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THE VIRTUES OF CLARITY: ROBERT
DORFMAN, FROM MATHEMATICAL
PROGRAMMING TO ENVIRONMENTAL
ECONOMICS

BY JULIEN GRADOZ

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The Virtues of Clarity: Robert Dorfman, from Mathematical Programming to Environmental Economics

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Abstract: This article explores the career of American economist Robert Dorfman (1916-2002), that can be divided into three distinct phases. During the first phase (1938-1958), he made contributions to mathematical programming and statistics. The clarity of his work was particularly emphasized by his colleagues, who believed it greatly helped disseminate mathematical programming among economists in the 1950s. In the second phase (1959-1972), he contributed to water management. His work during this phase was more applied and characterized by its interdisciplinary nature. Notably, he collaborated with oceanographers, political scientists, and sanitation engineers. Again, his explanations of the economic approach to water management and the relevance of mathematical programming in this context were praised for their clarity. During the third phase (1972-1997), he moved away from the specific case of water to focus more broadly on environmental economics, especially on critiques of cost-benefit analysis. By retracing his career, this article sheds light on the links among his various contributions and the role that clarity plays in how an economist's work is received.

Keywords: Robert Dorfman, mathematical programming, cost-benefit analysis, water management, environmental economics, Harvard Water Program

JEL codes: B30, D61, Q25, Q50

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1 Introduction

Robert Dorfman (1916-2002) was an American economist who spent most of his career at Harvard University. He is primarily known for an early article on sampling theory (Dorfman [1943]), for identifying the “Dorfman-Steiner condition” regarding firms’ optimal advertising investment (Dorfman and Steiner [1954]), for co-authoring the book *Linear Programming and Economic Analysis* with Paul Samuelson and Robert Solow [1958], for being a leading expert in water management during the 1960s, and for co-editing one of the first anthologies of texts devoted to environmental economics (Dorfman and Dorfman [1972]). At first glance, his various contributions may appear unconnected—a difficulty also reflected in the few texts that pay tribute to him (e.g., AER Editorial Board [1993]). In this context, the present article revisits Dorfman’s career and examines the links among his contributions. This perspective is valuable for two main reasons.

First, it addresses the lack of work focused on Dorfman’s career, despite his multiple contributions. Some studies do examine aspects of his work without making them their central focus—for instance, his years at the University of California, Berkeley (Assaf [2022]) or his role in the Harvard Water Program (Banzhaf [2023]). While these studies offer rich insights, they nevertheless remain focused on isolated aspects of his trajectory, preventing a full understanding of the connections among his different

contributions. Likewise, the intellectual autobiography that Dorfman [1997a] wrote at the time of the publication of a collection of his main writings offers interesting insights. However, it focuses on presenting the works included in that volume and suffers from the classic issue of post hoc rational reconstruction (Weintraub [2018]).¹ As we will see, it is rather by examining Dorfman's lesser-known works—those not included in the volume—that the links between his contributions become clearer. Revisiting his career also enables a discussion of underexplored topics and makes it possible to draw connections between elements that might initially appear unrelated, such as the development of mathematical programming, capital theory, the Harvard Water Program, the deployment of researchers to Pakistan by John F. Kennedy in 1961, and critiques of cost-benefit analysis.

Second, one of the most notable features of Dorfman's work is the consistent praise it has received for its clarity from his colleagues. This theme recurs in book reviews and tributes written about him. For example, the tribute published by Harvard University upon his death highlights that "his lifelong love of poetry and literature was reflected in the clarity and grace with which he was able to explain complex economics in simple language, widely remarked upon by his colleagues" (Harvard Gazette [2002]). Similarly, when he was named a distinguished fellow of the American Economic Association in 1992, the brief announcement published in the *American Economic Review* opened with the statement: "Robert Dorfman's characteristic intellectual style is based on a deep and painstaking mastery of the theoretical fundamentals, leading to a clear intuitive grasp of analytical questions and thence to masterly exposition."

Clarity is seldom the foremost trait for which economists are acknowledged. In Dorfman's case, however, it was anything but anecdotal: his colleagues believed it

¹ In particular, he reconstructs his career as having been characterized, from the moment he arrived at Harvard University in 1955, by a desire to study "public decisions"—albeit indirectly, since the subject was too broad to be addressed head-on. Taken together, his various contributions would then form, in the manner of a pointillist painting, a comprehensive view of this topic. The aim here is not to call into question Dorfman's perception of his own career, but simply to note the teleological nature of such a narrative.

played a key role in the spread of mathematical programming among economists during the 1950s and in the success of interdisciplinary collaborations within the Harvard Water Program. By emphasizing the clarity of Dorfman's work, this article contributes to historiographical discussions on the rhetoric and pedagogy of economics (e.g., McCloskey [1985]; Brent, Jhun, and Medema [2026]). To do so, it draws on Dorfman's published works as well as several archival sources, particularly the correspondence between Dorfman and Harold Hotelling.

The second section revisits the first phase of Dorfman's career (1938–1958), a period marked by his contributions to mathematical statistics and programming, without any indication that he would later engage with environmental economics. The third section focuses on Dorfman's work on water management (1959–1972). During this phase, he joined the Harvard Water Program, an interdisciplinary group within which he applied mathematical programming to the design of water-resource systems. This interdisciplinary orientation echoed Dorfman's earlier experience in the U.S. Army Air Forces during the 1940s. His interest in water management also led him to examine the problems of waterlogging and salinity in Pakistan, as part of an interdisciplinary team led by oceanographer Roger Revelle. The fourth section addresses Dorfman's work on environmental economics (1972–1997), which also marked the end of his career. During this phase, he moved beyond the specific case of water to address broader issues such as cost-benefit analysis, pesticide regulation, congestion, and the governance of common goods. The fifth section concludes.

2 Mathematical Statistics and Programming (1938–1958)

Robert Dorfman was born in New York in 1916. He earned a Bachelor of Arts in mathematical statistics in 1936 and a Master of Arts in economics in 1937 from Columbia University. He notably attended Harold Hotelling's classes, who at the time

taught mathematical economics through classical texts (Cournot, Dupuis...) and his own work (Gaspard and Missemmer [2022], p. 213)—including “The Economics of Exhaustible Resources” (1931).

The encounter with Hotelling had a profound impact on Dorfman. In a letter dated July 25, 1966,² written on the occasion of Hotelling’s retirement, Dorfman explained that he often introduced himself as a “student of Hotelling,” which often earned him enhanced respect from his peers. Dorfman also stated that he considered Hotelling an “unconventional but highly effective” teacher who inspired him in designing his own courses, particularly in mathematical economics (for more on Hotelling as a teacher, see Madow [1960]). In 1938, Dorfman published his first article in the *Biometrics Bulletin*, devoted to the δ -method in statistics—a method for determining the asymptotic distribution of a random variable.

From 1939 to 1943, he worked as a statistician for the federal government, a period during which he published his most cited article to this day, “The Detection of Defective Members of Large Populations” [1943], in *The Annals of Mathematical Statistics*. From 1943 to 1950, he served as an operations analyst for the U.S. Army Air Forces.³ During this period, he met George Dantzig, who became a central figure in linear programming in 1947 with his invention of the simplex algorithm (Dantzig [1990]). Dorfman later credited Dantzig with introducing him to linear programming during their years together in the U.S. Army Air Forces (Dorfman [1951], p. vii).

² I had access to the correspondence between Dorfman and Hotelling through Marion Gaspard, Antoine Missemmer, and Thomas Mueller, whom I thank warmly. Marion Gaspard and Antoine Missemmer digitized part of the Hotelling archives with a grant from ESHET as part of the project “Bifurcations in Natural Resource Economics.” The citation source for this letter is: “Hotelling Papers, Box #2, Folder ‘Miscellaneous D’, Rare Book and Manuscript Library, Columbia University. Digitised version by Marion Gaspard & Antoine Missemmer, June 2017.”

³ For more information on this part of his career, see Dorfman [1997] and Assaf [2022].

In a letter dated February 8, 1947,⁴ Dorfman sought Hotelling's support for a dissertation fellowship at the University of California, Berkeley. Much of the letter was devoted to comparing the teaching styles of two professors at Berkeley who had made a strong impression on him: Leo Rogin and William Fellner. Of the former, whom he described as "something of an economic philosopher," Dorfman wrote: "An economic theory or problem takes on an unexpected liveliness and richness in his hands, and its relevance to the day-by-day careers of society and social groups is illuminated." Of the latter, described as "an abstract theorist," Dorfman wrote: "[he is] blessed with as clean and clear a mind as any I have seen. He has the gift of cutting through the details to the heart of any theory he deals with" (*ibid.*). These qualities, which Dorfman admired in his professors, would later be frequently attributed to him.

In 1949, Dorfman participated in the "Zero Symposium" (Dantzig [2002], p. 45), the name given to the first conference devoted to linear programming (then commonly referred to as "activity analysis"), organized by Tjalling Koopmans and attended by Kenneth Arrow, Paul Samuelson, Oskar Morgenstern, Nicholas Georgescu-Roegen, among others.⁵

In 1950, he earned a PhD in economics from the University of California, Berkeley, for a dissertation entitled *Applications of Linear Programming to the Theory of the Firm*, which was published as a book the following year (Dorfman [1951]). That same year, he was appointed assistant professor at Berkeley. In 1955, he joined Harvard University, where he would remain for the rest of his career. His dissertation aimed to show how programming could assist economists in analyzing firms' production choices. It was therefore framed primarily as an expository contribution. In his review of the book published in the *Journal of the American Statistical Association*, Robert Solow described

⁴ The citation source for this second letter is: "Hotelling Papers, Box #29, Folder 'Dorfman, R.', Rare Book and Manuscript Library, Columbia University. Digitised version by Marion Gaspard & Antoine Missemer, June 2017."

⁵ This conference has been the subject of several studies in the history of economics, although Dorfman's participation has not been specifically highlighted (e.g., D  ppe and Weintraub [2014]).

it as a “little beauty of a book,” a “compact and readable introduction” and “a model of expository clarity” ([1952], p. 330). He added: “[The book] illustrates the new techniques [of programming] in application to the classical economics of the firm, and Dorfman eschews mathematical frills to keep the economics always to the fore. At the same time, the treatment is sufficiently rigorous.” In other words, from his very first book, Solow attributed to Dorfman the same qualities that Dorfman had admired in William Fellner. For his part, Erich Schneider praised in *Econometrica* this “clear and precise [...] excellent introduction” ([1954], p. 129). William Baumol added, in the *Journal of Political Economy*: “This book probably contains the most lucid and systematic presentation of the main programming techniques now available” ([1952], p. 459). Clarity was therefore a central theme in these reviews.

Reading these reviews, one might think that Dorfman succeeded in introducing programming—which only began to develop in earnest after 1947—to economists. However, it should be remembered that Solow, Schneider, and Baumol were themselves specialists in mathematical economics. In that context, the review published in the *American Economic Review* criticized Dorfman’s use of matrix notation, arguing that it was insufficiently explained for readers unfamiliar with linear algebra, implying “that this volume provides only part of a bridge to a nearby peninsula of linear programming, when more pages might have attempted to carry nonmathematicians to the shore of that strange land” (Smith [1953], p. 167).

Dorfman responded to this critique—without explicitly referencing the review—by publishing an article in the *American Economic Review* that year entitled “Mathematical, or ‘Linear,’ Programming: A Nonmathematical Exposition”, which began with the statement:

This paper is intended to set forth the leading ideas of mathematical programming purged of the algebraic apparatus which has impeded their general acceptance and appreciation ([1953], p. 797).

Accordingly, Dorfman reformulated the main algebraic results from his 1951 book using diagrams. It is worth noting that diagrammatic reformulations of algebraic results—or vice versa—were common in the 1950s (e.g., Giraud [2010]), and reflected the decade’s broader debates about the role of algebra in presenting economic results and in economics curricula (Weintraub [2002]; Blaug [2003]).⁶ Dorfman’s article was later praised for having “done much to familiarize readers of the *American Economic Review* with the usefulness and economic meaning of linear programming” (Thompson [1968], p. 485; see also Thomas Jr. and Revelle [1966], p. 299). It was also included as early as 1956 among the required readings for Wassily Leontief’s second-year economic theory course at Harvard University and, by 1957, in Carl Christ’s third-year econometrics course at the University of Chicago.⁷

Beyond clarifying the usefulness of programming for *American Economic Review* readers unfamiliar with mathematical economics, Dorfman also proposed a terminological clarification. In his view, the term “linear programming” could be misleading, since some problems associated with that label in fact relied on nonlinear relationships. Likewise, the expression “activity analysis,” commonly used in the 1950s, did not, in his opinion, adequately convey the types of problems being addressed. He suggested instead the term “mathematical programming,” hence his choice of the term in the title of his 1953 article. Dantzig ([2002], p. 46) credited Dorfman with having played a major role in popularizing this expression within operations research.

The 1950s were also marked by the publication of *Linear Programming and Economic Analysis* [1958], co-authored by Dorfman, Paul Samuelson, and Robert Solow. On the one hand, the book presents the tools and methods of mathematical programming. On the other hand, it identifies a range of economic problems that can be studied using

⁶ For an analysis of Dorfman’s position regarding these debates, see Gradoz [2025].

⁷ <https://www.irwincollier.com/chicago-econometrics-sequence-2-quarters-christ-1957/>
<https://www.irwincollier.com/harvard-second-year-graduate-economic-theory-leontief-1956-57/>

mathematical programming, comparing the advantages of this approach with those of marginal analysis. Finally, it highlights the connections between mathematical programming, game theory, and input-output analysis. The genesis of this book, supported by the RAND Corporation, has been discussed in several works in the history of economics (particularly Mirowski [2001]), so I focus here on its reception, and more specifically on the reviews published about it.⁸

As with Dorfman's first book, clarity of exposition is a recurring theme in these reviews. Richard Bellman, the inventor of dynamic programming, writes for example: "The writing is leisurely and lucid, and a model of what good scientific writing should be" ([1960], p. 939). Other reviews praise a work "distinguished by its clarity" (Dickson [1959], p. 116), with a "clarity of expression that will be useful to many readers" (J. S.⁹ [1958], p. 261; see also Johnston [1959], p. 84), in which the various parts are "always presented excellently" (G. D. [1966], p. 596), and some chapters are described as "marvels of simple, direct exposition" (Nerlove [1959], p. 85)—especially the appendix on the basics of linear algebra (Hutton [1958]; Dresch [1958]).

Some reviews suggested that the book's clarity of exposition might even be a more substantial contribution than those explicitly claimed by the book. For instance, when comparing game theory and input-output analysis, Dorfman, Samuelson, and Solow present both theories. Robert Hutton remarks that "the comparisons are interesting but the exposition of these theories in such lucid form is probably a more substantial contribution" ([1958], p. 773). Most reviewers offered high praise: "The authors give us by far the best general discussion of these subjects that has appeared anywhere" (Waugh [1958], p. 99); "applying the criteria of rigour, clarity, and interest, I consider the central six chapters to be one of the finest pieces of writing of its kind I have seen in economics" (Peston [1960], p. 74); and "in virtue of its breadth of scope, unity of

⁸ For a discussion of the use of book reviews in the history of economics as a means of studying a work's reception, see Gradoz and Medema [2025].

⁹ The author of this review is identified only by initials. This is also the case for two other reviews cited in this article.

method and understandability this book seems likely to become a landmark in modern economic theory” (Henderson [1958], p. 233). The *Econometrica* review borders on flattery when it states:

Every chapter of the book bears the unmistakable mark of experienced teachers, shunning no effort to explain what is done and why it is done. If a point does not become clear to the reader, he feels in most cases that it is he himself who has not done *his* part of the job. The authors certainly do not conclude any topic, even those that may seem most obvious and tedious from their own point of view, before nearly every explanation and hint, which might possibly be helpful to the reader, is given (Johansen [1960], p. 718)¹⁰.

Although the exact division of labor is unclear, it is reasonable to assume that Dorfman wrote the chapters on the applications of mathematical programming to the theory of the firm. Marc Nerlove judged these to be the “best chapters” and remarked that “it is here that the value of linear programming to the teaching of economics is spelled out most clearly” ([1959], p. 86). Therefore, amid a flood of praise for the book’s clarity, it is Dorfman’s chapters that are singled out in this respect.

In addition to his work on mathematical statistics and programming, Dorfman also authored a seminal article on non-price competition (Dorfman and Steiner [1954]), in which he derived with Peter Steiner a condition for optimal advertising investment by firms (for more on this article, see Gradoz [2025]); reviews of major works on mathematical programming; and several applied studies on the population over 65 in the United States (Dorfman [1954a]; Steiner and Dorfman [1957]).

Therefore, between 1938 and 1958—that is, between the publication of his first article and the publication of his book co-authored with Samuelson and Solow, which also marked the period in which he published several of his most influential works—there

¹⁰ In a similar spirit, Harald Dickson writes “the book vividly demonstrates the authors’ teaching abilities and their deep theoretical mastery” ([1959], p. 118). Dorfman used this book as a textbook for his course on general equilibrium theory at Harvard University (McDonald [2009], p. 164).

was no indication at the time that Dorfman would later engage with environmental economics. At this stage of his career, he was primarily recognized as a central figure in mathematical economics—a figure celebrated for his clarity, which many of his colleagues believed facilitated the dissemination of mathematical programming among economists. In this regard, Dorfman followed in the footsteps of his former professor William Fellner, the “abstract theorist” whose clarity and lucidity Dorfman had praised in a letter to Hotelling.

His career would later take a turn, leading him also to follow in the footsteps of his other professor, Leo Rogin, whose ability to highlight the relevance of economic theories and problems to the day-by-day careers of society and social groups he had admired. Dorfman would first shift his focus to water management before taking an interest more broadly in environmental economics.

3 Water Management (1959–1972)

In June 1959, Dorfman participated in a conference on the economics of watersheds, held in Knoxville, alongside agricultural economists, engineers, geologists and agronomists. In the conference proceedings, published in 1961, Dorfman’s chapter is the second and final entry in the section devoted to the “mathematical analysis” of this subject. The first chapter was written by Earl Orel Heady, who had introduced the principles of mathematical programming to agricultural economists (Heady [1954]) and who would later work on capital theory (Heady [1961a]). In his chapter, Heady emphasized:

In mathematical terms, a programming model can be formulated to consider most settings within which watersheds might be analyzed. As mentioned previously, the physical restraints within the watershed can be taken as fixed, while the capital required for development can be considered as variable. Using a criterion such as the plan which will maximize discounted net revenue (i.e.,

benefits), we could analyze the amount or scale of investment which is optimum and how this capital should be allocated between alternatives such as dams, channel improvement, farm-land treatment, forestry, or conventional farm investments (Heady [1961b], p. 207).

Heady therefore draws a direct connection between mathematical programming, capital theory, and natural resources management, here approached through watersheds. A similar connection can be found in Dorfman's work. Dorfman, Samuelson, and Solow highlight in their 1958 book the "vital connections" between capital theory and dynamic mathematical programming, and argue that the latter is essential for advancing capital theory, which they describe as "the most difficult field of modern economic theory" ([1958], p. viii). In 1959, Dorfman published two articles on capital theory [1959a, 1959b], and in one of them, he introduces what he calls "the 'bathtub theorem' in honor of the hydraulic engineers, who use it all the time" ([1959b], p. 353).¹¹ This theorem is used to "establish the relation between Bohm-Bawerk's period of production and the quantity of capital in an economy" (*ibid.*). In this context, even if the link between mathematical programming, capital theory, and water management is less direct in Dorfman's case than in Heady's, it is nonetheless present, making it possible to connect his various works from the late 1950s and early 1960s.¹²

In the 1959 conference proceedings, Dorfman applied mathematical programming to a simplified example: the construction of water reservoirs along the "Simple River." The goal was to determine the number, location, and capacity of the reservoirs. His

¹¹ "It asserts: in any reservoir of constant content, so that the rate of inflow equals the rate of outflow, the average period of detention equals the content of the reservoir divided by the rate of flow" (*ibid.*).

¹² It is also worth noting that at the Allied Social Sciences Associations conference held in St. Louis in December 1960 (which included the American Economic Association and the Econometric Society), Dorfman chaired the "Capital Theory" session in which Otto Eckstein and John Kendrick presented. Otto Eckstein had been working on water management issues since the late 1950s (Eckstein [1958]; Krutilla and Eckstein [1958]) and had contributed to *Economic Activity Analysis* (Morgenstern [1954]), which Dorfman reviewed (Dorfman [1955]). Dorfman also presented a paper entitled "Water and Welfare" in the "Regions and Resources" session, alongside Werner Hirsch and John Krutilla, the latter being a major figure in environmental economics.

chapter is entirely devoted to finding the numerical solution to this simplified example, which he intended as a demonstration of the practical value of mathematical programming in tackling *design problems*—here, the installation of water reservoirs along a river. Compared to his earlier work, Dorfman therefore shifts both the intended audience and the field of application, moving from the theory of the firm to design problems related to water management. However, his contributions remain primarily expository, intended to familiarize a specific audience with mathematical programming.

How did Dorfman come to work on water reservoirs at this point in his career? To understand this, it is worth noting that he presents the chapter as “a very preliminary pilot study of a method of analysis that the Harvard Water Resources Program is considering” (Dorfman [1961], p. 217).

The Harvard Water Program—or Harvard Water Resources Program—was founded in 1955, the same year Dorfman joined Harvard’s Department of Economics, at a time when he believed that “applied economics enjoyed more attention and prestige than it received at Berkeley” (Dorfman [1997a], p. xviii). This move therefore encouraged more applied research, in line with his earlier work on the elderly population in the United States.

Dorfman joined the Harvard Water Program in its second year (*ibid.*). The program primarily consisted of seminars and training sessions, and aimed at “investigating ways to improve the planning and design of multiunit, multipurpose water resource systems” (Martin [2003], p. 357). It brought together economists, engineers (notably in sanitation), and political scientists, and their collective work culminated a few years later in the publication of a book entitled *Design of Water-Resource Systems* (Maass *et al.* [1962]).¹³ The chapters in this book were written by members of the program, though the introduction emphasizes the collective nature of the thinking behind each chapter.

¹³ At the same time, Allen Victor Kneese—a leading figure in environmental economics—was also working on water management (Nishibayashi [2019]).

Among the participants in the program was Peter Steiner, Dorfman's long-time collaborator during his years at the University of California, Berkeley.¹⁴ The introduction to the book states:

One of the principal aims of the Harvard Water Program has been to improve the methodology of system design by joining engineering and economics more effectively than has been done in the past (Maass *et al.* [1962], p. 4).

This project was therefore fundamentally interdisciplinary (Banzhaf [2023]). Such collaboration between engineers and economists was not new to Dorfman, having been central to operations research in which he had been immersed during his years with the U.S. Army Air Forces (Dorfman [1960]).¹⁵ In the 1962 book, Dorfman authored a first chapter entitled “Basic Economic and Technologic Concepts: A General Statement.” This chapter aimed to introduce non-economist readers to the economic dimensions of water-resource systems. Dorfman began with a general presentation of production theory, then discussed specific issues related to water management—for example, the stochastic nature of available water reserves. He also addressed constrained maximization of the production function, the intertemporal dimension of water management, and various economic criteria for evaluating production plans (such as the “maximin-returns principle” and the “minimax-risk principle”). In this chapter, Dorfman drew on his renowned pedagogical clarity—clarity that had already helped disseminate mathematical programming among economists—for the benefit of readers unfamiliar with economics. A review of the book noted that “Dorfman’s chapter is an excellent introduction to production functions for engineers. It is particularly lucid on the treatment of uncertainty” (Foster [1964], p. 203). Another

¹⁴ In 1959, Steiner published an article in the *American Economic Review* titled “Choosing among Alternative Public Investments in the Water Resource Field,” in which he thanked several members of the Harvard Water Program, including Dorfman. The article applied mathematical programming to analyze how a public decision-maker might choose among multiple water-related projects (Steiner [1959]).

¹⁵ For more on the history of relationships between economists and engineers, see the *History of Political Economy* special issue on the topic (Duarte and Giraud [2020]).

praised it for helping “to clarify the objectives of economic analysis which have been somewhat obscured by both misunderstanding and political efforts in the past” (Linsley [1963], p. 39). Clarity therefore remained a quality associated with Dorfman’s writings during this second phase of his career. He also contributed a second chapter, entitled “Mathematical Models: The Multistrukture Approach,” focused on the use of mathematical programming in the design of water-resource systems—a direct continuation of his 1961 pilot study.

As Spencer Banzhaf emphasizes, one of the book’s important contributions was to highlight the importance, in design decision-making, of acknowledging the existence of multiple, incommensurable, and possibly contradictory objectives—“which included inter-household equity in the distribution of income, regional development, and other contributions to social welfare, such as the saving of human life from floods” (Banzhaf [2023], p. 174). This position amounted to a critique of traditional cost-benefit analysis—a critique that Dorfman would further develop in the 1970s (cf. *infra*). Hence, some scholars later linked the book to a “new interdisciplinary philosophy of problem solving” (Harrington et al. [2005]). The Harvard Water Program also played a crucial role in the creation of the journal *Water Resources Research* (Harrington et al. [2005]), whose inaugural article was written by Kenneth Arrow (Arrow [1965]). In the journal’s third issue, Dorfman [1965a] contributed an article entitled “Formal Models in the Design of Water Resource Systems,” in which he emphasized the need for engineers and economists to work together on water management problems.

In parallel, several members of the Harvard Water Program joined the White House Panel on the Problem of Waterlogging and Salinity in Pakistan. In 1961, during a state visit by Pakistani President Muhammad Ayub Khan, the issues of waterlogging and soil salinization were discussed with U.S. President John F. Kennedy. These problems had led to the abandonment of large areas of land in Pakistan, placing increasing pressure on the country’s ability to feed its population (Wiesner [1997], p. 2). Kennedy

proposed sending a team of experts to Pakistan to study these issues.¹⁶ The renowned oceanographer Roger Revelle was tasked with assembling and leading it. Dorfman accepted the invitation to join this interdisciplinary team, resulting in a trip to Pakistan in 1961. In 1964, the group published the *Report on Land and Water Development in the Indus Plain* (sometimes referred to as the “Revelle Report,” Indus being Pakistan’s principal river), and its findings were reflected in several of Dorfman’s publications at the time (Dorfman [1963]; Dorfman, Revelle, and Thomas [1965]). Dorfman’s expertise in the design of water-resource systems proved especially valuable to the group, as:

West Pakistan is an arid country, and its arable acreage is supported almost entirely by a system of irrigation canals, far and away the world’s largest (Dorfman [1963], p. 221).

This irrigation system posed several problems at the time, including water evaporation and seepage losses during transport—issues directly linked to waterlogging and soil salinization. Dorfman responded by proposing solutions inspired by the Harvard Water Program, some of them contained in the 1962 book. In 1970, following a similar logic, he constructed a model for designing water-resource systems in the Mekong basin (Sadove [1970], p. 165).

Finally, in 1972, Dorfman co-edited a book with Henry Jacoby (an economist whose dissertation he had supervised) and Harold Thomas Jr. (a sanitation engineer) entitled *Models for Managing Regional Water Quality*. The volume includes nine chapters, based on the premise that water quality management necessarily involves both technical and political considerations, and seeks to explore how such considerations can be combined in modeling the decisions of institutions responsible for this issue. Dorfman contributed a chapter entitled “Conceptual Model of a Regional Water Quality Authority,” which aimed precisely to develop such a model. This chapter—and indeed

¹⁶ Jerome Wiesner, who was Kennedy’s Science Advisor, believed that the proposal to send this group to Pakistan—a proposal Khan could hardly refuse—was a way to preempt any request from him for weapons deliveries, in the context of an arms race with India (Wiesner [1997], p. 2).

the book as a whole—can be seen as a response to the Water Quality Act of 1965 and the establishment of the U.S. Environmental Protection Agency in 1970, both of which brought water quality issues to the forefront. In his intellectual autobiography, Dorfman ([1997a], p. xix) acknowledged that the book was less successful than the 1962 volume, mainly due to its lesser originality. This lower impact is reflected in the limited number of reviews published on the book. This relative lack of success marked the end of Dorfman’s work specifically focused on water issues.

4 Environmental Economics (1972–1997)

Dorfman’s work on water management already belongs, in a sense, to the field of environmental economics. However, starting in 1972, he moved beyond the specific case of water to engage in broader reflections on cost-benefit analysis (Dorfman [1977b]), pesticide regulation (Dorfman [1982]), congestion (Dorfman [1984]), and the management of common goods (Dorfman [1997b]). This work notably led him to chair the National Research Council’s Committee on Prototype Analysis of Pesticides in 1978 and to serve as vice president of the Association of Environmental and Resource Economists in 1981. At the outset of this final phase, Dorfman was fifty-seven years old. He became professor emeritus in 1977, retired in 1987, and served as editor of the *Quarterly Journal of Economics* from 1976 to 1984. He published fewer notable contributions and acknowledged in his intellectual autobiography that many of his writings from this period were received with “apathy” (Dorfman [1997a], p. xxviii).

In this context, we will focus on two of the most significant contributions from this final phase of Dorfman’s career: the anthology of texts on environmental economics he co-edited, and his critique of cost-benefit analysis as it is applied to environmental issues.

In 1972, he co-edited with his wife Nancy Dorfman one of the first anthologies of texts on environmental economics. The anthology was presented as a response to the

growing concerns at the time about the depletion of natural resources and environmental degradation. They described the role of the economist in addressing these concerns as follows:

Economists have a double concern in the matter: that the viability and healthfulness of the environment be preserved, and that the measures taken to protect the environment be effective and not reduce the flow of ordinary useful goods and services any more than is necessary. This second concern is the economist's special province, and for that reason his adrenalin begins to flow when he hears some of the more alarmist proposals for meeting the "environmental crisis." Is there really an environmental crisis, or only a problem that we can deal with soberly? Is the environmental problem so severe that the growth in the output of goods and services must be brought to a halt while millions in this country and hundreds of millions throughout the world still live in poverty? Irrespective of how severe the problem is, how can we best maintain the flow of ordinary real income without abusing the environment? (Dorfman and Dorfman [1972], p. xi).

Economists are seen as a bulwark against environmental alarmism and as those best positioned to study the trade-offs involved in allocating scarce resources—a standard conception of the economist's role in environmental issues at the time.¹⁷ A review of the anthology noted that "in the introduction, the two editors present the economic problem of environmental protection with conceptual clarity and elegant exposition" (A. Ca. [1975], p. 190). Another added: "Dorfman and Dorfman also set the tone of the book in the matters of style and use of mathematics. They and almost every one of their authors write clearly and use only simple algebraic and graphical tools. No need to be a Ph.D. mathematician to follow these materials" (Russell [1978], p. 485). Clarity remained a consistent hallmark of Dorfman's writing throughout his career.

¹⁷ For a broader perspective on environmental economics during this period, see Berta, Debref, and Vivien [2021].

Many of the texts included in the anthology reflect Dorfman's research interests and academic network. Alongside classic articles such as "The Problem of Social Cost" (Coase [1960]) and "The Economic Theory of a Common-Property Resource: The Fishery" (Gordon [1954]), we also find "Environmental Repercussions and the Economic Structure: An Input-Output Approach" (Leontief [1970]), which draws a direct link between themes from the early part of Dorfman's career and environmental economics. Leontief, a colleague at Harvard University, was the subject of several tributes written by Dorfman (Dorfman [1954b]; [1973]; [1995]).¹⁸ The anthology also features "The Animal Farm: A Mathematical Model for the Discussion of Social Standards for Control of the Environment" (Thomas Jr. [1963]), an article cited fewer than 45 times since publication according to Google Scholar (July 2025), but authored by one of Dorfman's coauthors and colleagues in the Harvard Water Program. Another relatively obscure article, though notable for its connection to Dorfman's network, is "Externalities, Information and Alternative Collective Action" (Davis and Kamien [1969]), published in *The Analysis and Evaluation of Public Expenditures: The PPB System*, a government report to which Dorfman also contributed (Dorfman and Jacoby [1969]).

In the second edition of the book, published in 1977, "The Economics of Resources or the Resources of Economics" (Solow [1974]), written in the interim, was added — Solow having co-authored a book with Dorfman two decades earlier. "Criteria for Social Investment" (Arrow [1965]), the first article published in *Water Resources Research*, a journal whose creation was related to the Harvard Water Program, was also included. In the preface to the second edition, the Dorfman's noted that the four years separating the two editions were marked by the publication of *The Limits to Growth* (Meadows et al. [1972]) and the first oil shock, which led them to include more texts on natural resources depletion and global environmental analysis (Dorfman and Dorfman [1977], p. ix).

¹⁸ For more on the career of Leontief, particularly the development of input-output analysis, see Akhabbar [2019].

In the third edition, published in 1993, two texts by Robert Dorfman were included, along with two by Robert Solow. Thomas Schelling—Leontief’s former doctoral student—also appeared in this edition with two contributions. The Dorfman explained that this edition placed even greater emphasis on the “global environment,” particularly through the lens of climate change and the emergence of pollution rights markets. Starting with the fourth edition, Robert Stavins [2000], also a member of Harvard University’s Department of Economics, took over from the Dorfman. While they are warmly thanked in the introduction, their influence had largely disappeared by the fourth edition: the selected texts were entirely different, and Robert Dorfman’s writings were no longer included. The seventh edition of the book was published in 2019, still under Stavins’s editorship.

The second major contribution made by Dorfman during this period was his critique of cost-benefit analysis, which he formulated in several works [1977a, 1977b, 1978, 1996]. In a book he edited in 1965, he noted that cost-benefit analysis had been popularized some thirty years earlier and had mainly been used in the context of water management projects (Dorfman [1965b], p. 2). This referred, implicitly, to the Flood Control Act of 1936, which established the use of this approach for evaluating and comparing government projects aimed at limiting flood-related damage (Banzhaf [2023], p. 270). Given his prior experience in water-resource systems, Dorfman was well aware of both the strengths and limitations of this approach. As cost-benefit analysis began to be used more frequently in the 1970s to assess various environmental issues (air pollution, pesticide effects...), Dorfman felt it was necessary to highlight its limitations to a broader audience. In an article entitled “Why Benefit-Cost Analysis is Widely Disregarded and What to Do About It,” he wrote:

Three prominent shortcomings of benefit-cost analysis as currently practiced are (1) it does not identify the population segments whom the proposed measure benefits or harms, (2) it attempts to reduce all comparisons to a single

dimension, generally dollars and cents, and (3) it conceals the degree of inaccuracy or uncertainty in its estimates (Dorfman [1996], p. 1).

The first shortcoming refers to the fact that this approach aggregates costs and benefits without accounting for the possibility that certain groups might be harmed by a project—even if the project benefits the majority. One could even imagine situations in which all the costs are borne by a specific group, while all the benefits accrue to others, potentially generating social conflict. This raises the issue of the project’s political feasibility, which cost-benefit analysis tends to overlook. Yet, as Dorfman pointed out, even the most rigorous cost-benefit analysis may prove irrelevant to a policymaker aware of the project’s political infeasibility—ultimately rendering the effort futile. For this reason, he argued for the adoption of a “multiple-objective” framework (Dorfman [1996], p. 5), one that explicitly incorporates considerations of political feasibility. This is incompatible with traditional cost-benefit analysis (Banzhaf [2023]), which relies on a single monetary metric—identified by Dorfman as the second major shortcoming. The third shortcoming involves two elements. First, certain things—particularly in environmental contexts—are difficult to assign monetary values to. Dorfman gave the example of evaluating the benefits of reducing respiratory illnesses through decreased nitrous oxide concentrations in the air. Second, because costs and benefits unfold over time, future costs and benefits must be included in the project evaluation, which introduces uncertainty. Another major source of uncertainty, according to Dorfman, lies in the behavioral responses of economic agents to the implementation of a project. He gave the example of the development of new (potentially more harmful) pesticides in response to the banning of existing ones—an outcome he saw as largely unpredictable.

It is worth noting that the shortcomings identified by Dorfman, and his broader critique of cost-benefit analysis, were relatively standard at the time. Dorfman’s contribution in this area stemmed from the authority many people attributed to him due to his earlier work on water management, which gave weight to his critique.

Moreover, on several occasions, he expressed these criticisms in texts not primarily aimed at economists (e.g., Dorfman [1985]), thereby helping to disseminate critiques of cost-benefit analysis to a broader audience.

5 Conclusion

Robert Dorfman's career exemplifies that of a transmitter of knowledge. In the 1940s, he witnessed the invention of the simplex algorithm by his friend George Dantzig—an event that marked the rise of mathematical programming. He then devoted the 1950s to convincing economists of the value of this method. His work was widely praised by colleagues for its clarity—a quality they believed played a decisive role in the dissemination of mathematical programming among economists during that decade.

In the late 1950s, having identified the connections between mathematical programming, capital theory, and natural resources management—and becoming involved in several interdisciplinary groups—Dorfman dedicated his research to demonstrating the usefulness of economic reasoning and mathematical programming in the design of water-resource systems. Once again, the clarity of his explanations was praised by his colleagues, this time facilitating interdisciplinary collaboration within the Harvard Water Program.

Finally, after more than a decade of exposure to cost-benefit analysis applied to water management, Dorfman devoted his final years to exposing its limitations, addressing both environmental economists and policymakers. He also co-edited, with Nancy Dorfman, one of the earliest anthologies on environmental economics, in which debates over cost-benefit analysis played a central role.

Dorfman therefore appears as an economist whose main contributions do not lie in specific theoretical results, but rather in his exceptional expository talent—and whose position at the intersection of different scholarly communities facilitated the transfer of numerous techniques and forms of knowledge throughout his career.

It is relatively rare for clarity of exposition to be recognized as the principal strength of an economist. In this sense, revisiting Dorfman's career allows us to highlight an exemplary figure through the lens of a theme that is only occasionally discussed in the literatures on the rhetoric and pedagogy of economics. While the literature on the rhetoric of economics has often focused on problems of clarity—for example, when Deirdre McCloskey [1985] explained the poor reception of John Muth's [1961] article on rational expectations as due to its cryptic writing—it is far less common to find analyses centered on the exceptional clarity of certain works.

Likewise, the literature on the pedagogy of economics pays significant attention to the clarity of explanations found in textbooks (see, for instance, the debate between David Colander [2016] and Gregory Mankiw [2016] in the *Eastern Economic Journal*), but much less to the clarity of academic articles used as pedagogical tools—which were the case for many of Dorfman's works. In this respect, revisiting Dorfman's trajectory offers a starting point for deepening historiographical reflection on the role of clarity in the reception and transmission of economic knowledge.

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