others. Many wish to vary the amount of isolation they have and may prefer to be isolated on weekends or for part of the year but would find such an existence undesirable on a permanent basis. While the standard economic works on location will be helpful in addressing this issue, it is believed that they should be supplemented by additional conceptualization and empirical work. The traditional approach has been to give the major emphasis to the relationship of space and distance to the production of goods. In an affluent society, consumption may be relatively more important.

A paper by Kelso [1962] anticipated the importance of the economics of space. In this paper, he drew explicit attention to two neglected areas of research on land utilization. These areas were (1) utilization in space with time explicit and (2) utilization in time with space explicit.

Resource Development and Income Distribution

Much of the literature of resource economics consists of an application of the neoclassical efficiency model of resource allocation to problems of resource development. The entire benefit-cost approach is an attempt to discover whether a given resource development will improve national income by increasing the efficiency with which resources are used. Although the distributional consequences and the equity effects of such investments have often been treated, these considerations often become secondary to the main thrust, which is designed to get at the efficiency effects.

The same theoretical framework can be used, of course, to investigate the income distribution effects (Harry G. Johnson [1973]). In fact, there is a literature of income distribution that goes back at least to Ricardo. There is little doubt that the question of income distribution effects is of much greater popular interest than that of economic efficiency. Nevertheless, the tools for allocation of the total product to factor shares are not as well developed as are the means for the investigation of efficiency conditions. Additionally, the tools for investigating personal or household distribution of income are even less well developed because we know so little about the distribution of income-earning assets.

Identifying the beneficiaries and measuring the benefits of farm programs have long been a concern of agricultural economists. Many have hypothesized that most of the benefits of farm programs are capitalized into land values. Chryst [1956] presented an excellent statement of the logic underlying this position. Others who have written in the same vein include Heady [1952a], Clawson [1963a], Raup [1963, 1965], Back [1966], Back and Wunderlich [1966], and Gaffney [1965]. Gibson and associates in Virginia undertook a series of studies supporting the hypothesis that at least some of the income from government programs became capitalized into land values (Maier, Hedrick, and Gibson [1960], Gibson, Arnold, and Aigner [1962], Boxley and Gibson [1964]).

In 1959, George Tolley published the results of an empirical investigation on the effect of reclamation on the remainder of agriculture. His analysis provided for a treatment of regional impacts, and he concluded that the South bore much of the cost of Western reclamation. Back [1964] called for greater emphasis on empirical research that would estimate the distributional and growth effects of water resource investments. In 1969, he argued further that

investment in natural resources may not be an efficient way to develop a region so that it becomes more competitive in an urban-industrial context. Gardner [1966] analyzed water policies, public land policies, and agricultural conservation payments with respect to distribution of income both within agriculture and between agriculture and the rest of the economy. Although the distributional objectives of such programs were unclear, he concluded that resource development policies were generally an inefficient means of redistributing income. More recent studies designed to isolate distributional impacts of resource development are those of Kalter and Stevens [1971] and Beattie and associates [1971].

These empirical studies of the income distributional consequences of resource development vary with respect to the impact of the redistribution. Some, like Tolley's, have been mainly concerned with geographic redistribution. Others have dealt with occupation classes or income classes, whereas still others have concentrated on asset holdings. The methodological problems are obviously very different for measuring the different types of impact. The above citations demonstrate that a substantial literature exists on these consequences.

Outdoor Recreation

Several references have been made in the preceding sections to the economic evaluation of outdoor recreation over the past one and one-half decades. Although others have contributed to this area of study, agricultural economists, with their quantitative skills, have made a disproportionately large contribution to the methodology in this field. As was pointed out previously, in the 1950s postwar prosperity and increased leisure time mobility led to a significant increase in the consumption of publicly provided outdoor recreational services. The resulting need to evaluate public resource allocations for these endeavors, together with increasing sophistication in benefit-cost evaluation procedures elsewhere (especially for water resource development projects), provided the social need and the intellectual challenge to address the issue of evaluation of publicly provided outdoor recreational services.

Our fundamental concern here, however, is not with statistics but with the application of economic theory. Hotelling [1949] provided the basic theoretical approach for much subsequent work. Clawson [1959] and Trice and Wood [1958] made similar modifications and adaptations of Hotelling at about the same time. Hotelling suggested that demand curves could be derived by observing the rate of participation of certain population groups in outdoor recreational activities at a certain site as a function of the costs required to transport them from their places of residence to the site. These demand curves could then be used to derive value estimates for the site in question.

The usual procedures for deriving these values have been the estimation of maximum revenues to a nondiscriminating monopolist, especially in the early work, and more recently the integration of demand curves to derive users' willingness to pay and consumer surplus.

In his original work Clawson derived statistical demand functions for several of the national parks. The clarity of his exposition made his work the standard reference during the following decade and stimulated much additional research. Although his demand functions were simple, Clawson recognized the need for greater sophistication in statistical demand estimation for outdoor recreation.

Brown, Singh, and Castle [1964] followed in Clawson's footsteps and developed one of his suggestions to incorporate income as an explanatory variable in the demand function for outdoor recreation. Observations on the "price variable" were made through extensive sample surveys. These researchers also attempted to use a simultaneous equation framework, but with very limited success. They concluded that "price" in this context is "to a great extent predetermined." Most of the subsequent work in this area has used a single equation approach. Examples are the studies by Wennergren [1965], McNeely and Badger [1968], and Coppedge and Gray [1968].

Although in departments of agricultural economics and other institutions considerable resources flowed into the study of the demand for outdoor recreational resources, it appeared to some that this area of research might be a bottomless pit, if readily generalizable empirical results were expected from this work. The principal difficulty stemmed from the heterogeneity of the recreational commodity consumed. Even when demand functions were estimated for such seemingly specific outdoor activities as boating or salmon and steelhead fishing, it was difficult to generalize the results. The hypothesis that it was necessary to discover the quantitative differences that mattered to recreationists in their consumption of outdoor recreational services led to extensive research on the quality variables or site characteristics important in these leisure time activities. Although Stevens's [1966] work was undertaken for a different purpose, it had an important influence in this area. Stevens's "quality variable" in sport fishing was fishing success. It served as a shifter of the demand function. Some of the subsequent work such as that done by Reiling, Gibbs, and Stoevener [1973] utilized the same approach. In other cases, Stevens's work on the quality variable strengthened the argument for the inclusion of site characteristics as explanatory variables in the demand functions or led to a higher level of disaggregation of the quantity variable in these demand models (Johnston and Pankey [1968]). Some of the research reports undertaken in the West under regional project WM 59 had this par-

ticular thrust (Cooperative Regional Research Technical Committee WM 59 [1968, 1970]).

The same regional project also focused on the socioeconomic characteristics (other than income level) of recreationists as demand determinants. Some of this work was frustrated by the need to work with aggregate data in the Hotelling-Clawson demand model. It created a need for methodological developments that would allow the use of individual observations in statistical demand functions for outdoor recreation. Some developments in this area are discussed below.

To return for a moment, however, to the subject of quality characteristics, the interesting work by Wennergren and Fullerton (Wennergren and Fullerton [1972], Wennergren, Fullerton, and Wrigley [1973]) must be mentioned. They break down site values (rents) into location and quality factors. Quality rents are the residuals after location rents have been accounted for. In the analysis, these residuals are regressed against various site characteristics; hence site values are explained by locational and qualitative differences.

In their empirical work researchers have encountered several difficulties in the treatment of the price variable for outdoor recreation. These were mundane issues: Which costs are fixed and which are variable? Does the price unit reflect unit costs per day per recreationist, or is the group recreating together (usually the family) the appropriate denominator? Or should the unit cost pertain to the recreation trip instead of the recreation day? Pearse [1968] and Gibbs (Reiling, Gibbs, and Stoevener [1973]) developed formulations that are helpful in this regard. Both focus on the number of days taken per trip as the dependent variable. This eliminates use of some distance zone aggregates traditionally applied in the Clawson-Hotelling model. Hence some of the difficulties encountered with the use of socioeconomic variables discussed earlier no longer pertain when individual observations can be used in the statistical analysis. The primary conceptual focus of these investigators lies, however, with the separation of the traditional price variable into two components: on-site costs and travel costs. The former are viewed as fixed costs and shifters of the recreationist's budget constraint, whereas the latter serve the function of commodity prices in demand analysis. Gibbs derived estimates of statistical demand functions and discovered that the derivation of consumer's surpluses from these functions is not straightforward and is an issue requiring additional theoretical analysis.

Many students have questioned the sole concern with the money budget constraint. Is it not possible that the consumer's time constraint is equally important? Knetsch [1963] described a downward bias in value estimates for outdoor recreational resources when time costs were not taken into account

explicitly. Cesario and Knetsch [1970] made some concrete suggestions for developing a trade-off function between travel costs and time costs. This methodology has been applied by Shulstad [1974]. Brown, Nawas, and Stevens [1973] suggested that much of the difficulty of multicollinearity between money and time cost variables can be overcome where individual observations instead of the traditional distance zone aggregates are used for the statistical derivation of outdoor recreational demand functions.

The subject of time continues to be bothersome in this area of research. Perhaps Schultz's suggestions [1972] about the economic value of human time together with the conceptual work of Linder [1970] and Baumol [1973] and comments by Phelps [1973] provide the basis for synthesizing a broader conceptual basis for empirical work.

The book by Clawson and Knetsch, *Economics of Outdoor Recreation* [1966], deserves special comment. This volume does much more than address questions of demand analysis: outdoor recreation is viewed in a leisure-work context, supply issues are treated, and policy issues for public investment in and pricing of publicly provided outdoor recreational services are discussed. The same and other policy issues were also addressed by Seckler [1966, 1968], Gardner [1967], Stoevener and Brown [1967], Krutilla [1967], and Goldin [1970].

A report by Kalter [1971] brings the literature up to date on methodological developments and contains a comprehensive bibliography. The most recent, and to the practitioner most readily accessible, treatment of the subject is again by Knetsch [1974]. A recent study by Sinden is also an interesting treatment of the developing methodology of this field [1974].

Some Neglected Areas

Because the field of resource economics encompasses a more extensive literature than it is practical to include in this review, there are undoubtedly inadvertent omissions of significant literature on those topics chosen for inclusion. Beyond this, the authors are aware of other areas that have been neglected simply because resources were not available for more complete treatment.

One important neglected area is that of forest economics. Well-known textbooks on forest economics and policy include those by Duerr [1960], Gregory [1972], and Worrell [1970]. In recent years, there has been increased interaction between agricultural resource economists and forest economists. Forest economists have been invited to contribute to the annual meetings of the American Agricultural Economics Association: see Hagenstein [1971] on "Forestry, Public Pressures, and Economic Development"; Muench [1972] on "Forest Resource Policy and Management"; Apsey, Garton, and Hajdu

[1973], Gamache [1973], and Holland [1973] on "International Trade Policy . . ."; Clawson [1974] and Duerr [1974] on "Forest Economics."

Another area of significant literature not included here is that of mineral economics. With the emergence of energy as a resource having numerous implications, this literature is becoming increasingly extensive. It is also doubtful that justice has been done to marine economics in all of its facets. In addition, there are newly developing areas of interest, such as weather modification, which have not been reviewed (Sewell [1966], Stevens and Castle [1967]). There is also literature on the untreated land tenure and resource development problems of the American Indian (Brophy and Aberle [1966]). Space and radio wave spectra are other examples of neglected areas.

The Continuing Evolution of Natural Resource Economics

The Contemporary Scene

It was suggested earlier that the work of resource economists has historically been strongly influenced by the broad sweep of social events. Little reason exists to suspect a less iconoclastic attitude in the near future. To the contrary, at least three factors propel us along an evolutionary path. One is the nature of the individuals who are attracted to resource economics and their proclivity for involvement in the arena of public policy. A second factor is that social problems are instrumental in defining the economic resources available to academicians, including resource economists. Ironically, institutional lags in funding may result in the study of problems whose day has largely passed. On the other hand, research support for emerging areas of concern may be delayed too long. Nonetheless, one must expect a broad correspondence between the work done by resource economists and that expected of them.

A third and perhaps more contentious expectation is that resource economists will be significantly affected by a developing conceptual base that focuses on group decision making generally, rather than on natural resources specifically.[18] The substance of this argument will be developed later in this survey. For now, suffice it to say that resource economists will continue to be problem-oriented, as in the past.

It is extremely hazardous to try to be definitive about what constitutes the current scene, let alone predict what the future will be. Nevertheless, it is probably not far off the mark to suggest a set of issues that are of immediate concern to resource economists and that are likely to remain uppermost in their interests for some time to come. One could discuss these under popular headings, that is, environmental policy and economic growth, population growth and concentration, land use, energy, and community development.

For present purposes, it might be noted that common threads run through these problem areas. Identification and expansion of these threads will be vital to orderly development of future efforts. As a starting point, the following factors might be noted.

First, much attention has been given in the past to uses of natural resources as factors of production (Castle [1963]). Now and in the future their use as consumption goods will receive equal or greater attention. A general "quality of life" rubric might subsume most of the issues on which resource economists are working.

Second, historically, property rights have been structured to facilitate industrialization and economic growth (Shaffer [1969]). As natural resources have gained prominence as consumer goods, the utility lost through externalities has become more apparent. Both nonmarket valuation and externality theory have flourished in the literature.

Third, demands for participation in group decision making in order to resolve perceived inequities have taken on a public dimension heretofore unachieved (Dahl [1970]). On the one hand, some of this may be transitory. On the other hand, it does reflect social dissonance with *both* market and nonmarket institutions for resolving conflict.

Fourth, resource economists well versed in welfare economics and the concept of "market failure" are becoming more sophisticated (or less naive) about the strengths and limitations of nonmarket resource allocation. This corresponds in direction, if perhaps not yet in degree, to popular demands for assessment of the public sector itself.

Contemporary Resource Economics

It is fitting, at this point, to reconstruct from earlier sections a synopsis of the conceptual-analytical base with which resource economists work. Similar assessments have also appeared in the *Journal of Farm Economics* and the *American Journal of Agricultural Economics* (Buchanan [1969], Castle [1965], Kelso [1965], Ruttan [1971], Schmid [1969, 1972], Schultz [1968], Shaffer [1969]). In addition, the critiques of general economic methodology that have surfaced in the *American Economic Review* also have much relevance for resource economics (Myrdal [1972], Robinson [1972], Stigler [1965]). At the risk of considerable oversimplification, the nature of the conceptual-analytic base, and the use of that base, are summarized below.

First, the base is essentially microstatic, stressing theories of the firm, consumer behavior, and markets. The macroeconomic base remains fairly shallow even though considerations of interest rates, price levels, and employment levels were incorporated into the public investment literature in the mid-1950s (Eckstein [1958]). As evidenced in the previous section, macro ele-

ments are usually expressed in terms of aggregated micro relationships for communities, regions, and states.

Moreover, with the exception of relying more heavily on welfare economics, the conceptual-analytic base is not greatly different from that of most agricultural economists. Except for the fact that it relies less heavily on optimizing techniques, the quantitative apparatus also bears much resemblance to that of agricultural economists generally.

The use to which the tools are put, however, is the principal differentiating characteristic of resource economists. Implicitly or explicitly, their attention is to problems of group decision making where natural resources are involved as inputs or outputs, or both. Having ventured outside the more sheltered domain of entrepreneurial economics, two circumstances must be dealt with. One is the role of economic institutions. In entrepreneurial economics, institutions are exogenous to the system although analysts may choose to vary their levels or perhaps even ignore their existence. In resource economics, institutions are more nearly endogenous to the system; the extent to which this is really so will be addressed shortly. The second circumstance follows directly since the usefulness of optimization as a fictional construct or scientific fiction diminishes as the analysis moves away from single firms and households, and toward larger, more heterogenous groups (Ciriacy-Wantrup [1967]).

In addition, resource economists have gained maturity in the subtleties of applied welfare economics; they now shy away from "social optima" in recognition of the fact that the multiple-dimensioned objective function is inherent in group decision making. The degree of allegiance to economic efficiency as a norm has declined in favor of approaches that would recognize as legitimate the viewpoints of the various affected groups (Beattie et al. [1971]).

Finally, resource economists have become increasingly tolerant of "muddling through" as descriptive of political reality, and hence more pragmatic in assessing how their work is viewed by those in the political process (Braybrooke and Lindblom [1963], Lindblom [1959]). Although strict allegiance to efficiency has declined, resource economists are often cast in the role of "partisan efficiency advocates," to use Charles Schultz's phrase [1968], since efficiency is bound to hold a low priority among the other partisans. Resource economists face the occupational hazard of becoming schizoid; they continue to have some degree of allegiance to efficiency even though they recognize that efficiency is not all that matters.

The Adequacy of the Conceptual-Analytical Base

In any assessment of current tools and their applicability to real world problems, one must recognize the strengths and limitations of welfare economics.

There is not enough space here to provide a detailed analysis of welfare economics, but Boulding has captured the essence of the subject in the following manner:

> It [welfare economics] is an attempt to answer with great exactness the question, what do we as economists really mean when we say that one state or condition of the social system is economically "better" than another? This is a good question, even if at the end of fifty years of discussion the answer that emerges is that we are really not sure. This at least is a good honest conclusion and the exercise we have gone through as economists to reach it is one that other social scientists might well emulate [1970, p. 90].

After two decades, we are still faced with Arrow's General Impossibility Theorem that no social choice mechanism for aggregating individual preferences would satisfy, simultaneously, four reasonable conditions detailed in his *Social Choice and Individual Values* [1963]. Progress has been made in removing this roadblock; Arrow also provided that one choice mechanism, majority rule, does satisfy the four conditions when applied to only two alternatives. Edwin Haefele, formerly of Resources for the Future, seized this as a rationale for two-party representative government as a utility mechanism for synthesizing social choice from individual preferences [1971, 1973]. Along a different tack, Gordon Tullock argued that the Impossibility Theorem is largely irrelevant when the number of voters is large [1967]. His conclusion reflects an increasing degree of pragmatism among welfare economists, as contrasted to the initial futility that followed in the wake of the Arrow theorem. To quote Tullock:

> That the majority voting process normally leads to a determinate outcome and that this outcome is apt to be reasonably satisfactory will surprise no practical man. Clearly this is what does happen. One of the real problems raised by Arrow's book was why the real world democracies seemed to function fairly well in spite of the logical impossibility of rationally aggregating preferences. The solution I have offered, that no decision process will meet Arrow's criteria perfectly, but that a very common decision process meets them to a very high degree of approximation, permits us to reconcile the theoretical impossibility with the practical success of democracy [1967, p. 270].

Welfare economics has been invaluable in identifying what really cannot be said yet *is* often said in public and academic debate. Experience has counseled that a variety of viewpoints should be considered instead of just one and that empirical evidence should be brought to bear on distributional issues as well

as those of allocative efficiency. It has also urged that external effects be measured and that alternative institutional forms for coming to grips with externalities be explored.

Yet the slowness of institutions to respond to change causes some concern that disciplinary efforts have not been all that they could be. Shaffer [1969] and T. W. Schultz [1968] wrote papers in the late 1960s to this effect. Shaffer placed the blame for institutional lag primarily on scientific industrialization and the pervasiveness of external effects, and argued for a much expanded role for social scientists in prescribing new institutional forms. Schultz also dealt with disequilibria in terms of lags in institutions that provide services to the increasingly valuable human resource and argued that institutions could and should be made endogenous to economic analysis. Both the prominence and the persuasiveness of these authors cause one to speculate on the ability of economists in general, and resource economists in particular, to make institutions truly endogenous to a theoretical framework. This potential will be explored in the remainder of this section.

In order to maintain perspective, however, two analgesics should be administered. The first is something to alleviate concern about the degree to which inadequacies in the conceptual base of resource economists should be held accountable for real world institutional lags; excessive guilt feelings may be based on an expectation of science that is unwarranted. The second, a historical reminder of previous efforts, was expressed by Stigler [1965]:

> The economic role of the state has managed to hold the attention of scholars for over two centuries without arousing their curiosity. . . . Economists have refused either to leave the problem alone or to work on it [p. 14].

Further, he wrote:

> It will become an occasion for humorous nostalgia when arguments for private or public performance of a given activity are conducted by reference to the phrase, external economies, or by recourse to a theorem on perfect competition [p. 17].

Can Institutions Be Made Endogenous in an Economic Framework? An Outline of the Task

T. W. Schulz [1968] proposed that there are three approaches to treating institutions in economic analysis. These are: (1) omit or impound them by abstracting from them, (2) treat them as subject to change exogenously, or (3) treat them as "variables within the economic domain, variables that respond to the dynamics of economic growth" [p. 1116]. It should be noted

that Ciriacy-Wantrup [1969] was exceedingly critical of what he termed an "institutional vacuum" in Schultz's work. To cite his objections to the 1968 article:

> Is this vacuum filled by the belated admission of institutions as factors, the services of which are supplied in kind and quantity in accordance with the demand for them until a demand-supply equilibrium is reached? This comforting notion is presented as a "theory" in a field in which it is claimed that "there are virtually no terms of reference, concepts with specifications that can be identified, and no economic theory to guide the analysis." The facts are quite to the contrary. Institutions have been the central focus of the study of social organization for more than a century, both by adherents of the theory of economic determinism of institutions and by its opponents [1969, p. 1318].

Although there is considerable substance to Ciriacy-Wantrup's objections, the Schultz article is used here for two reasons. First, it provides a convenient point of departure to address the efficiency of an expanded treatment of institutions. Second, this controversy between two senior statesmen reveals severe disagreement within the profession with respect to institutional analysis.

While it is true that most resource economists work "with" institutional change, they do so primarily in terms of appraising allocative and distributional outcomes of alternative institutional arrangements. (An increasing degree of generality with respect to institutional analysis is now appearing in the *American Journal of Agricultural Economics.* Alan Randall's award-winning article [1972b] provides an excellent example.) To Schultz, "The essence of their work is to begin with an *ad hoc* institutional change" [1968, p. 1116], an approach which simply regards institutional change as exogenous rather than inquiring as to its origin. To take Schultz's mandate seriously would obviously add substantially to the relevant theoretical framework. Taking it seriously would also necessitate asking questions, particularly on the supply of services through institutions, that resource economists have not yet asked in any serious manner.

Before outlining the task, one should first define terms. Ciriacy-Wantrup defines an institution as "a social decision system that provides decision rules for adjusting and accommodating, over time, conflicting demands . . . from different interest groups in a society" [1969, p. 1319]. From Ostrom and Hennessey's book: "We conceive of institutions to be nothing more or less than decision-making arrangements" [1975, p. i]. Schultz defines them as "behavioral rules" [1968, p. 1114]. Given these definitions, the central question is how to bring institutions into the theoretical core of economics. To cite Schultz:

> To get on with this task, two key concepts are required, that is, the economic value of the function performed by an institution[19] and the concept of an economic equilibrium [1968, p. 1116].

In response to Schultz's first concept, it was shown earlier in this review that resource economists are not incapable of dealing with nonmarket values, if that is required. It is his second concept that envisages a quantum leap in capabilities. In essence, it requires an explanation for the *supply* of those services made available as a result of group decision making, as well as the *demand* for these services. Explaining the supply of these services, in terms of quantity, quality, or organizational form, is surely at the fringe of the resource economists' expertise at this point in time. In real world form, these variables have been presumed to be resolved by the political process. In their conceptual form, they have largely been left to the fields of political science, law, and public administration.

Even though this is at the fringe of the expertise of resource economists, the more pertinent question is whether there exists a developing body of literature in this area. The answer is "yes," although the literature is scattered about in much the same manner that resource economics literature has been throughout its lifetime. It is dominated by a few names: economists like Buchanan and Tullock (Buchanan and Tullock [1962], Tullock [1964a, 1964b, 1967]), Olson [1965], Downs [1967], Niskanen [1971], and Bish [1971]; political scientists such as Lindblom (Lindblom [1959], Braybrooke and Lindblom [1963]), Dahl [1970], Riker [1962], the Ostroms (Ostrom [1974], Ostrom and Hennessey [1975], Ostrom and Ostrom [1971]), and Black [1958]. This literature, while applicable to natural resource issues, is far from being limited to those issues. As a result, it has the potential for both encouraging and allowing natural resource economics to deal with group decision making generally, and hence, to evolve as a discipline.

In the next section, it is argued that elements of the natural resource economics literature, with the emerging public choice literature, provide crucial elements of an expanded theoretical base within which institutions may be viewed as endogenous variables. No claim is made that resource economists will lead the way in this development, nor that they should undertake research not within their domain of comparative advantage. Instead, it is contended that the intellectual context within which they work will be both modified and enhanced by these developments.

Public Choice as an Evolutionary Discipline

The ultimate objective of public choice[20] as a science is to treat normative questions as scientific propositions. Yet scientific propositions must be

testable—a hurdle that welfare economics and public choice have yet to resolve. Steiner made the humbling observation that

> obviously the question, "What is the public interest?" has no simple answer. Asking it invites the sort of smile reserved for small children and benign idiots [1969, p. 56].

Yet, the current inability to test normative propositions about group decision making should not detract from the possibility that some related positive propositions *can* stand the tests of scientific method. Thus the ability to generate and test new and meaningful positive propositions within an expanded theoretical framework becomes the pragmatic criterion by which to judge success or failure of future intellectual effort. The direction of such effort might be facilitated by identifying (1) what positive questions could be generated by the new and expanded conceptual framework, and (2) the key synthetic concepts that would characterize such a framework.

It is suggested that the following categorization of questions might be useful:

1. What particular goods and services emanating from institutions are produced, in what quantities and time periods, and by whom?
2. How homogenous or heterogenous is the product mix from a particular institution?
3. Who benefits from and who bears the costs of the institutional service, and how are these outcomes translated into subsequent actions?
4. How does economic growth affect the relationships in 3 above?
5. How do group constitutions or decision rules act to facilitate or retard changes in the above?

This set of questions is broader than the set asked by virtue of making explicit, in a positive and predictive sense, the demand for and supply of services derived through group decision making, and the process by which these services are created and sustained. Moreover, it implies a necessary dynamic by describing how economic growth affects both the process and the outcome of group decision making.

As to synthetic concepts upon which we can draw, the following outline is intended primarily to stimulate thinking, and certainly not to serve as a definitive statement. It is sketchy, of necessity, yet an attempt to be synoptic may help to spot errors of omission or commission and hence to obtain a better initial reading on the efficacy of an expanded public choice framework. This outline contains the following elements.

1. The common dichotomy between market and nonmarket resource allocation is overly simplistic since it fails to recognize that a wide variety of institutional arrangements can be used to define what we consider a "market."

The market is not a self-evident phenomenon; it is defined only when "who can do what to whom" is defined by law, custom, or both.

2. An adaptation of Ciriacy-Wantrup's article on hierarchical decision levels [1967] may be useful in formalizing the structure of property rights and how this structure impinges on individual decision units.[21] Although Ciriacy-Wantrup's application was to water resource policy, the concept is easily extended to natural resource policy in general. At the first and lowest level in this hierarchy, decisions relate directly to the control of inputs and outputs by firms and households. The prime elements are production and utility functions; institutions are taken as constraints.[22]

Decision making at the second level in the hierarchy provides the institutional framework for decisions made at the lowest (operating) level. This level contains both resource law and governmental bureaus that administer and manage natural resources. The structure and distribution of property rights at any point in time are thus defined at the second level. Decision making at the third and highest level provides the constitutional basis for natural resource institutions that comprise the second level. At this level are the legislative, executive, and judicial branches of federal, state, and local government.

3. The influence of second-level institutions on first-level decisions (by firms and consumers) is already well recognized by economists. If we are to treat institutions as endogenous variables, however, the influence of first-level decision making *on* higher-level institutions must be addressed explicitly. To do so would permit us to explain the responsiveness (or the lack thereof) of institutions to economic growth, as translated through the actions of first-level decision units.[23]

The desire of first-level actors to create, modify, or replace second-level institutions has been conceptualized in the public choice literature through methodological individualism. This approach is so commonplace to economists that it is taken for granted, yet its implications have led Vincent Ostrom to conclude that the academic field of public administration is badly in need of a new intellectual paradigm [1974]. The traditional Wilsonian paradigm in public administration has long held that the efficiency of bureaucracy may be *presumed* as long as key principles of organization are followed. Accordingly, the large number of independent and overlapping public jurisdictions in metropolitan areas is often pointed to as a violation of these principles. If one starts from the standpoint of the representative individual, however, as did Buchanan and Tullock in their powerful *Calculus of Consent* [1962], quite the opposite conclusion might follow. To cite the Ostroms' analysis:

> Once we contemplate the possibility that public administration can be organized in relation to diverse collectivities organized as concurrent

> political regimes,we might further contemplate the possibility that there will not be one rule of good administration for all governments alike. Instead of a single integrated hierarchy of authority coordinating all public services, we might anticipate the existence of multiorganizational arrangements in the public sector that tends to take on the characteristics of public-service industries composed of many public agencies operating with substantial independence of one another [1971, p. 212].

While the Ostrom's conclusions obviously have normative implications, they rest on a foundation of positive, testable assertions about how individuals would view various decision rules, based on their expectations of probable gains and losses.

4. As established through second-level institutions, the structure of property rights in natural resources may have considerable effect on incentives and outcomes at the first level, and thus on the dynamic stability of any extant decision system. Especially where certain physical attributes of natural resources make ownership difficult, expensive, or even impossible, an extraordinary number of externalities may be generated. The logic of individualistic inaction, to be expected in certain situations, has been established by Olson [1965]. Even though the net social gains from improved air quality might be positive, for example, the affected individuals might be rationally inactive in terms of group formation and group action. Inactivity, however, is a special case; people can and do gain benefits from collective action. Hence the opportunity exists to understand how and why collective action does attempt modification or creation of second-level institutions. Again, to cite the Ostroms:

> The analysis of Mancur Olson would lead us to conclude that undertaking collective actions to provide public goods and services such as national defense, public parks, and education is not easily accomplished. If unanimity were the only decision rule that individuals utilized to undertake collective action, most public goods would not be provided. Yet, individuals do surmount the problems of collective inaction to constitute enterprises which do not rely strictly upon the voluntary consent of all who are affected. . . . While many students of public administration would not immediately see the relevance of a logic of constitutional decision making for the study of public administration, we feel that it provides an essential foundation for a different approach to the field. Using this logic, public agencies are not viewed simply as bureaucratic units which perform those services which someone at the top instructs them to perform. Rather, public agencies are viewed as means for allocating decision-making capabilities in order to provide public goods and services responsive to the preferences of individuals in different social contexts (Ostrom and Ostrom [1971, p. 207]).

It should be noted that "allocating decision-making capabilities" is, in effect, institution creating, which is what we are attempting to capture in analysis.

5. An immediate outgrowth of the above thinking is that natural resource agencies, functioning as part of the second-level set of institutions, are active rather than passive entities; hence their actions are susceptible to analysis. Helen Ingram's *AJAE* article [1973] on regional water institutions is very much in line with this position. Resource economists have long involved themselves with analysis of such agency actions as the development of multipurpose water projects. On the other hand, Ciriacy-Wantrup defines these as first-level decisions in his hierarchy, that is, as having to do with control of inputs and outputs.[24] What economists have not yet done to any significant degree is to attempt analysis of behavioral characteristics of the agencies themselves. Within the *JFE* and *AJAE* literature, we should note Bryant's analysis [1972, 1973] of the demand for and supply of food stamps through the Food Stamp Program. The vehemence with which his model was rejected by Hiemstra [1973] and Breimyer [1973] is interesting in itself.

A leading exception to this failure by economists to carry out behavioral analyses of bureaucracies is Niskanen's recent, path-breaking attempt [1971] to derive a positive theory of supply by bureaus.[25] Niskanen defines bureaus as "nonprofit organizations which are financed, at least in part, by a periodic appropriation or grant" [p. 15]. They "specialize in providing those goods and services that some people prefer to be supplied in larger amounts than would be supplied by their sale at a per-unit rate" [p. 18]. Hence bureaus are neither necessarily large nor governmental; a country club or charitable organization would fit the definition. Nor do they necessarily provide services which the market cannot provide; they may expand or even replace the existing market supply.

Niskanen's basic assumption on behavior, and one used to facilitate future testing of hypotheses, is that bureaus maximize budgets, based on their ability to deliver a promised set of activities in exchange for a budget. The plausibility of this assumption is argued on the grounds that a bureaucrat's salary, perquisites of office, public reputation, power, and patronage are all positive functions of budget size. To quote Niskanen:

> The rationality of budget maximization by bureaucrats may best be illustrated by considering the consequences of contrary behavior. Consider the probable consequences for a subordinate manager who proves without question that the same output could be produced at, say, one-half the present expenditures. In a profit-seeking firm this manager would probably receive a bonus, a promotion, and an opportunity to find another such economy; if such rewards are not forthcoming in a

> specific firm, this manager usually has the opportunity to market his skills in another firm. In a bureau, at best, this manger might receive a citation and a savings bond, a lateral transfer, the enmity of his former colleagues, and the suspicion of his new colleagues. Those bureaucrats who doubt this proposition and who have good private employment alternatives should test it . . . once [1971, p. 38].

Again, the physical nature, and accompanying property right definition, of many natural resources should lead resource economists to delve more deeply into the supply behavior of bureaus. This intellectual effort would go hand-in-hand with addressing the process by which the *demand* for collective action arises and is articulated through the political process.[26] Only when both processes are better understood will economics provide a positive theory of the demand for and supply of services provided through institutions, as urged by Schultz.

6. The relationship between first-level decisions by firms and individuals and second-level natural resource institutions is thus seen as a dynamic, interactive process which methodological individualism allows us to model.[27] To be of maximum value, however, economists must look to the real world instead of to their own preferences in order to understand and accommodate themselves to the nature of this process. Lindblom ably articulated this process as "disjointed incrementalism," or more simply—"muddling through" (Braybrooke and Lindblom [1963], Lindblom [1959]). Whereas Schmid [1969, p. 1311] described "a learned, if not congenital, bias in favor of explicit decision making" among economists, Lindblom characterized the political process quite to the contrary. Instead of following a "rational-comprehensive" method of first defining objectives, then applying means-end analysis to a broad variety of alternative means, the political process "muddles through" with interdependent (and often implicit) ends and means, and by considering only policies that differ incrementally from each other. Rather than finding these to be negative attributes, Lindblom defended them as a systematic and rational way of coping with conflict, uncertainty, and the sheer limitations of human intellectual capacity.

The implications for the economist should be fairly obvious—do not expect objectives to be clearly stated, and do expect that the process will be essentially conservative in terms of staying close to the status quo. At the same time, the economist can, has, and should "stretch" decision makers by continuing to analyze nonmarginal alternatives. For one thing, these alternatives might not have outcomes as drastic as first feared; second, the very existence of nonmarginal alternatives facilitates their eventual political respectability and, hence, allows society to choose from a broader set of alternatives.

7. If, in fact, these additional elements of positive theory can be added to

our analytical framework, we must then look at their implications for normative analysis, the ultimate objective. The argument to this point is that an interactive process characterizes the decision hierarchy, that these interactions between first-level actors and second-level institutions can, in fact, be modeled, and that the interactive process is of a particular nature. Throughout our intellectual history, economists have looked for normative significance in terms of the *outcomes* of change, starting with the Kaldor-Hicks compensation principle. As *process* is introduced into our models and becomes amenable to analysis, the possibility is raised that *both* process and outcome may need to be characterized in welfare terms.[28]

Lindblom's "muddling through" process seems to have one sole, internal criterion—that a policy is "good" if the partisans agree that it is good. Such a conclusion must be based, it is submitted, on acceptance of the prevailing distribution of power, and hence property right definitions, since these delimit "who" the partisans are.[29] Another blind alley was noted by Wildavsky [1966], viewing the role of economic analysis in government through the Planning, Programming, and Budgeting System (PPBS). Wildavsky's concern was that PPBS, in adding an "efficiency advocate," was imposing upon the political process an illegitimate, external criterion.

8. The answers (and even the right quesions to ask) will not come easily, and may not come at all. One obviously has to be somewhat patient about the direction and progress of a discipline. Yet there are opportunities to be exploited, and some tools with which to exploit them. Irrespective of the future identity of resource economics as a distinct discipline or subdiscipline, many of the historical concerns and approaches of resource economists will be part of the evolving intellectual effort to understand and to aid in resolving problems of group decision making in natural resource use.

Notes

1. Any reader with a deeper interest in the philosophic foundations of agricultural economics is referred to the survey article by Glenn Johnson, entitled "Philosophic Foundations of Agricultural Economic Thought" (Glenn Johnson [1981]).

2. A third approach derived from Mill's classical economics, but on which we will spend no time here, was Karl Marx [1909-12] and his socialism-communism. Marx differed from George in that he argued for the public ownership of all capital and land and the public capture of all capital and land incomes. In this regard, his argument and George's were similar, differing chiefly in the inclusiveness of their strictures on private property and the private capture of property incomes.

3. The following brief social history is intended to serve as an introduction to the section. Its relatively greater emphasis on the early part of the postwar period is deliberate. It is believed the reader is more likely to be aware of recent developments than those of the immediate post-World War II period.

4. It is somewhat inaccurate to say that a group of senators issued that document except in a very literal sense. The basic work for the document was done by an interagency group under the chairmanship of Henry Caulfield. This was the forerunner of the soon-to-be-established Water Resources Council, of which Caulfield was the first director.

5. For a view of the political controversy associated with the Bureau of Agricultural Economics, Hardin [1946] is recommended.

6. The authors are indebted to Max Tharp [1974] whose manuscript on natural resource economics research in the USDA provided much of the material on land economics research.

7. For a discussion of the uses and misuses of "scientific fictions," see Ciriacy-Wantrup [1956b].

8. See Lynne, Castle, and Gibbs [1973] for an enumeration and a discussion of the major legislative acts in this connection.

9. Numerous references can be cited in support of this statement. For a competent treatment of the subject at that time, see Hirshleifer, De Haven, and Milliman [1960].

10. It was not any violation of the conditions of economic efficiency that finally discouraged government investment in natural resources. Rather, it was concern with the redistribution of income, exclusion or bypassing of nonmarket values, and tight budgets that combined to reduce federal investment in water resource development.

11. For an elaboration of this concept, see Castle [1970].

12. For examples of this more recent literature on common property resources, see Cummings and Burt [1969], Plourde [1970], Fullenbaum, Carlson, and Bell [1971, 1972], V. L. Smith [1968, 1969, 1971, 1972], Southey [1972], Gould [1972], G. Brown, Jr. [1974], Burt and Cummings [1970], Bell [1972], Turvey [1964], Quirk and V. L. Smith [1969], O'Rourke [1971, 1973], and Cassidy [1973].

13. No attempt has been made in this review to cite all the literature on the social rate of discount. However, a good listing of literature and a good presentation of the principal arguments may be found in a report of the Western Agricultural Economics Research Council, Water Committee [1968], especially the articles by Harberger [1968], Stockfisch [1968], Haveman [1968], and Marglin [1968]. The statement of Harry Steele [1968] provides the perspective of one who is aware of the operational problems associated with the selection of a social discount rate.

14. For a comprehensive review of the literature on property rights, see Furubotn and Pejovich [1972].

15. The motivation for the Coase article arose from a study of the political economy of broadcasting that the author was conducting.

16. In an article in the *Journal of Law and Economics*, Demsetz [1966, p. 62] says, "The mix of output that is produced will be independent of the distribution of property rights among persons *except insofar as changes in the distribution of wealth affect demand patterns.*" Randall [1972a, p. 28] called attention to this, "but just as F. M. Bator [1957] has demonstrated that efficiency can only be defined in terms of a specified distribution of income, I emphasize here that efficiency can only be defined in terms of a specified set of property rights."

17. Within land economics, land tenure was emphasized, hence the name "land tenure" was applied to this early committee.

18. This is not to say that all natural resource problems can be solved by means of this developing conceptual base. Rather, it *is* to say that this base will take us more directly into the area of general group decision making, irrespective of whether or not the

problems are defined as natural resource related. The current movement of resource economists into the community development area is indicative of this trend.

19. Institutions are perceived by Schultz as suppliers of particular services. These services might include convenience, the reduction of transaction costs, information, pooling of risks, or provision of public services. For each of these services, there is presumed to be a demand and hence an equilibrium position [1968, pp. 1116-1117].

20. The name "public choice" was selected by a community of scholars assembled by Buchanan and Tullock at Virginia Polytechnic Institute and State University in 1963 to represent both their society and their journal (Ostrom and Ostrom [1971]). As intended here, the term is not meant to be limited to the work of that group but to indicate a sharing of their intellectual concerns.

21. The individual decision units are primarily firms and consumers, although Ciriacy-Wantrup sees the water projects of government as analogues to firms and thus operating at the first level.

22. Ciriacy-Wantrup's contribution here was not in devising new concepts of hierarchical decision structures but in applying existing concepts to water resource issues.

23. If economic growth itself is affected by second-level institutions, the analysis would have to accommodate this inherent simultaneity. For example, state laws inhibiting transfer of water from agriculture to higher-valued uses may retard local economic growth. If so, the political demand for institutional revision by nonagricultural interests may, in turn, be inhibited if the extent of that demand is a function of the income of those parties.

24. To cite Ciriacy-Wantrup: "It should be noted that a differentiation is made here between projects of federal and state agencies and those agencies themselves. This is in accordance with procedures of economic optimizing. Thus, optimizing procedures are applied to projects of the Bureau of Reclamation and not to the Bureau itself or the laws regulating its establishment, organization, and operation" [1967, p. 180].

25. Tullock [1964a] and Downs [1957, 1967] have also used economic tools to analyze behavioral relations within bureaus, but neither has developed the supply implications fully in the manner of Niskanen.

26. Niskanen's supply analysis, by design, started with the demand for bureau services as expressed through the sponsoring organization and thus avoided considering the demand creation and articulation process in depth.

27. Buchanan and Tullock [1962, p. 3] consider methodological individualism to be as follows:

> Collective action must be under our postulate, composed of individual actions. The first step in our construction is, therefore, some assumption about individual motivation and individual behavior in social as contrasted with private or individualized activity. Our theory thus begins with the acting or decision-making individual as he participates in the processes through which group choices are organized. Since our model incorporates individual behavior as its central feature, our 'theory' can perhaps best be classified as being methodologically individualistic.

28. A wag might note that if one insurmountable obstacle already exists, the marginal discomfiture of a second insurmountable obstacle is zero.

29. Warren Samuels and others treated many of these issues at The Summer Institute on Property held at Vail, Colorado, in 1971 and initiated by the Interregional Resource Economics Committee (Samuels [1972], Wunderlich and Gibson [1972]). The proceedings of this institute provide a valuable contribution to the emerging literature that is being characterized here.

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