## DECLARATION OF KENNETH J. ARROW

## I. QUALIFICATIONS AND INTRODUCTION

A. I, Kenneth J. Arrow, am the Joan Kenney Professor of Economics and Professor of Operations Research at Stanford University. I received the degrees of B.S. in Social Science from The City College in 1940, M.A. in mathematics from Columbia University in 1941, and Ph.D. in economics from Columbia University in 1951. I have taught economics, statistics, and operations research at the University of Chicago, Harvard University, and Stanford University, and I have written more than 200 books and articles in economics and operations research. I am the recipient of numerous awards and degrees, including the Nobel Memorial Prize in Economic Science (1972). A significant part of my writing and research has been in the area of economic theory, including the economics of innovation and its relation to industrial organization. My curriculum vitae is attached.

B. I had been asked by the Antitrust Division to consult with them on the possible courses of action with regard to Microsoft Corporation, before the filing of the proposed Consent Decree. I have now been asked by them to comment on the Memorandum of Amici Curiae against the proposed final judgment offered by Gary L. Reback and others.

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## II. THE ECONOMIC RATIONALE FOR THE GOVERNMENT'S COMPLAINT

### A. The Elimination of Artifical Barriers to Entry

The Government's complaint against and settlement with Microsoft will eliminate artificial barriers that Microsoft had erected to prevent or slow the entry of competing suppliers of operating system software products for IBM-compatible PCs. The complaint addressed certain practices associated with Microsoft's MS-DOS and Windows operating system software products and the successors to those products (specifically, the product code-named Chicago to be released as Windows 95).

Microsoft erected artificial barriers to the entry and growth of competing operating system vendors through its contractual relations with original equipment manufacturers of IBM-compatible PCs (OEMs). These practices included the following: (i) contract terms that required OEMs to pay Microsoft based on the number of computers shipped whether or not those computers had a Microsoft operating system preloaded (the "per-processor" contract); (ii) unnecessarily long terms for the contracts with OEMs for the use of Microsoft's operating system software products; and (iii) large minimum purchase obligations for OEMs ("minimum commitments").

Microsoft's contractual relations with OEMs had created strong economic incentives for OEMs to deal exclusively with Microsoft. OEMs with a per-processor contract were obligated to pay Microsoft a royalty fee for every computer they sold with a specified type of microprocessor (e.g., the Intel 486). The royalty had to be paid even if the OEM elected to load an operating system on the machine from a different vendor. As a consequence, OEMs who did elect to load competing operating system software products had to pay a double royalty - one to the supplier of the software actually used and a second royalty to Microsoft.

The per-processor incentives for exclusive purchases from Microsoft made it more difficult for suppliers of competing operating systems to find willing outlets for their products in the important OEM distribution channel. This barrier was compounded by Microsoft's long contract terms and by the inclusion of large minimum commitment obligations in the OEM contracts. The long contract terms, along with the exclusivity incentives of the per-processor contract, made it difficult for OEMs to switch to an alternative supplier of operating system software products. OEMs with a per-processor contract had a large financial incentive to deal exclusively with Microsoft for the duration of the contract.

Large minimum commitments had an economic effect similar to that of the per-processor contract. An OEM with a minimum commitment has a "take-or-pay" obligation for the amount of the minimum commitment. As in the per-processor contract, this obligation can force an OEM into a situation where purchasing from a competing supplier of operating system software products would require the OEM to pay a double royalty. For example, suppose the OEM had planned to sell 100,000 computers and agreed to a minimum commitment with Microsoft for 100,000 units of MS-DOS. The OEM would face a financial penalty if it purchased operating system software from another supplier and if, as a consequence, the OEM's purchases from Microsoft fell below the minimum commitment of 100,000 units. In that event, the OEM would have to pay royalties to both Microsoft and the alternative supplier for each unit that the OEM buys from the alternative buyer.

B. Opening Access to the OEM Distribution Channel

A new competitor has to overcome the natural barriers to entry that exist in many markets and especially the software markets. The Department of Justice's complaint against Microsoft and the resulting settlement eliminated unnecessary and artificial obstacles erected by Microsoft to disadvantage future competition.

This action will not eliminate natural advantages enjoyed by Microsoft which result from its own innovative activity and the commercial success of the IBM-compatible PC platform.

Despite the importance of natural advantages (see section III below) in the market for IBM-compatible PCs, the complaint and proposed remedies addressed competitive issues that are critical to the success of new competition in this market. The most effective and economic point of entry for sales of IBM-compatible PC operating systems is the OEM distribution channel. New operating system software products should have unimpeded access to this channel. The Government's complaint and proposed settlement provide needed relief to facilitate the entry of new competitors, such as IBM's OS/2.

## III. INCREASING RETURNS AND BARRIERS TO ENTRY

### A. The Presence of Increasing Returns and Barriers to Entry

The analysis of the Department of Justice and the *amici curiae* brief agree that the software market is peculiarly characterized by increasing returns to scale and therefore natural barriers to entry. Large-scale operation is low-cost operation and also conveys advantages to the buyer. Virtually all the costs of

production are in the design of the software and therefore independent of the amount sold, so that marginal costs are virtually zero. There are also fixed costs in the need to risk large amounts of capital and the costs associated with developng a reputation as a quality supplier. Further, there are network externalities, in particular, the importance of an established product with a large installed base and the related advantage of a product that is compatible with complementary applications.

Installed base generally refers to the number of active users of a particular software product. A software product with a large installed base has several advantages relative to a new entrant. Consumers know that such a product is likely to be supported by the vendor with upgrades and service. Users of a product with a large installed base are more likely to find that their products are compatible with other products. They are more likely to be able successfully to exchange work products with their peers, because a large installed base makes it more likely that their peers will use the same product or compatible products. Installed base is particularly important to the economic success of an operating system software product. The value of the operating system is in its capability to run application software. The larger the installed base of a particular operating system, the more likely it is that independent software vendors will write programs that run on

that operating system, and, in this circular fashion, the more valuable the operating system will be to consumers.

The large installed base of IBM-compatible PCs that use Microsoft's operating system software reflects Microsoft's dominance of that market and undoubtedly contributes to its competitive advantage over competing operating system vendors. One important question is the theoretical analysis of the consequences of this advantage in a world of increasing returns. In particular, it is necessary to ask to what extent, if any, would government policy to interfere with natural advantages of scale lead to an improvement from the viewpoint of the consumers. A second question is the extent to which the anticompetitive behavior complained of has in fact contributed to Microsoft's dominance.

B. First-Mover Advantage and Increasing Returns

On pages 36ff. of the *amici curiae* brief, there is a penetrating discussion of the role of increasing returns in altering conclusions based on competitive markets with constant returns. I have little disagreement with the bulk of the statements made but do not agree with the implications for policy that the writers of the brief draw.

It is correct that under strongly increasing returns, the tendency of the market is towards monopoly. The brief does not, to be sure, allow very much for the theoretically and empirically very well-known possibility of imperfect competition. Economies of scale need not lead to a single producer, though they do lead to market power for the producers.

However, there is undoubtedly the possibility of monopolization, and it is certainly possible that the monopolization is inefficient. But notice that most of the steps in the dynamic process leading to monopoly or imperfect competition are steps in which the growth of the monopoly arises by offering a cheaper or superior product. As indeed the brief emphasizes, the process is entirely natural in the market. On what basis can a government intervene to insure a better outcome?

If monopolization is inevitable, as the *amici*'s argument, implies, then the outcome can only be criticized on the basis that the wrong monopolist survived. We are dealing with a complex system in which the outcome is not easily predictable. Indeed, predictions in the whole modern history of the information business have been very poor. AT&T did not realize the consequences to it of the development of the transistor, which eventually destroyed its monopoly. IBM was hesitant about

entering the electronic computer industry altogether and failed to understand the potential of PCs; otherwise, it would have made a very different contract with Microsoft. Xerox developed the basic ideas which developed into Apple and took no economic advantage of them. This unpredictability is precisely what would be expected of a complex self-organizing dynamic system. But it also means that the government is not in a position to predict either, and interference to pick the winner of this dynamic process is likely to be counterproductive.

The *amici curiae* brief notes that, "once a market is 'tipped' in favor of a particular competitor, it would take *truly massive* forces to return the market to a state of equilibrium (i.e., competition)" (p. 40; italics added). There are two remarks to be made here. (1) Clearly, competition is not a state of equilibrium or at any rate not of stable equilibrium, as a preceding quotation on the same page makes clear. (2) "Truly massive" forces are very likely to impose their own truly massive costs, which have to be weighed against the gain from competition, which, under increasing returns, is sure to be inefficient, or from "tipping" the equilibrium in the right direction, which is usually unknowable.

To be more concrete, in this situation, any set of remedies is likely to be of the form of penalizing whatever firm happens to be

leading, Microsoft in this instance. This may take the form of disintegrating the firm horizontally or vertically or of imposing constraints on its ability to enter certain markets. A rule of penalizing market successes that are not the result of anticompetitive practices will, among other consequences, have the effect of taxing technological improvements and is unlikely to improve welfare in the long run.

This is not to deny that a firm with a large installed base or other realization of scale economies may sometimes be in a position to impose artificial barriers, and these should be regulated or prohibited, as the present proposed Final Judgment already does. But interfering with purely natural barriers to entry can be dangerous to the economy's welfare.

The *amici curiae* brief does in fact a good job of presenting possible arguments for not going further in trying to break up a natural monopoly (pp. 74-83): inevitability of monopoly, entry by alliances, Microsoft's own self-interest in competition in applications software, and the efficiencies of integration. The brief attempts to refute these, but in my judgment makes only small critical points.

C. Anticompetitive Conduct and the Present Installed Base

The brief makes much of the fact that Microsoft's installed base has increased in five years from about 18 million units to 100 million or more. It ascribes this growth to anticompetitive behavior. It seems to conclude that even though, given the installed base, there might be large real costs in effecting changes, they should be made anyway, since the installed base was itself the result of anticompetitive actions.

This conclusion appears flawed for a number of reasons. Clearly, the six-fold growth in the installed base is primarily the result of the extraordinary commercial success of the IBM-compatible PC platform, in which MIcrosoft's product development and marketing played a part. In such a situation of rapid growth, the previous installed base should have provided a relatively weak constraint on entry. For the most part, Microsoft appears to have achieved its dominant position in its market as a consequence of good fortune and possibly superior product and business acumen.

It appears that the effect of Microsoft's OEM licensing practices on its installed base is far less than claimed in the *amici* brief. Microsoft's anticompetitive licensing practices, although a significant impediment to the use of the OEM distribution channel

by competing operating system suppliers, made only a minor contribution to the growth of Microsoft's installed base. Even this minor contribution overstates the economic impact of Microsoft's licensing practices on its installed base barrier to the entry and growth of competing operating systems.

Microsoft first instituted its per-processor licensing arrangement in 1988. However, this contract did not affect enough of the OEM channel to foreclose competition until FY 1992, when 50% of all OEM sales of MS-DOS were sold pursuant to per-processor licenses. The corresponding number was 20% in FY 1989, 22% in FY 1989, and 27% in FY 1991.

The data on the fraction of the OEM channel affected by Microsoft's anticompetitive licensing practices lead to the inescapable conclusion that the per-processor contract did not have a material impact on the installed base of Microsoft operating system software. The complaint and proposed Final Judgment address the effects of Microsoft's licensing practices on *future* sales of competing operating systems.

In any case, increased sales of DR-DOS would not have significantly affected Microsoft's installed base advantage. DR-DOS was marketed as an operating system software product that was

fully compatible with MS-DOS. Because DR-DOS supported the same application program interfaces as did MS-DOS, application program developers would have continued to write for MS-DOS (or Windows) even if DR-DOS sales had been much larger.

D. The Transience of First-Mover Advantage and the Importance of Open Markets

The history of market shares in PC application software has been marked by great volatility. Although first-mover advantages and increasing returns are important, there are many examples to show that such advantages are far from permanent. As examples, consider the fates of Wordstar, Apple Computer, and IBM itself. All were once dominant in critical PC-related product markets; yet each has experienced rapid loss of market shares.

Noting this transience is not a justification for complacency. On the contrary, it requires effort to maintain the openness of markets, so that new technologies can have an opportunity to enter and show their value relative to older ones.

Accordingly, the proposed settlement appropriately addresses and remedies the anticompetitive effects of the practices challenged in the complaint.

I declare under penalty of perjury under the laws of the United States that the forgoing is true and correct.

Executed on the 17th of January 1995.

Kenneth J. Arrow

March 1992

# BIOGRAPHICAL SKETCH

## KENNETH J. ARROW

### Personal

Born: 23 August, 1921
Wife's name: Selma
Children: David Michael and Andrew Seth

### Education

B.S. in Social Science, City College, New York, 1940. Major: Mathematics.
M.A., Columbia University, 1941. Field: Mathematics.
Ph.D., Columbia University, 1951. Field: Economics.

### Positions

Captain, U. S. Army Air Corps, 1942-46 (Weather Officer).
Research Associate, Cowles Commision for Research in Economics, 1947-49.
Assistant Professor of Economics, University of Chicago, 1948-49.
Consultant, the RAND Corporation, 1948-date.
Acting Assistant Professor of Economics and Statistics, Stanford University, 1949-50.
Associate Professor of Economics and Statistics, Stanford University, 1950-53.
Executive Head, Department of Economics, Stanford University, 1953-56.
Professor of Economics, Statistics, and Operations Research, Stanford University, 1953-68
Economist, Council of Economic Advisers, U. S. Government, 1962.
Acting Executive Head, Department of Economics, Stanford University, 1962-63.
Visiting Professor of Economics, Massachusetts Institute of Technology, Fall, 1966.
Fellow, Churchill College (Cambridge, England), 1963-64, 1970, 1973, 1986.
Guest Professor, Institute for Advanced Studies, Vienna, June 1964, June 1970.
Professor of Economics, Harvard University, 1968-74.
James Bryant Conant University Professor, Harvard University, 1974-79.
Joan Kenney Professor of Economics and Professor of Operations Research, Stanford University, 1979 to 1991.
Senior Fellow by Courtesy, Hoover Institution on War, Revolution and Peace, 1981 to date.
Part-time Professor, European University Institute, 1986.
External Professor, Santa Fe Institute, 1988 to date.
Professor of Economics Emeritus, 1991 to date.

### Honors and Awards

Gold Pell Medal (highest grades), City College, New York, 1940.
Phi Beta Kappa.
Social Science Research Fellow, 1952.
Fellow, Center for Advanced Study in the Behavioral Sciences, 1956-57.
John Bates Clark Medal, American Economic Association, 1957.
LL.D. (honorary) University of Chicago, 1967.
M.A. (honorary) Harvard University, 1968.
Marshall Lecturer, Cambridge University, Spring 1970.

D.Soc/Eco.Sci. (honorary), University of Vienna, 1971.
LL.D. (honorary), City University of New York, 1972.
Nobel Memorial Prize in Economic Science, 1972.
John R. Commons Lecture Award, Omicron Delta Epsilon, 1973.
D.Sci. (honorary), Columbia University, 1973.
D.Soc.Sci. (honorary), Yale University, 1974.
Dr. (honorary), Universite Rene Descartes, 1974.
LL.D. (honorary) Hebrew University of Jerusalem, 1975.
LL.D. (honorary), University of Pennsylvania, 1976.
D.Pol.Sci. (honorary), University of Helsinki, 1976.
Member, National Academy of Sciences (Chairman, Section 54, 1976-1979, Council member 1990 to date).
Fellow, American Academy of Arts and Sciences (Vice President, 1979-80, 1991-94).
Member, American Philosophical Society.
Member, Institute of Medicine.
Foreign Honorary Member, Finnish Academy of Sciences.
Corresponding Member, British Academy.
Sigma Xi (President, Stanford Chapter, 1981-82).
Tanner Lecturer, Oxford University, Spring 1983.
2nd Class Order of the Rising Sun, Japan, 1984.
Tanner Lecturer, Harvard University, Spring 1985.
Dr. of Letters, University of Cambridge, 1985.
Dr. Honoris Causa, Universite d'Aix-Marseille III, 1985.
von Neumann Prize of The Institute of Management Sciences and the Operations Research Society of America, 1986.
LL.D. (honorary) Washington University in St. Louis, 1989.
Clarendon Lectures, Oxford University, November 1989.
LL.D. (honorary) Ben-Gurion University of the Negev, 1992.

Professional Societies

Econometric Society (Fellow; Vice President, 1955, President, 1956, Member of the Council, 1983).
Institute of Mathematical Statistics (Fellow).
American Statistical Association (Fellow).
American Economic Association (Member, Executive Committee, 1967-1969; President-elect, 1972; President, 1973; Distinguished Fellow).
The Institute of Management Sciences (President, 1963; Chairman of the Council, 1964).
Western Economic Association (President, 1980-1981).
American Association for the Advancement of Science (Fellow; Chair, Section K, 1982).
International Society for Inventory Research (President, 1983-1988).
Honorary President, International Economic Association; President 1983-1986; Member, Executive Committee, 1986-1992.
The Society for Social Choice and Welfare, Caen, France, First President, 1992-93.

## PUBLICATIONS OF KENNETH J. ARROW

BOOKS

1. [1951] *Social Choice and Individual Values*. New York: Wiley.

2. [1958] (with S. Karlin and H. Scarf) *Studies in the Mathematical Theory of Inventory and Production*. Stanford, California: Stanford University Press.

3. [1958] (with L. Hurwicz and H. Uzawa) *Studies in Linear and Non-Linear Programming*. Stanford, California: Stanford University Press.

4. [1959] (with M. Hoffenberg and the assistance of H. Markowitz and R. Shephard) *A Time Series Analysis of Interindustry Demands*. Amsterdam: North-Holland Publishing Co.

5. [1963] *Social Choice and Individual Values*. Wiley: New York, 2nd edition.

6. [1965] *Aspects of the Theory of Risk-Bearing*. Yrjö Jahnssonin säätiö Helsinki, Finland.

7. [1970] (with M. Kurz) *Public Investment, the Rate of Return, and Optimal Fiscal Policy*. Baltimore and London: The Johns Hopkins Press.

8. [1971] (with F. H. Hahn) *General Competitive Analysis*. San Francisco: Holden-Day; Edinburgh: Oliver & Boyd.

9. [1971] *Essays in the Theory of Risk-Bearing*. Chicago: Markham; Amsterdam and London: North-Holland.

10. [1974] *The Limits of Organization*. New York: W. W. Norton.

11. [1976] (with S. Shavell and J. Yellen) *The Limits of the Market Economy*, (in Japanese). Memorandum for Ministry of International Trade and Industry, Japan.

12. [1976] *The Viability and Equity of Capitalism*. E. S. Woodward lecture, Department of Economics, University of British Columbia.

13. [1977] (with L. Hurwicz) *Studies in Resource Allocation Processes*. Cambridge, London, New York, and Melbourne: Cambridge University Press.

14. [1983] *Collected Papers of Kenneth J. Arrow, Volume 1, Social Choice and Justice*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

15. [1983] *Collected Papers of Kenneth J. Arrow, Volume 2, General Equilibrium*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

16. [1984] *Collected Papers of Kenneth J. Arrow, Volume 3, Individual Choice under Certainty and Uncertainty*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

17. [1984] *Collected Papers of Kenneth J. Arrow, Volume 4, The Economics of Information.* Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

18. [1985] *Collected Papers of Kenneth J. Arrow, Volume 5, Production and Capital.* Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

19. [1985] *Collected Papers of Kenneth J. Arrow, Volume 6, Applied Economics.* Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

20. [1986] (with Hervé Raynaud) *Social Choice and Multicriterion Decision-Making.* Cambridge, Massachusetts: The MIT Press.

BOOKS EDITED

1. [1960] (with S. Karlin and P. Suppes) *Mathematical Methods in the Social Sciences, 1959: Proceedings of the First Stanford Symposium*. Stanford, California: Stanford University Press.

2. [1962] (with S. Karlin and H. Scarf) *Studies in Applied Probability and Management Science*. Stanford, California: Stanford University Press.

3. [1969] (with T. Scitovsky) *Readings in Welfare Economics*. American Economic Association Series of Republished Articles in Economics. Homewood, Illinois: Richard D. Irwin, Vol. XII.

4. [1971] *Selected Readings in Economic Theory from Econometrica*. Cambridge, Massachusetts, and London: MIT Press.

5. [1978] (with S. J. Fitzsimmons and R. Wildenmann) *Zukunftsorientierte Planung und Forschung fur die 80er Jahre*. Koningstein/Ts., German Federal Republic: Athenaum Verlag.

6. [1981] (with C. C. Abt and S. J. Fitzsimmons) *Applied Research for Social Policy: The United States and the Federal Republic of Germany*. Cambridge, Massachusetts: Abt.

7. [1981] (with M. Intriligator) *Handbook of Mathematical Economics, Volume I*. Amsterdam, New York and London: North-Holland.

8. [1982] (with M. Intriligator) *Handbook of Mathematical Economics, Volume II*. Amsterdam, New York and London: North-Holland.

9. [1985] (with Seppo Honkapohja) *Frontiers of Economics*. Oxford and New York: Basil Blackwell Ltd.

10. [1986] (with M. Intriligator) *Handbook of Mathematical Economics, Volume III*. Amsterdam, New York and London: North-Holland.

11. [1988] (with M. J. Boskin) *The Economics of Public Debt*. Basingstoke and London: Macmillan in association with The International Economic Association.

12. [1988] (with P. W. Anderson and D. Pines) *The Economy as an Evolving Complex System*. Redwood City, California: Addison-Wesley.

13. [1988] *The Balance between Industry and Agriculture in Economic Development. Volume I: Basic Issues*. Basingstoke and London: Macmillan in association with The International Economic Association.

14. [1991] *Issues in Contemporary Economics. Volume I, Markets and Welfare*. Basingstoke and London: Macmillan for International Economic Association.

COLLECTIVE STUDIES

1. [1971] (as member of Climatic Impact Committee of the National Research Council, National Academy of Sciences, National Academy of Engineering) *Environmental Impact of Stratospheric Flight*. Washington, D. C.: National Academy of Sciences.

2. [1977] (as member of Nuclear Energy Policy Study Group) S. M. Keeny, Jr., et al, *Nuclear Power Issues and Choices*. Cambridge, Massachusetts: Ballinger.

3. [1979] H. H. Landsberg, et al, *Energy: The Next Twenty Years*. Cambridge, Massachusetts: Ballinger.

4. [1981] (as Chairman of the Committee for a Planning Study for an Ongoing Study of Costs of Environment-related Health Effects, Institute of Medicine) *Costs of Environment-related Health Effects*. Washington, D. C.: National Academy Press.

5. [1991] (as member of the Oversight Review Board of the National Acid Precipitation Assessment Program) *The Experience and Legacy of NAPAP*. Washington, DC: National Acid Precipitation Assessment Program.

NONTECHNICAL ARTICLES

1. [1961] "Does the Majority Ever Rule?" introductory notes. *Portfolio and Art News Annual* 4:76-78.

2. [1974] "Taxation and Democratic Values." *The New Republic* 171:18:23-25.

3. [1975] "How Much to Fear from OPEC?" *Moment* 1:2:32-34.

4. [1978] "Capitalism, Socialism, and Democracy," (symposium). *Commentary* 65:4:29-31.

5. [1978] "A Cautious Case for Socialism." *Dissent*, Fall, 472-480.

6. [1979] "The Economy and the Economist." *Partisan Review* 1:113-216.

7. [1981] "Two Cheers for Regulation." *Harper's* 262:18-22.

8. [1982] "Why People Go Hungry." *New York Review of Books* 29:12:24-26.

9. [1983] "The Economics of 1984." In P. Stansky (ed.) *On Nineteen Eighty-Four*. San Francisco: W. H. Freeman, pp. 43-48.

10. [1984] "The International Economic Order of the Twenty-First Century." In Osaka Junior Chamber, Inc., *Wisdom Toward the 21st Century*. Tokyo: YMCA Press, pp. 173-227 (in Japanese).

11. [1984] "The Economy as Order and Disorder." In P. Livingston (ed.) *Disorder and Order*. Saratoga, California: ANMA Libri., pp. 162-172.

12. [1986] "Kenneth J. Arrow." In W. Breit and R. W. Spencer (eds.) *Lives of the Laureates: Seven Nobel Economists*. Cambridge, Massachusetts, and London, pp. 43-57.

13. [1987] "Redistribution to the Poor: A Collective Expression of Individual Altruism." In F. Jiménez (ed.) *Poverty and Social Justice*. Tempe, Arizona: Bilingual Press, pp. 39-46.

14. [1989] "The Multiple Responsibilities of the Corporation." In J. E. Weiler (ed.), *The First International Symposium on Stakeholders*. Dayton, Ohio: Center for Business and Economic Research, School of Business Administration, University of Dayton, pp. 53-62.

15. [1989] Chapter 1. In W. Sichel (ed.) *The State of Economic Science*. Kalamazoo, Michigan: W. E. Upjohn Institute for Employment Research.

16. [1991] "Economic Forecasting." In G. E. Gaull (ed.) *New Technologies and the Future of Food and Nutrition*. New York: Wiley. Chapter 25, pp. 135-140.

17. [1992] "Decision Making by Individuals and Systems." In Office of Naval Research: *Forty Years of Excellence*. Arlington, Virginia: Office of Naval Research. Pp. 123-127.

18. [1992] "I Know a Hawk from a Handsaw." In M. Szenberg (ed.) *Eminent Economists*. Cambridge and New York: Cambridge University Press. Pp. 42-50.

19. [1992] "Moral Thinking and Economic Interaction." In Pontifical Council for Justice and Peace, *Social and Ethical Aspects of Economics*. Vatican City. Pp. 17-22.

PAPERS

1. [1949] On the Use of Winds in Flight Planning. *Journal of Meteorology* 6:150-159.

2. [1949] (with D. Blackwell and M. A. Girshick) Bayes and Minimax Solutions of Sequential Decision Problems. *Econometrica* 17:213-44.

3. [1950] Homogeneous Systems in Mathematical Economics: A Comment. *Econometrica* 18:60-62.

4. [1950] A Difficulty in the Concept of Social Welfare. *Journal of Political Economy* 58:328-46.

5. [1951] Alternative Proof of the Substitution Theorem for Leontief Models in the General Case. In T. C. Koopmans, (ed.) *Activity Analysis of Production and Allocation*. New York: Wiley, Chapter IX.

6. [1951] (with T. E. Harris and J. Marschak) Optimal Inventory Policy. *Econometrica* 19:250-72.

7. [1951] Alternative Approaches to the Theory of Choice in Risk-Taking Situations. *Econometrica* 19:404-37.

8. [1951] Little's Critique of Welfare Economics. *American Economic Review* 41:923-34.

9. [1951] Mathematical Models in the Social Sciences. In D. Lerner and H. D. Lasswell (eds.), *The Policy Sciences*. Stanford, California: Stanford University Press, pp. 129-54.

10. [1951] An Extension of the Basic Theorems of Classical Welfare Economics. In J. Neyman (ed.), *Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley and Los Angeles: University of California Press, pp. 507-32.

11. [1952] The Determination of Many-Commodity Preference Scales by Two-Commodity Comparison. *Metroeconomica* IV:107-15.

12. [1952] Le principe de rationalité dans les décisions collectives. *Économie Appliquée* V:469-84.

13. [1953] Le rôle des valeurs boursières pour la répartition la meilleure des risques, *Économetrie*. Colloques Internationaux du Centre National de la Recherche Scientifique, Vol. XI, pp. 41-47.

14. [1953] (with E. W. Barankin and D. Blackwell) Admissible Points of Convex Sets, *Contributions to the Theory of Games, II*. Princeton: Princeton University Press, pp. 87-91.

15. [1954] (with G. Debreu) Existence of Equilibrium for a Competitive Economy. *Econometrica* 22:265-90.

16. [1954] Import Substitution in Leontief Models. *Econometrica* 22:491-92.

17. [1956] (with L. Hurwicz) Reduction of Constrained Maxima to Saddle-Point Problems. In J. Neyman (ed.) *Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley and Los Angeles: University of California Press, Vol. V, pp. 1-20.

18. [1956] (with A. C. Enthoven) A Theorem on Expectations and the Stability of Equilibrium. *Econometrica* 24:288-93.

19. [1957] Statistics and Economic Policy. *Econometrica* 25:523-31.

20. [1957] (with L. Hurwicz) Gradient Methods for Constrained Maxima. *Operations Research* 5:258-65.

21. [1957] Decision Theory and Operations Research. *Operations Research* 5:765-74.

22. [1958] Utilities, Choices, Attitudes: A Review Note. *Econometrica* 26:1-23.

23. [1958] Tinbergen on Economic Policy. *Journal of the American Statistical Association* 53:89-97.

24. [1958] The Measurement of Price Changes. In Joint Economic Committee, *The Relationship of Prices to Economic Stability and Growth*. Washington, D.C.: U.S. Government Printing Office, pp. 77-88.

25. [1958] (with M. Nerlove) A Note on Expectations and Stability. *Econometrica* 26:297-305.

26. [1958] (with A. Alchian and W. M. Capron) *An Economic Analysis of the Market for Scientists and Engineers*. Santa Monica, California: The Rand Corporation, RM 2190-RC.

27. [1958] (with M. McManus) A Note on Dynamic Stability. *Econometrica* 26:448-54.

28. [1958] (with L. Hurwicz) On the Stability of the Competitive Equilibrium. *Econometrica* 26:522-52.

29. [1959] Toward a Theory of Price Adjustment. In M. Abramovitz and others, *The Allocation of Resources*. Stanford, California: Stanford University Press, pp. 41-51.

30. [1959] (with W. M. Capron) Dynamic Shortages and Price Rises: The Engineer-Scientist Case. *Quarterly Journal of Economics* 63:292-308.

31. [1959] Rational Choice Functions and Orderings. *Economica*, N. S. 26:121-27.

32. [1959] (with H. D. Block and L. Hurwicz) On the Stability of the Competitive Equilibrium, II. *Econometrica* 27:82-109.

33. [1959] Functions of a Theory of Behavior Under Uncertainty. *Metroeconomica* 11:12-20.

34. [1960] (with L. Hurwicz) Competitive Stability Under Weak Gross Substitutability: The "Euclidean Distance" Approach. *International Economic Review* 1:38-49.

35. [1960] Optimization, Decentralization, and Internal Pricing in Business Firms. In *Contributions to Scientific Research in Management*. Western Data Processing Center, Graduate School of Business Administration, University of California, Los Angeles, pp. 9-18.

36. [1960] Decision Theory and the Choice of a Level of Significance for the t-Test. In I. Olkin and others (eds.), *Contributions to Probability and Statistics*. Stanford, California: Stanford University Press. pp. 70-78.

37. [1960] The Work of Ragnar Frisch, Econometrician. *Econometrica* 28:175-92.

38. [1960] Price-Quantity Adjustments in Multiple Markets with Rising Demands. In K. J. Arrow, S. Karlin, P. Suppes (eds.) *Mathematical Methods in the Social Sciences, 1959*. Stanford, California: Stanford University Press, pp. 3-16.

39. [1960] (with L. Hurwicz) Decentralization and Computation in Resource Allocation. In R. W. Pfouts (ed.), *Essays in Economics and Econometrics*. Chapel Hill: University of North Carolina Press, pp. 34-104.

40. [1960] (with L. Hurwicz) Stability of the Gradient Process in N-Person Games. *Journal of the Society for Industrial and Applied Mathematics* 8:280-94.

41. [1960] (with L. Hurwicz) Some Remarks on the Equilibria of Economic Systems. *Econometrica* 28:640-46.

42. [1961] Additive Logarithmic Demand Functions and the Slutsky Relations. *Review of Economic Studies* 28:176-81.

43. [1961] (with H. B. Chenery, B. Minhas and R. M. Solow) Capital-Labor Substitution and Economic Efficiency. *Review of Economics and Statistics* 43:225-50.

44. [1961] (with L. Hurwicz and H. Uzawa) Constraint Qualifications in Maximization Problems. *Naval Research Logistics Quarterly* 8:175-91.

45. [1961] (with A. C. Enthoven) Quasi-Concave Programming. *Econometrica* 29:779-800.

46. [1962] Case Studies: Comment. In National Bureau of Economic Research, *The Rate and Direction of Inventive Activity: Economic and Social Factors*. Princeton: Princeton University Press, pp. 335-38.

47. [1962] Economic Welfare and the Allocation of Resources for Invention. In National Bureau of Economic Research, *The Rate and Direction of Inventive Activity: Economic and Social Factors*. Princeton: Princeton University Press, pp. 609-25.

48. [1962] Optimal Capital Adjustment. In K. J. Arrow, S. Karlin, and H. Scarf (eds.), *Studies in Applied Probability and Management Science*. Stanford, California: Stanford University Press, pp. 1-17.

49. [1962] (with M. Nerlove) Optimal Advertising Policy Under Dynamic Conditions. *Economica* N. S., 29:129-42.

50. [1962] The Economic Implications of Learning by Doing. *Review of Economic Studies* 29:155-73.

51. [1962] (with L. Hurwicz) Competitive Stability Under Weak Gross Substitutability: Nonlinear Price Adjustment and Adaptive Expectations. *International Economic Review* 3:233-55.

52. [1963] Conference Remarks. In M. Astrachan and A. S. Cahn (eds.), *Proceedings of RAND'S Demand Prediction Conference, January 25-26, 1962*. Santa Monica, California: The RAND Corporation, RM-3358-RP, pp. 125-34.

53. [1963] Utility and Expectation in Economic Behavior. In S. Koch (ed.), *Psychology: A Study of a Science*. New York: McGraw-Hill, Vol. 6, pp. 724-52.

54. [1963] The Economic Cost to Western Europe of Restricted Availability of Oil Imports: A Linear Programming Computation. Appendix D in H. Lubell, *Middle East Oil Crises and Western Europe's Energy Supplies*. Baltimore: John Hopkins Press, pp. 214-220.

55. [1963] Comment on Duesenberry's "The Portfolio Approach to the Demand for Money and Other Assets." *Review of Economics and Statistics* 45, Supplement, pp. 24-27.

56. [1963] Uncertainty and the Welfare Economics of Medical Care. *American Economic Review* 53:941-73.

57. [1963-4] Control in Large Organizations. *Management Science* 10:397-408.

58. [1964] Optimal Capital Policy, the Cost of Capital, and Myopic Decision Rules. *Annals of the Institute of Statistical Mathematics* 16:21-30.

59. [1964] Research in Management Control: A Critical Synthesis. In C. P. Bonini, R. K. Jaedicke, and H. M. Wagner (eds.), *Management Controls: New Directions in Basic Research*. New York: McGraw-Hill, Chapter 17, pp. 317-327.

60. [1965] Connaissance, Productivité et Pratique. *Bulletin SEDEIS*, Étude No. 909 Supplement.

61. [1965] *Statistical Requirements for Greek Economic Planning*. Center of Planning and Economic Research, Lecture Series No. 18. Athens, Greece.

62. [1965] Uncertainty and the Welfare Economics of Medical Care: Reply (The Implications of Transaction Costs and Adjustment Lags). *American Economic Review* 55:154-58.

63. [1965] Criteria for Social Investment. *Water Resources Research* 1:1-18.

64. [1965] The Economic Context. In S. T. Donner (ed.) *The Future of Commercial Television, 1965-1975*. (privately printed) pp. 116-39.

65. [1966] Discounting and Public Investment Criteria. In A. V. Kneese and S. C. Smith (eds.), *Water Research*. Baltimore: Johns Hopkins Press, pp. 13-32.

66. [1967] Values and Collective Decision-Making. In P. Laslett and W. G. Runciman (eds.), *Philosophy, Politics and Society, Third Series*. Oxford: Basil Blackwell, Chapter 10, pp. 215-232.

67. [1967] The Place of Moral Obligation in Preference Systems. In S. Hook (ed.) *Human Values and Economic Policy*. New York: New York University Press, Part II, 3, pp. 117-19.

68. [1967] Samuelson Collected. *Journal of Political Economy* 85:506-13.

69. [1968] Economic Equilibrium. In *International Encyclopedia of The Social Sciences*. New York: The Free Press, Vol. 4, pp. 376-386.

70. [1970] Meyer A. Girshick. In *International Encyclopedia of the Social Sciences*. New York: The Free Press, Vol. 6, pp. 191-93.

71. [1968] The Economics of Moral Hazard: Further Comment. *American Economic Review* 58:537-39.

72. [1968] (pseudonym of Archen Minsol; joint with H. B. Chenery, B. S. Minhas, and R. M. Solow) Some Tests of the International Comparisons of Factor Efficiency with the CES Production Function: A Reply. *Review of Economics and Statistics* 50:477-9.

73. [1968] Optimal Capital Policy with Irreversible Investment, in J. N. Wolfe (ed.), *Value, Capital, and Growth*, Edinburgh: Edinburgh University Press, pp. 1-20.

74. [1968] Applications of Control Theory to Economic Growth, in American Mathematical Society, *Mathematics of the Decision Sciences*, Providence: American Mathematical Society, Part 2, pp. 85-119.

75. [1969] Classificatory Notes on the Production and Transmission of Technological Knowledge. *American Economic Review Papers and Proceedings* 59:29-35.

76. [1969] The Organization of Economic Activity: Issues Pertinent to the Choice of Market Versus Nonmarket Allocation. In Joint Economic Committee, U. S. Congress, *The Analysis and Evaluation of Public Expenditures: The PPB System, Vol. 1*; pp. 47-66.

77. [1969] (with M. Kurz) Optimal Consumer Allocation Over an Infinite Horizon. *Journal of Economic Theory* 1:68-91.

78. [1969] Tullock and an Existence Theorem. *Public Choice* VI: 105-112.

79. [1969] (with M. Kurz), Optimal Public Investment Policy and Controllability with Fixed Private Savings Ratio. *Journal of Economic Theory* 1:141-77.

80. [1969] (with D. Levhari) Uniqueness of the Internal Rate of Return with Variable Life of Investment. *Economic Journal* 79:560-66.

81. [1969] The Social Discount Rate. In G. G. Somers and W. D. Wood (eds.) *Cost-Benefit Analysis of Manpower Policies*. Kingston, Ontario: Industrial Relations Centre, Queen's University.

82. [1970] The Effects of the Price System and Market on Urban Economic Development. In K. J. Arrow et al, *Urban Processes As Viewed by the Social Sciences*. Washington, D. C.: The Urban Institute, pp. 11-20.

83. [1970] (with M. Kurz) Optimal Growth with Irreversible Investment in a Ramsey Model. *Econometrica* 38:331-344.

84. [1970] New Ideas in Pure Theory: Discussion. *American Economic Review Papers and Proceedings* 60:462-3.

85. [1970] (with R. C. Lind) Uncertainty and the Evaluation of Public Investment Decisions. *American Economic Review* 60:364-78.

86. [1970] Criteria, Institutions, and Function in Urban Development Decisions. In A. H. Pascal (ed.) *Thinking About Cities*. Belmont, California: Dickenson.

87. [1970] Induced Technical Change and Patterns of International Trade: Comment. In R. Vernon (ed.) *The Technology Factor in International Trade*. New York: National Bureau of Economic Research, pp. 128-32.

88. [1971] The Firm in General Equilibrium Theory. In R. Marris and A. Wood (eds.) *The Corporate Economy: Growth, Competition, and Innovative Potential*. Cambridge, Massachusetts: Harvard University Press, and London: Macmillan, pp.68-110.

89. [1971] A Utilitarian Approach to the Concept of Equality in Public Expenditures. *Quarterly Journal of Economics* 85:409-415.

90. [1972] (with L. Hurwicz) An Optimality Criterion for Decision-Making Under Ignorance. In C. F. Carter and J. L. Ford (eds.), *Uncertainty and Expectations in Economics: Essays in Honour of G. L. S. Shackle*. Oxford: Basil Blackwell, pp. 1-11.

91. [1972] (with R. C. Lind) Uncertainty and the Evaluation of Public Investment Decisions: Reply. *American Economic Review* 62:171-2.

92. [1972] Problems of Resource Allocation in United States Medical Care. In R. M. Kurz and H. Fehr (eds.), *The Challenge of Life*. Basel and Stuttgart: Birkhauser, pp. 392-408.

93. [1972] Models of Job Discrimination. In A. H. Pascal (ed.) *Racial Discrimination in Economic Life*. Lexington, Massachusetts, Toronto and London: D. C. Heath, Chapter 2, pp. 8-102.

94. [1972] Some Mathematical Models of Race in the Labor Market. In A. H. Pascal (ed.), *Racial Discrimination in Economic Life*. Lexington, Massachusetts, Toronto and London: D. C. Heath, Chapter 6, pp. 187-204.

95. [1972] Gifts and Exchanges. *Philosophy and Public Affairs* 1:343-62.

96. [1972] (with D. Levhari and E. Sheshinski) A Production Function for the Repairman Problem. *Review of Economic Studies* 39:241-9.

97. [1973] Some Ordinalist-Utilitarian Notes on Rawl's Theory of Justice. *Journal of Philosophy* 70:245-63.

98. [1973] (with D. Starrett) Cost- and Demand- Theoretical Approaches to the Theory of Price Determination. In J. R. Hicks and W. Weber (eds.) *Carl Menger and the Austrian School of Economics*. Oxford: The Clarendon Press, Chapter 7, pp. 129-148.

99. [1973] Higher Education as a Filter. *Journal of Public Economics* 2:193-216.

100. [1973] General Economic Equilibrium: Purpose, Analytic Techniques, Collective Choice. In *Les Prix Nobel en 1972*. Stockholm: The Nobel Foundation, pp. 206-231.

101. [1973] Social Responsibility and Economic Efficiency. *Public Policy* 21:303-318.

102. [1973] Formal Theories of Social Welfare. In P. P. Wiener (ed.) *Dictionary of the History of Ideas*. New York: Scribner, Volume IV, pp. 276-284.

103. [1973] *Information and Economic Behavior*. Stockholm (lecture): Federation of Swedish Industries.

104. [1973] The Theory of Discrimination. In O. Ashenfelter and A. Rees (eds.) *Discrimination in Labor Markets*. Princeton: Princeton University Press, pp. 3-33.

105. [1973] (with F. J. Gould and S. M. Howe) A General Saddle Point Result for Constrained Optimization. *Mathematical Programming* 5:225-234.

106. [1973] Rawls's Principle of Just Saving. *Swedish Journal of Economics* 75:323-335.

107. [1974] The Measurement of Real Value Added. In P. A. David and M. W. Reder (eds.) *Nations and Households in Economic Growth*. New York and London: Academic Press, pp. 3-19.

108. [1974] Stability Independent of Adjustment Speed. In G. Horwich and P. A. Samuelson (eds.) *Trade, Stability, and Macroeconomics*. New York and London: Academic Press, pp. 181-202.

109. [1974] Capitalism, for Better or Worse. In L. Silk (ed.) *Capitalism: The Moving Target*. New York: Quadrangle/New York Times Company, pp. 105-113.

110. [1974] Unbounded Utility Functions in Expected Utility Maximization: Response. *Quarterly Journal of Economics* 88:136-138.

111. [1974] Limited Knowledge and Economic Analysis. *American Economic Review* 64:1-10.

112. [1974] Optimal Insurance and Generalized Deductibles. *Scandinavian Actuarial Journal* 1974:1-42.

113. [1974] (with A. C. Fisher) Environmental Preservation, Uncertainty, and Irreversibility. *Quarterly Journal of Economics* 88:312-319.

114. [1974] On the Agenda of Organizations. In R. Marris (ed.) *The Corporate Society*. New York and Toronto: Wiley, pp. 214-234.

115. [1974] The Combination of Time Series and Cross-Section Data in Interindustry Flow Analysis. *European Economic Review* 5:25-32.

116. [1974] Government Decision Making and the Preciousness of Human Life. In L. R. Tancredi (ed.) *Ethics of Health Care*. Washington, D. C.: National Academy of Sciences, Chapter II, pp. 33-47.

117. [1975] Vertical Integration and Communication. *The Bell Journal of Economics* 6:173-183.

118. [1975] Thorstein Veblen as an Economic Theorist. *The American Economist* 19:5-9.

119. [1975] On a Theorem of Arrow: Comment. *Review of Economic Studies* 62:487.

120. [1975] Economic Development: The Present State of the Art. *Papers of the East-West Communication Institute*, No. 14.

121. [1976] Economic Dimensions of Occupational Segregation: Comment I. *Signs* 1, No. 3, Part 2, pp. 233-237.

122. [1976] Quantity Adjustments in Resource Allocation: A Statistical Interpretation. In R. E. Grierson (ed.) *Public and Urban Economics*, Lexington, Massachusetts, Toronto and London: Lexington Books, Chapter 1, pp. 3-11.

123. [1976] *Theoretical Issues in Health Insurance.* The University of Essex, Noel Buxton lecture for 1973.

124. [1976] Welfare Analysis of Changes in Health Coinsurance Rates. In R. N. Rossett (ed.) *The Role of Health Insurance in the Health Services Sector.* New York: National Bureau of Economic Research, Chapter 1, pp. 2-23.

125. [1976] Evaluation of Social Experiments: Discussion. In C. G. Abt (ed.) *The Evaluation of Social Programs.* Beverly Hills and London: Sage Publications, pp. 49-54.

126. [1976] The Rate of Discount for Long-Term Public Investment. In H. Ashley, R. L. Rudman, and C. Whipple (eds.) *Energy and the Environment: A Risk-Benefit Approach.* New York: Pergamon, pp. 113-140.

127. [1976] The Genesis of Dynamic Systems Generated by Metzler Matrices. In R. Henn and O. Moeschlin (eds.) *Mathematical Economics and Game Theory: Essays in Honor of Oskar Morgenstern.* Berlin, Heidelberg, and New York: Springer-Verlag, pp. 629-644.

128. [1977] Extended Sympathy and the Possibility of Social Choice. *American Economic Review Papers and Proceedings* 67, No. 1:219-225.

129. [1977] Current Developments in the Theory of Social Choice. *Social Research* 44:607-622.

130. [1978] The Future and the Present in Economic Life. *Economic Inquiry* 16:157-170.

131. [1978] Nozick's Entitlement Theory of Justice. *Philosophia* 7:265-279.

132. [1978] Risk Allocation and Information: Some Recent Theoretical Developments. *The Geneva Papers on Risk and Insurance*, No. 8, June 1978 (Association Internationale pour l'Étude de l'Économie de l'Assurance).

133. [1978] Jacob Marschak's Contributions to the Economics of Decision and Information. *American Economic Review, Papers and Proceedings*, Vol. 68, pp. xii-xiv.

134. [1978] Jacob Marschak. In *International Encyclopedia of the Social Sciences.* New York: The Free Press, Vol. 18, Biographical Supplement, pp. 500-507.

135. [1979] (with R. Radner) Allocation of Resources in Large Teams. *Econometrica* 47:361-385.

136. [1979] The Economics of Information. In M. L. Dertouzos and J. Moses (eds.) *The Computer Age: A Twenty-Year View.* Cambridge, Massachusetts: MIT Press, pp. 306-317.

137. [1979] (with J. P. Kalt) *Petroleum Price Regulation.* Washington, D.C.: American Enterprise Institute for Public Policy Research.

138. [1979] The Property Rights Doctrine and Demand Revelation under Incomplete Information. In M. Boskin (ed.) *Economics and Human Welfare.* New York and London: Academic Press, pp. 23-39.

139. [1979] The Trade-Off Between Growth and Equity. In H. I. Greenfield, A. M. Levenson, W. Hamovitch, and E. Rotwein (eds.) *Theory for Economic Efficiency: Essays in Honor of Abba P. Lerner.* Cambridge, Massachusetts: MIT Press, pp. 1-11.

140. [1980] (with S. Chang) Optimal Pricing, Use and Exploraton of Uncertain Natural Resource Stocks. In P. T. Liu (eds.) *Dynamic Optimization and Mathematical Economics.* New York: Plenum, pp. 105-16.

141. [1980] Microdata Simulation: Current Status, Problems, Prospects. In R. Haveman and K. Hollenback (eds.) *Microeconomic Simulation Models for Public Policy Analysis.* New York and London: Academic Press, Vol. 2, pp. 253-265.

142. [1980] Real and Nominal Magnitudes in Economics. *Journal of Financial and Quantitative Analysis* 25:773-783.

143. [1981] Futures Markets: Some Theoretical Perspectives. *Journal of Futures Markets* 1:107-113.

144. [1981] Optimal and Voluntary Income Distribution. In S. Rosefielde (ed.) *Economic Welfare and the Economics of Soviet Socialism: Essays in Honor of Abram Bergson*, Cambridge, United Kingdom: Cambridge University Press, pp. 276-88.

145. [1981] (with L. Pesotchinsky and M. Sobel) On Partitioning a Sample with Binary-Type Questions in Lieu of Collecting Observations. *Journal of the American Statistical Association* 76:402-9.

146. [1981] Pareto Efficiency with Costly Transfers. In J. Los (ed.) *Studies in Economic Theory and Practice.* Amsterdam: North-Holland Publishing Company, Chapter 6.

147. [1981] The Social Choice Perspective. *Hofstra Law Review* 9:1373-80.

148. [1981] The Response of Orthodox Economics. In H. E. Daly and A. F. Umaña (eds.) *Energy, Economics, and the Environment*. Boulder, Colorado: Westview Press, pp. 109-113.

149. [1981] On Finance and Decision Making. In R. Vernon and Y. Aharoni (eds.) *State-Owned Enterprise in the Western Economies*. London: Croom Helm, pp. 63-69.

150. [1982] Risk Perception in Psychology and Economics. *Economic Inquiry* 20:1-9.

151. [1982] Income Testing and Social Welfare: An Optimal Tax-Transfer Model: Discussion. In I. Garfinkel (ed.) *Income-Tested Transfer Programs: The Case for and Against*. New York and London Academic: Press, pp. 319-323.

152. [1982] The Rate of Discount on Public Investments with Imperfect Capital Markets. In R. C. Lind and others, *Discounting for Time and Risk in Energy Policy*. Washington, D. C.: Resources for the Future, pp. 115-136.

153. [1982] Comment on Evolutionary Models in Economics and Law: Cooperative versus Conflict Strategies, by Jack Hirshleifer. In F. Zerbe (ed.) *Research in Law and Economics*, Volume 4: 81-87.

154. [1983] Contributions to Welfare Economics. In E. C. Brown and R. M. Solow (eds.) *Paul Samuelson and Modern Economic Theory*. New York: McGraw-Hill, pp. 15-30.

155. [1983] Innovation in Large and Small Firms. In J. Ronen (ed.) *Entrepreneurship*. Lexington, Massachusetts: Lexington Books, pp. 15-28.

156. [1983] Team Theory and Decentralized Resource Allocation: An Example. In P. Desai (ed.) *Marxism, Central Planning, and the Soviet Economy*. Cambridge, Massachusetts, and London: The MIT Press, Chapter 4, pp. 63-76.

157. [1983] Behavior under Uncertainty and Its Implications for Policy. In B. Stigum and F. Wentstóp (eds.) *Foundations of Utility and Risk Theory with Applications*. Dordrecht: D. Reidel, pp. 19-32.

158. [1984] Permanent and Transitory Substitution Effects in Health Insurance Experiments. *Journal of Labor Economics*, 2:259-267.

159. [1985] The Informational Structure of the Firm. *American Economic Review Papers and Proceedings* 75: No. 2, 303-307.

160. [1985] Maine and Texas. *American Economic Review Papers and Proceedings* 75: No. 2, 320-323.

161. [1985] The Economics of Agency. In J. W. Pratt and R. J. Zeckhauser (eds.) *Principals and Agents: The Structure of Business*. Boston: Harvard Business School Press, Chapter 2, pp. 37-51.

162. [1986] Rationality of Self and Others in an Economic System. *Journal of Business* 59: S385-S399.

163. [1986] Planning and Uncertainty. In I. Adelman and J. E. Taylor (eds.) *The Design of Alternative Development Strategies*. Rohtak, India: Jan Tinbergen Institute of Development Planning, Chapter 9.

164. [1986] Comments, in R. G. Cummings, D. S. Brookshire, and W. D. Schulze (eds.) *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*, Totawa. New Jersey: Rowman and Allanheld, pp. 180-185.

165. [1987] The Demand for Information and the Distribution of Income. *Probability in the Engineering and Informational Sciences* 1:3-13.

166. [1987] Technical Information, Returns to Scale, and the Existence of Competitive Equilibrium. In T. Groves, R. Radner, and S. Reiter (eds.) *Information, Incentives, and Economic Mechanisms*. Minneapolis: University of Minnesota Press, Chapter 7, pp. 243-255.

167. [1988] Ricardos Werk aus der Sicht der modernen Ökonomie. In K. J. Arrow, M. Ricardo, and H. Recktenwald, *David Ricardo: Eine moderne Würdigung*. Düsseldorf: Verlag Wirtschaft und Finanzen, pp. 43-59.

168. [1988] Presidential address: General Economic Theory and the Emergence of Theories of Economic Development. Chapter 2 in K. J. Arrow (ed.) *The Balance between Industry and Agriculture in Economic Development, Volume 1: Basic Issues*. Basingstoke and London: Macmillan for the International Economic Association, pp. 22-32.

169. [1988] Overview of the Conference. In S. Borner (ed.) *International Finance and Trade in a Polycentric World*. London: Macmillan in association with the International Economic Association, pp. 392-396.

170. [1989] Joan Robinson and Modern Economic Theory: An Interview. In G. Feiwel (ed) *Joan Robinson and Modern Economic Theory*. New York: New York University Press, Chapter 3, pp. 147-185.

171. [1989] Von Neumann and the Existence Theorem for General Equilibrium. In M. Dore, S. Chakravarty, and R. Goodwin (eds.) *John von Neumann and Modern Economics*. Oxford: Clarendon Press, Chapter 2, pp. 15-28.

172. [1989] A "Dynamic" Proof of the Frobenius-Perron Theorem for Metzler Matrices. In T. W. Anderson, K. B. Atheyra, and D. L. Iglehart (eds.) *Probability, Statistics, and Mathematics: Papers in Honor of Samuel Karlin*. Boston: Academic Press, pp. 17-26.

173. [1991] Certainty Equivalence and Inequivalence for Prices. In L. W. McKenzie and S. Zamagni (eds.) *Value and Capital: Fifty Years Later*. Basingstoke, U.K.: Macmillan for the International Economic Association, pp. 41-63.

174. [1991] Cowles in the History of Economic Thought. In *Cowles Fiftieth Anniversary*. New Haven: Cowles Foundation for Research in Economics, pp. 1-24.

175. [1991] The Dynamics of Technological Change. In Organization for Economic Co-operation and Development, *Technology and Productivity: The Challenge for Economic Policy*. Paris: OECD, pp. 473-6.

176. [1991] Panel Contribution: The Transition from Communism to an Alternative Economic Organisation. In A. B. Atkinson and R. Brunetta (eds.) *Economics for the New Europe*. Basingstoke and London: Macmillan, in association with the International Economic Association, pp. 377-382.

177. [1991] Scale Returns in Communication and Elite Control of Organizations. *Journal of Law, Economics, and Organization* 7, Special Issue, 1-6.

178. [1992] Informational Equivalence of Signals. In P. Dasgupta, D. Gale, O. Hart, and E. Maskin (eds.) *Economic Analysis of Markets and Games*. Cambridge, Massachusetts, and London: The MIT Press. Pp. 169-183.

179. [1992] Transition from Socialism. *Estudios Economicos* 6: No. 1, 5-22.

180. [1992] Sex Differentiation in Annuities: Reflections on Utilitarianism and Inequality. In R. Selten (ed.) *Rational Interaction*. Berlin: Springer-Verlag. Pp. 333-336.

181. [1992] The Basic Economics of Arms Reduction. In W. Isard and C. H. Anderton (eds.) *Economics of Arms Reduction and the Peace Process*. Amsterdam: Elsevier. Chapter 2. Pp. 57-61.

182. [1992] Excellence and Equity in Higher Education, *Education Economics* 1: 5-12.

183. [1993] Economic Integration and the Future of the Nation-State. *Contemporary Policy Issues* XI: 1-6.

184. [1993] Contingent Valuation of Nonuse Values: Observations and Questions. In J. Hausman (ed.) *Contingent Valuation: A Critical Assessment*. Amsterdam: North-Holland, Chapter XIV, pp. 479-484.