Transforming Economics: Theodore W. Schultz, 1902–1998 *In Memoriam*

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> "Well-reasoned doubts are good for economics. Neither theory, nor data, nor mathematics can fully resolve them. ...Economic behavior is more complex than our thoughts about it; our thoughts, however, are more comprehensive than standard theory; and standard theory is more comprehensive than mathematical economics. Each of these has its advantages. What is known from all of them is nevertheless subject to doubts. Economics would be better if we would substitute reasoned doubts for our parochial economic doctrines."
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> T. W. Schultz, 1986[2]

An obituary should be a celebration of a life rather than a dirge to mourn its passing. Ted Schultz's life was lived in and through his ideas, and in his life he transformed economics. In this essay, I focus primarily on his ideas and the changes they wrought in our profession.

Ted was born on a farm near Arlington, South Dakota, on April 30, 1902; death overtook him two months short of his 96th birthday on February 26, 1998 in Evanston, Illinois. He was intellectually active and productive well past 90. His early experiences on the farm during World War I, on account of which he missed graduating from high school, and of the post-war agricultural depression which followed, his extended visit to the tumultuously emergent Soviet Union in the summer of 1929, to which he returned in 1960 as a guest of the Soviet Academy of Sciences, and his stint at Iowa State College (now University), from which he abruptly resigned in 1943 to move to the University of Chicago, shortly to become its chairman, were the events which shaped his ideas. Chicago deeply influenced him, but his ideas also changed the department and transformed economics. As he closes his very brief autobiography for the Nobel Foundation[3]: "In addition, and beyond this, there is the standard puffing vita." Well, not so standard but rather, I would say, not so central to who Ted Schultz was and what his life meant to economics.

1. Formative Influences

The first two decades of the 20th century were a prosperous time for U. S. farmers: Although agricultural output increased only about 8 percent between 1900 and 1910, and 9 percent between 1910 and 1920, prices were relatively high and stable. The expansion of agricultural output was limited by the availability of good arable land, which had provided the source for much of the growth of agriculture through the 19th century. But, following the First World War, a prolonged agricultural depression set in characterized by generally falling, but unstable, prices for agricultural commodities. Ted interrupted his education to work on the family farm. The extraordinary foreign demand for products of U. S. agriculture slacked off in 1920 and prices fell disastrously in 1920-21. Farm output, however, increased slowly but steadily throughout the decade, about 15 percent between 1920 and 1930, mainly as a result of a modest increase in inputs of mechanical power and machinery and in total factor productivity. Ted, sensing that the route to a better life for farmers and their families lay through increased education, enrolled in a short

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[2] In Mark Blaug, *Who's Who in Economics: A Biographical Dictionary of Major Economists, 1700 - 1984*, 2nd. ed., Cambridge, MA: The MIT Press, 1986, p. 763.

[3] He was awarded the 1979 Alfred Nobel Memorial Prize in Economic Sciences jointly with Arthur Lewis.

course in agriculture at South Dakota State in 1921 and was able to enter college there, despite his lack of proper credentials and over the objections of his family, in 1924, where he completed both a bachelor's and a master's degree in agricultural economics in 1927. He went on to obtain his Ph.D. in economics at what we now might consider the somewhat unorthodox department which then existed at the University of Wisconsin. His interest in and concern with the problems of unstable agricultural prices and the sources of productivity growth in agriculture stem from these personal experiences, and his intuition that the key to enhanced well-being lay through education from both his own interrupted education and his rapid catch-up in 1924-27. His understanding of the role of economic institutions and organization had its origins in the "institutionalism" of John R. Commons and his "Wisconsin School."

The 1920's were a period of considerable intellectual ferment and enthusiasm for social reform especially among young people. John Reed's *Ten Days that Shook the World* (1920) aroused much interest in and admiration of the Soviet social experiments associated with the so-called New Economic Policy.[4] All would shortly come to an end in the Stalinist era which began c.1929. One can imagine both the keen interest and skepticism of the young Ted Schultz; as was so characteristic of him, he had to go see for himself notwithstanding the considerable danger and hardship such a trip entailed at that time. "Walking around," seeing things for oneself, talking to people, were all things Ted repeated many times over much later in developing countries.[5]

In 1930, Ted, Ph.D. in hand, became assistant professor at Iowa State College.[6] His training at Wisconsin had been in the "institutionalist" tradition of Commons, Hibbard and Taylor, not out of the mainstream for the time, but not the direction in which economics was moving. Sensing the need for theory and quantitative methods, Ted began to educate himself, working through a good deal of statistical methodology with Snedecor and somehow considerable microeconomic theory as well. Although he never really mastered these subjects in a technical sense, he knew good theory and good econometrics when he saw it and was able to bridge the old and new styles of economics both at Iowa and later at Chicago. Moreover, his keen economic intuition and often profound insight proved more reliable in the end than any technical expertise.

Ted's first published paper, "Diminishing Returns in View of Progress in Agricultural Production" (1932), dealt with the widely prevalent belief in secular diminishing returns, especially in agriculture, which Schultz found inconsistent with the "facts." Ted's attempt to explain the discrepancy between received doctrine and observation in this respect occupied him for the next two decades and led him directly to embrace the concept of human capital (an old idea one can find in Adam Smith [7]and in J. S. Mill[8], see section 3 below) and to elaborate it greatly in the course of the remainder of his professional

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[4]The naivité of many young people with respect to the Soviet experiment is depicted with historical accuracy in Warren Beatty's 1981 film *Reds*.

[5] In commenting on an early draft of this essay, Clif Wharton reminded me that Ted headed up a Ford Foundation funded National Planning Association study of U. S. technical assistance in Latin America from 1953 to 1957. During these four years Ted travel extensively in Latin America and immersed himself directly at the grass roots level in the study of human capital development in the developing world. From these experiences emerged many of the ideas on human capital and the nature of traditional agriculture, which Ted contributed to our discipline. Wharton was at that time a member of the multi-disciplinary team Ted put together for the study. Ted's approach to the NPA study was clearly colored by his experience in the Soviet Union of the 1920s.

[6] Schultz, himself said little about the Iowa State years. An account of these years and the famous "margarine" controversy which occasioned his departure for Chicago is contained in R. R. Beneke, "T. W. Schultz and Pamphlet No. 5: The Oleo Margarine War and Academic Freedom," *Choices*, 2nd. Quarter, 1998, pp. 4-8. See also, C. M. Hardin, *Freedom in Agricultural Education*, Chicago: University of Chicago Press, 1955.

[7] *An Inquiry into the Nature and Causes of the Wealth of Nations, ad variorum* edition, edited by R. H. Campbell, A. K. Skinner, and W. B. Todd, Oxford: Clarendon Press, 1976, pp.118-119.

[8] *Principles of Political Economy with Some of Their Applications to Social Philosophy*, London : J.W. Parker, 1848, Book I, Chapter V, § 7, pp. 74-75. Schultz himself takes a contrary view with respect to J. S.

career. At this time he must have read or reread carefully Frank Knight's *Risk, Uncertainty and Profit* (1921).[9] During the Iowa years, he was much concerned with the traditional fields of agricultural economics: Farm management and extension and agricultural research. His paper, "The Theory of the Firm and Farm Management Research" (1939), is an attempt to bridge the gap between microeconomic theory and the advice agricultural economists are often called upon to give farmers.

The 1920's had been depressed years for farmers. Farm prices hit a low in 1932 and began more or less steadily to recover, albeit slowly and punctuated by a sharp decline in 1938-39. Early on in the period there had been many foreclosures, but former owners frequently stayed on as tenants. Indeed, few resources left agriculture because there were almost no opportunities elsewhere in the economy. Although, agricultural technology was advancing apace, adoption was slowed by lack of the requisite financial resources and price incentives. Output grew but slowly. Some cushion was provided by the agricultural price support programs and other policies of subsidizing agriculture introduced as a result of the preceding prolonged depression in agriculture. These were later to prove quite destabilizing and destructive in the post World War II period, especially when coupled with an almost explosive adoption of "pent-up" technology. Certainly, Ted's thinking about the relationship between agriculture and the economy as a whole, in particular the effects of macroeconomic fluctuations on the well-being of farmers were much influenced by these events. But there were even more momentous consequences for Ted in the Iowa State microcosm. Iowa and the College were, like the world at large, in sorry financial state; when the chairman of the economics department departed in 1935 there was no money to appoint an illustrious successor; the 33-year old assistant professor Schultz was named to the post. As it turned out, he had a natural talent for administration and, more importantly, for generating financial support.

As chairman Ted not only attracted a group of distinguished young economists, both to the faculty and as graduate students (among them Oz Brownlee, Gale Johnson, as students, and George Stigler, Leo Hurwicz, Margaret Reid and Gerhard Tintner as faculty), but he encouraged and supported innovative research and extension activities. One of these was to prove "fatal," although from hindsight it was most propitious to his intellectual development. Dairy producers battled the manufacturers of oleomargarine at that time and in the Midwest had succeeded in persuading the state legislatures to enact very restrictive legislation. In 1943, Brownlee, then a graduate student had prepared an Experiment Station Report presenting evidence that margarine was comparable to butter nutritionally and much less wasteful of precious resources, scarce in time of war. The National Dairymen's Association mounted a massive campaign to have the report withdrawn or at least modified. The President of the College, Charles E. Friley, bent to the pressure and ordered that it be done. To Schultz this was a flagrant violation of the principles of academic freedom and of the obligation of the land-grant colleges and universities to serve the common weal rather than special interests. He warned Friley that he and others would resign if Friley persisted. Friley did and, in 1943-44, Schultz and 15 others in the department decamped, Ted and Gale Johnson for Chicago, permanently, others for temporary refugee status there or elsewhere.[10] Jacob Viner, who had himself suffered the slings and arrows of anti-Semitism and who knew well the value of academic freedom, is said to have made this possible.

Mill's contribution (in "Investment in Human Capital," 1961), and I must admit that Mill's statements are not entirely consistent with one another on this subject.

[9] As Griliches points out in his comments on an earlier draft of this essay, one of the key ideas Ted got from Knight was that knowledge creation was the mechanism that prevented the onset of diminishing returns. But Ted did not believe that this just happened; investments in knowledge and in education were required. And the role of government in all of this was central. These ideas were later elaborated in both Ted's work on human capital and on the disequilibrium nature of the transformation of traditional agriculture.

[10] Hugo Sonnenschein, now the President of the University of Chicago, placed particular emphasis on Ted's influence on academic freedom in his part in the Schultz memorial, May 5,1998.

2. Shaping and Being Shaped by "The Chicago School"[11]

In his introduction to *Chicago Essays in Economic Development* (Chicago: University of Chicago Press, 1972), David Wall writes: "...the marks of the distinctive features of the methodological approach universally recognized in the profession as that of the Chicago school [...are:] first, that theory is of fundamental importance; second, that theory is irrelevant unless set in a definite empirical context; and third, that in the absence of evidence to the contrary, the market works." Note that the last point is not that the market *always* works, but rather that we need to focus attention on possible failures of the market mechanism and on potential or realized conflicts between policies and market solutions --and such failures and conflicts need to be documented. Unfortunately, some doctrinaire adherents take the tenet literally and without the important qualification attached. Reder (*op. cit.*, p.11) calls this the "Tight Prior Equilibrium" theory, and spells it out in considerable detail; but I think his description is of the doctrinaire approach rather than of the more accommodating and empirically oriented spirit which Ted brought to the debate, and by which it was transformed.

Chicago from its very inception in 1893 has always been a very innovative place and put considerable emphasis on research potential and performance as the most important single criterion for faculty recruitment, retention and promotion. This has been true throughout the University and most especially in the social sciences. The leading figures in the 1930's were Jacob Viner (1892-1970) and Frank Knight (1885-1972). Viner, born in Montreal of immigrant parents, had studied with Frank W. Taussig (1859-1940) at Harvard. He taught at Chicago in 1916-17 and 1919-46 when he departed for Princeton. Knight studied at Cornell with Allyn A. Young (1876-1929) and Alvin S. Johnson (1874-1971), taught at Chicago 1917-1919, at the University of Iowa (not Iowa State) 1920-1926 and then at Chicago 1927-1958, where he remained in emeritus status until his death in 1972. Viner and Knight set the tone for the Department in the 1930's (strongly anti Keynesian and anti imperfect/monopolistic competition and not very quantitatively oriented) but it was a diverse group which included Paul Douglas (1892-1976), at Chicago 1920-1948, later U. S. Senator from Illinois (1948-1966), and Henry Schultz (1893-1938), at Chicago from 1926 until his untimely death in an automobile accident, and the author of the pioneering *Theory and Measurement of Demand* (Chicago: University of Chicago Press, 1938). Later Oskar Lange (1904-1965) was recruited in 1938 to make sense of continuing developments in macroeconomics and theories of imperfect and monopolistic competition. He left in 1945 to become the Polish ambassador to the U. S. Significantly for Chicago's subsequent evolution and for Ted's role in the department, Alfred Cowles, a wealthy business man who had founded the Cowles Commission in Colorado Springs with Irving Fisher and Ragnar Frisch and had also been instrumental in the founding of the Econometric Society, prevailed upon the University and the department to permit a move to Chicago where Henry Schultz was to become its Director. The move occurred just prior to Henry Schultz's death; Theodore O. Yntema (1900-1985), at Chicago 1923-1948 when he left to become vice president for finance of the Ford Motor Company, took the reins until a successor to Schultz could be found. Jacob Marschak (1898-1977) was recruited for the job in 1943; he, in turn, recruited Tjalling Koopmans in 1944; both left for Yale in 1955 when the Cowles Commission moved there to become the Cowles Foundation with considerably greater financial resources than heretofore. This was the milieu in which Ted, something of a protege of Viner and a great admirer of Knight, found himself. Conflict was building, exacerbated by the arrival of Milton Friedman (1912-) in 1946. George Stigler (1911- 1991), whom Ted had known at Iowa in 1936-1938, did not arrive until 1958, although he was also offered an appointment by the department in 1946.

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[11] There are a number of accounts of the nature and development of "The Chicago School", among them, M. W. Reder, "Chicago Economics: Permanence and Change," *Journal of Economic Literature, 20:* 1-38, 1982. Daniel Sumner's essay, "Agricultural Economics at Chicago," pp. 14-29 in J. M. Antle and D. A. Sumner, *The Economics of Agriculture,* Vol. 2, Chicago: University of Chicago Press, 1996, because of its focus gives more detail on the roles of Schultz and Johnson. But none of the accounts give Schultz the credit I believe he is due for having pulled disparate factions together and in many ways shaped the "School." My father, S. H. Nerlove, taught at the University of Chicago from 1920 to 1963 in the precursor of both the economics department and the Graduate School of Business and in the latter when the two split. He had been a student of J. M. Clark, Paul Douglas, and Jacob Viner, was a close friend of Henry Schultz and Oscar Lange, and knew Frank Knight well. Indeed, he knew everybody. I rely in part on conversations with him in the 1950's and 1960's with regard to Schultz's role from 1944 on.

In 1946, two years after Ted came to Chicago, he became chairman of the department, a post he held until 1961. The department was in some disarray: Lange who got along with everybody had left in 1945. Knight had lost interest in economics but at least was no longer so *actively* hostile to the quantitative and mathematical approach. Friedman, who was a fine statistician and quite capable of doing difficult and even mathematical theory and who, moreover, was strongly empirically oriented in a way Knight was not, inherited that mantle. Viner left that year. Douglas was busy making a political career, although his former student Gregg Lewis carried on his tradition of strong empirical focus. Friedman was joined in the same year, 1946, by W. Allen Wallis (1912-1998) at the Graduate School of Business; both were openly hostile to the Cowles group. It is difficult at this distance to know where Ted stood in this matter; my impression is that he knew the value of what Marschak and Koopmans and the group around them were doing, and certainly had a great deal of personal respect for both. He certainly had no wish to see them go, but in the end his mediation efforts failed: Cowles, Marschak and Koopmans moved to Yale in 1955 (some push, but a lot of pull, to be fair). But while it lasted, Cowles had a major impact on Chicago economics. Trygve Haavelmo, trapped by the war, was there until 1947; Gerard Debreu was there from 1948 and accompanied the group to Yale in 1955; and many, many others.[12] The list reads like a veritable *Who's Who* of economic theory and econometrics: Kenneth Arrow, Lawrence Klein, Franco Modgliani, Edmond Malinvaud, Hendrik Houthakker, Clifford Hildreth, Harry Markowitz, T. W. Anderson, Herman Rubin, Abraham Wald, and Leonid Hurwicz, to mention a few in no particular order. Once more, Chicago offered a home to innovative research on the fringes of what was then mainstream economics.

But Schultz's main contribution to Chicago economics was neither in hanging on to Cowles as long as Chicago did nor to its distinctive "public" image, which is largely that of Henry Simons, Friedman, Stigler, Wallis, and later Becker, Coase, Lucas, and Posner, but rather to the distinctive style of inquiry which emerged from the workshop system.[13] In agricultural economics there is a long tradition of collaborative and interactive research stemming from the organization of land-grant institutions and the specific obligations of research and extension imposed on them. What Schultz and his student D. Gale Johnson (1916-), who arrived at Chicago with him in 1944, did was to adapt this land-grant institution to the Chicago setting. This system came to dominate Chicago graduate training and research in all fields of economics has come to be widely imitated elsewhere, albeit nowhere with the success which has been achieved at Chicago.

Reder (1982, *op. cit*, p. 2) writes that "...the dominant characteristic of a Chicago economist's professional environment is the frequency and intensity with which he engages in substantive discussion about on-going research. Seminars, workshops, and discussion groups exist elsewhere, but at Chicago the number is [now] very large, and the discussion intense. While students attend them [indeed, actively participate]..., workshops are not student discussion groups. Rather they are places where faculty members of all ranks, and visitors, discuss current research and debate new results. The tone of the workshop discussion is greatly influenced by the fact that senior faculty members attend, and participate actively. The senior faculty is not confined to the workshop's directors, but normally include others. Workshops, therefore, are places where issues in current research are debated by leaders of the field immediately concerned and of adjacent fields as well." The style of a workshop also differs substantially from the usual seminar or lecture elsewhere: Elsewhere, the person presenting the seminar generally talks for most of the time with discussion confined to the last half hour (at best!); but, at a Chicago workshop, the paper is distributed beforehand, read thoroughly by participants (or supposed to be), and the presenter is given only 10 minutes or so before debate is joined. Such a style is the consequence of an on-going and coherent

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[12] See Christ, C.F., "The Cowles Commission's Contributions to Econometrics at Chicago, 1939-1955", *Journal of Economic Literature, 32:* 30-59, 1994.

[13] A. C. Harberger, who contributed greatly to the influence of Chicago economists and Chicago economics in the developing world, especially Latin America, has his own distinctive style and "image." He too put his own personal stamp on the workshop system. The powerful influence exerted by Ted, in turn, on Harberger and Chicago development economics is discussed below. In his remarks at the Memorial service, Gale Johnson emphasized the *joint* contribution of both to institutions and people as well as to research and policy in Latin America and elsewhere.

program of research. Such a coherent program was characteristic of the group around Schultz and Johnson from their arrival.[14]

In 1948, Ted who had already developed strong ties with the Rockefeller Foundation and related funding activities of the Rockefeller brothers, persuaded the Foundation to fund "...[a] program of research in agricultural economics under the direction of Professor T. W. Schultz." This was to be a multidisciplinary effort to study "... the full efficient use of human effort and capital in agriculture, and to indicate policies for modifying circumstances that give rise to underemployment and poverty."[15] This program and the funds it provided for graduate student support led directly to the establishment of the Workshop in Agricultural Economics, which served as the model for other workshops at Chicago, and which has characterized the Chicago style for more than 50 years. Research to 1951 dealt largely with problems related to resources, particularly labor, and the consequences of macroeconomic instability on U. S. agriculture. In 1951, the Rockefeller Foundation renewed its grant, but now emphasized the problem of low productivity and low income in U. S. agriculture. Problems of grain storage and price stability were also a continuing theme, with major pieces of research done by Robert Gustafson, Hendrik Houthakker, and Lester Telser. New work on natural resources was also undertaken by George Tolley under the auspices of this segment of the Rockefeller grant. Rockefeller support was renewed periodically throughout the 1950's and 1960's, even past Ted's "official" retirement, and into the 1970's, but the emphasis gradually shifted towards development, problems of international stability and human capital.[16] From the beginning, when focus was on U. S. agricultural policies and how incentives to invest in agriculture were distorted, to the present emphasis on poor countries, the influence of the distinctive Chicago point of view is apparent. Ted was both shaped by the Chicago School and did, himself, much to create it in its less doctrinaire form.

3. Agricultural Instability, Agricultural Productivity and Human Capital

Because of the history of instability of agricultural prices, the particularly disastrous consequences of the vicissitudes of weather, which have constantly affected agriculture since it emerged 12,000 years ago, the increasing effects of cyclical instability in the growing nonagricultural economy in which agriculture is immersed, and the relative immobility of agricultural resources, both human and nonhuman, there was a great concern among agricultural economists, and indeed more generally, with instability and uncertainty in agriculture. These concerns led to considerable legislation as well as research interest in both the problem of instability in agriculture generally and in the effects of policies, those proposed as well as those implemented, to deal with it and its consequence for farm people.[17] D. Gale Johnson's 1945 Ph.D. dissertation written under Schultz's direction and greatly inspired by him dealt with the problem and consequences of price instability in agriculture.[18] Many of Ted's early papers dealt with the economic effects of agricultural programs, expectation formation, the effects of uncertainty, and agricultural adjustment in a changing economy. His first important book, *Agriculture in an Unstable Economy* (1945) dealt with this topic. Much of this work is summarized in Ted's 1953 "quasi-textbook," *The Economic*

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[14] Griliches recalls that Ted "...read many of the papers written by his colleagues and students, across fields, and commented in detail on them." Wharton and Krueger also noted Ted's wide interests, openness to views differing from his own and willingness to expend considerable time and effort on the work of colleagues and students. It was this spirit that permeated the Chicago workshop system.

[15] Quoted by Sumner, *op. cit.*, p. 19, from the proposal.

[16] Other of Schultz's students from this period who should be mentioned are Vernon Ruttan, Robert Evenson, Finis Welch, Bruce Gardner and Wallace Huffman, but there were many, many more, and more still who were influenced by him at Chicago.

[17] A very brief account of the period and legislation of the 1930's and 1940's is contained in my *The Dynamics of Supply: Estimation of Farmers' Response to Price,* Baltimore: The Johns Hopkins Press, 1958, pp. 169-175. A detailed account of these policies and their historical and economic background is contained in Murray R. Benedict, *Farm Policies of the United States, 1790 - 1950: A Study of Their Origins and Development,* New York: The Twentieth Century Fund, 1953. Excerpts from much of the original legislation and related USDA publications of the period are to be found in Wayne D. Rasmussen, *Agriculture in the United States: A Documentary History,* New York: Random house, 1975, Vols. 3-4.

[18] Later published as *Forward Prices for Agriculture,* Chicago: University of Chicago Press, 1947.

Organization of Agriculture, especially Part II: "Economic Instability and Agriculture," pp.175-248, and Part III: "Economic Organization for Development and Stability," Chapter 19, "Organizing Agriculture for Economic Stability," pp. 321-334, and Chapter 20, "Organization for Price Stability," pp. 325-366.

It is now more-or-less common place that the effects of macroeconomic policy and macroeconomic events on agriculture is far greater than the other way around, even in developing countries in which the agricultural sector bulks large. But in the U. S. of the 1930's and 1940's that was not a generally held view among economists; Schultz's work, *inter alia*, helped to dispel our professional myopia.[19] More importantly, the beginnings of a more comprehensive view of the role of human capital were being developed.

After the war, Ted served as a consultant to the occupation forces in Germany under Lucius Clay. Although he rarely spoke about this experience and wrote only one paper directly related to it (*AER, 40,* 1950), I think it helped him to sharpen his ideas on the subject of human capital and its role in economic development, or, in this case, the recuperation of the German economy.[20]

From the very beginning, Ted was preoccupied with the puzzle of why the "facts" failed to reflect the widely held view of the prevalence of diminishing returns in agriculture. His first published paper, "Diminishing Returns in View of the Progress in Agricultural Production" (1932) dealt with this issue, but perhaps his most important essay on why we haven't observed classical diminishing returns to agriculture was "The Declining Importance of Agricultural Land," published in this journal in 1951. Ted's views on this matter and his resolution of the puzzle were greatly colored by his reading of the now famous 1928 paper by Allyn Young in this journal and his (Ted's) interpretation of Knight's theoretical argument against the existence of diminishing returns.[21] Knight's well-known views on the implications of uncertainty and the role of entrepreneurship were also instrumental in shaping Ted's views about the nature of human capital and the role of the human agent in coping with disequilibria. Somewhat belatedly, Ted recognized echoes of these ideas in Schumpeter's theory of economic development.[22]

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[19] Of course, the Populists, William Jennings Bryant in particular, knew this very well. John Steinbeck gives a description more consistent with what Schultz knew from experience to be the case in his 1939 novel *Grapes of Wrath.*

[20] The following passage, Mill, *loc. cit.*, directly concerns this point: "An enemy lays waste a country by fire and sword, and destroys or carries away nearly all moveable wealth existing in it: all its inhabitants are ruined, and yet, in a few years after, everything is much as it was before. ...If its effective population have not been extirpated at the time, and are not starved afterwards; then, with the same skill and knowledge which they had before, with their land and its permanent improvements undestroyed, ... they have nearly all the requisites for their former amount of production." (Mill, *loc. cit.*, p. 75.) In "Investment in Human Capital" (1961), Schultz puts the matter in a similar vein: "Another aspect of the same basic question, which admits of the same resolution, is the rapid postwar recovery of countries that had suffered severe destruction of plant and equipment during the war. The toll from the bombing was all too visible....Economists were called upon to assess the implications of these wartime losses for recovery. In retrospect, it is clear that they overestimated the prospective retarding effects of these losses. Having had a small hand in this effort, I have had a special reason for looking back and wondering why the judgements that we formed soon after the war proved to be so far from the mark. The explanation that is now clear is that we gave altogether too much weight to nonhuman capital in making these assessments. We fell into this error, I am convinced, because we did not have a concept of *all* capital and, therefore, failed to take account of human capital and the important part that it plays in production in the modern economy."

[21] Young, A., "Increasing Returns and Economic Progress," *Economic Journal, 38:* 527-542, 1928. Young's approach to increasing returns was via an extension of Smith's concept of the division of labor and its limitation by the extent of the market. (See George J. Stigler, "The Division of Labor Is Limited by the Extent of the Market," *Journal of Political Economy 59:* 185-193, 1951.)

[22] Schumpeter, J. A., *Theorie der wirtschaftlichen Entwicklung,* Leipzig: Duncker & Humblot, 1912. Many of these ideas that economic growth is essentially a disequilibrium phenomenon are re-echoed as well in Nicholas Kaldor's 1984 Mattioli Lectures, *Causes of Growth and Stagnation in the World Economy,* Cambridge: University Press, 1996.

The 1951 paper was pivotal in Ted's thinking about capital, especially human capital, knowledge, natural resources, value and growth. Much later in his 1977 Bicentennial Lecture to the Economic Research Service of the U. S. Department of Agriculture (reprinted in *Origins of Increasing Returns,* 1993), he wrote: "In thinking about nonrenewable natural resources, the common sense perception of their eventual exhaustion or permanent impairment as a source of amenities is not in dispute. ... The critical unsettled economic question in this connection pertains to the changes over time in the substitution possibilities among natural resources, labor, and reproducible capital." (p. 80.) To understand these possibilities "...We require an all-inclusive concept of capital. Reproducible tangible wealth is only one category of capital. Although natural resources are not reproducible, they are ...another category of capital. Human agents are the most important category in this all-inclusive concept...." (p. 73.) His 1956 paper, "Reflections on Agricultural Production and Supply, " lays out the idea that the "unexplained growth in agricultural output should be explained by expanding the concept of inputs to account for their quality and to treating new knowledge and the contribution of public invests in such knowledge as inputs. If inputs were correctly measured, he argued a "correct" index of output per unit of input ought to remain roughly constant. Here one can see the origins of growth accounting,[23] human capital theory,[24] and endogenous growth theory.[25]

Ted pursued the themes of the contribution of knowledge to productivity and of human capital, particularly the economics of education and of the family, throughout the 1960's and 1970's. Gary Becker (*op. cit.*, p. 1) gives much of the credit to Ted for reviving interest in Smith's all inclusive concept of capital: "Recent years have witnessed intensive concern with and research on investment in human capital, much of it contributed or stimulated by T. W. Schultz. The main motivating factor has probably been a realization that the growth of physical capital, at least as conventionally measured, explains a relatively small part of the growth of income in most countries. The search for better explanations has led to improved measures of physical capital and to an interest in less tangible entities, such as technological change and human capital. Also behind this concern is ...the rapid growth in expenditures on education and health." Earlier contributions to this revival include those of Milton Friedman and Simon Kuznets in *Income from Independent Professional Practice* (New York: National Bureau of Economic Research, 1945) and Jacob Mincer in "Investment in Human Capital and Personal Income Distribution" (*Journal of Political Economy, 66:* 281-302, 1958), although as their titles suggest, primary interest focused on the relation between investment in human capital and the personal distribution of income. Of course Becker himself and his students contributed mightily to the stream of human capital studies and ramifications. But much of the credit must go, as Becker avows, to Ted and the atmosphere he and Gale Johnson created in the Chicago department where Becker was a graduate student in the early 1950's.

Ted's most important and inclusive essay on human capital theory is his 1961 Presidential Address to the American Economic Association, "Investment in Human Capital." In this essay, Schultz lays out many of the most important applications of human capital theory: to the economics of health and of education, to family economics and the determination of population, *inter alia,* areas of research he vigorously pursued. His arguments in "Children: An Economic Perspective" (1973) and "The High Value of Human Time: Population Equilibrium" (1974) are central to an explanation of the so-called *demographic transition*, historically in Western Europe and taking place in developing countries today.[26]

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[23] Zvi Griliches, "Measuring Inputs in Agriculture: A Critical Survey," *Journal of Farm Economics, Proceedings Issue, 42(5):* 1411-1433, 1960. Griliches' important work on the economics of technical change was also inspired, as he himself acknowledges, by Schultz's view of the stock of knowledge as a form of capital, in which it was possible to invest.

[24] T. W. Schultz, "Investment in Human Capital," *American Economic Review, 51:* 1-17, 1961; Gary S. Becker, *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education,* 1st ed., New York: National Bureau of Economic Research, 1964. In his remarks at the Memorial service, Becker acknowledged the formative influence of Schultz's ideas on his own.

[25] Paul M. Romer, "Increasing Returns and Long Run Growth," *Journal of Political Economy, 94:* 1002-1037, 1986; Robert E. Lucas, "On the Mechanics of Economic Development," *Journal of Monetary Economics, 22:* 3-42, 1988; Kaldor, *loc. cit.*

[26] I have summarized the Schultzian perspective in "Household and Economy: Toward a New Theory of Population and Economic Growth." *Journal of Political Economy, 82*:S200-S218, 1974. From this perspective, the argument runs as follows: Good nutrition and health care increase youngsters' chances of

4. "The Economics of Being Poor" and Transforming Traditional Agriculture

Ted's most important contribution has been to transforming development economics.[27] I focus in this essay on the nature of this contribution in some detail.

In his scathingly vitriolic review of *Transforming Traditional Agriculture,* Thomas Balogh (1905-1985), later Lord Balogh, wrote (*Economic Journal, 74:* 996-999, 1964): "No transforming of Chicago: this is an ill-informed and potentially mischievous book on a subject which is among the most vital and most urgent in the world. It is ill-informed because Professor Schultz ignores literature essential if a balanced judgement on the transformation of primitive peasant agricultural production is to be arrived at, and the basis for effective policy is to be found in the largest and most populous parts of the world. ...It is also an unscientific book." Time has treated Schultz's work with greater charity than it has Lord Balogh's. It is difficult in retrospect to appreciate how revolutionary Ted's views on the economics of development were.[28]

Since the time of the classical economists and Marx, agriculture has been largely regarded as a source of labor, capital and sometimes entrepeneurship for development of the urban/industrial sector, the growth of which has been believed central to general economic development. Hand in hand with this view of agriculture is the doctrine of labor surplus and zero marginal productivity of labor in traditional

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survival and may also affect their ability to absorb future investments in intellectual capital. To the extent that such investments increase the life span, particularly the span of years over which a person can be economically active, such an increase in quality will raise the return to investments in human capital, which sons and daughters may later wish to make in themselves. To the extent that better health and nutrition result in a reduction in child mortality, they increase the satisfactions accruing to parents from other forms of investment, which also raise child quality, for the returns to these investments may then be expected to be enjoyed over a longer period of time on average. Better health and nutrition lower the costs of further investments in human capital relative to those in other forms of capital and increase the returns therefrom. As long as the rates of return to investments in human capital remain above, or fall more slowly than, the rates of return to investments in other forms of capital, parents will be induced to bequeath a greater part in the form of human capital. What happened sometime in the nineteenth and early twentieth centuries in the West was that the second agricultural revolution sparked off a cumulative movement away from an unstable equilibrium between population and natural resources, which reduced infant and child mortality and set off a cumulative process of investment in better health and nutrition and in public health, leading to a surge in economic growth and population, but eventually resulting in substitution of quality in the form of further human capital investments for numbers of children. The sources of such increases in the rates of return to investments in human capital are different today than in Europe in the late eighteenth and early nineteenth centuries, but the outcome is the same.

[27] At least, this is my view. Not all who knew him well, and whose own ideas were profoundly influenced by his, would agree. But all of his ideas on human capital, the sources of economic growth and increasing returns, and the importance of knowledge and input quality find reflection in his remarkable insights on the process of agricultural development and the role of agriculture in economic development more generally. Moreover, it can plausibly be argued that much of modern principal-agent and contract theory spring from early work on why sharecropping can be economically rational, in turn stimulated by Schultz's views that traditional agriculturalists were in fact behaving rationally.

[28] In notes for her remarks at the Schultz Memorial Service, Anne Krueger wrote: "It is almost impossible, with hindsight, to understand how great Ted's contribution to understanding economic development was. Development was seen to be 'different' because 'normal economics' didn't apply. It was said to be that cultural obstacles, structural rigidities, dependence on primary commodities and other phenomena made developing economies different. At bottom, people (most of whom were then in agriculture) were thought to be set in their traditional ways, either too content or too ignorant to be willing to change or to respond to incentives. ...Ted challenged all that frontally." The place of *Transforming Traditional Agriculture* in the development economics literature is assessed in detail in R. Ball and L Pounder, "'Efficient but Poor' Revisited," *Economic Development and Cultural Change,44:* 735-760, 1996.

agriculture. Modern versions of this theory of the relation between agriculture and other sectors in the process of economic growth in dealing with theories of dual development as exemplified by those of W. Arthur Lewis, extended by Ranis and Fei, and of Dale Jorgenson,[29] rest on a view of traditional agriculture in direct opposition to the characterization in *Transforming Traditional Agriculture* (1964), namely that traditional agriculture may be poor but it is nonetheless characterized by efficient use of the resources available. This implies that, if factors of production are withdrawn from the agricultural sector in order to fuel the growth of the nonagricultural sectors of a developing economy, agricultural output will fall and the terms of trade between agriculture and nonagriculture will turn in favor of agriculture, choking off further growth and development of both sectors. Why then is traditional agriculture so poor and why does it appear so stagnant? A part of the explanation is provided by Sol Tax, on whom Schultz relies, in terms of the lack of modern or effective technology.[30] But this is not the whole story, for it remains to explain why there is so little investment in the discovery and development of more effective technology in a traditional context. This is what Schultz attempts to explain and in so doing to lay the foundation for a theory of how agriculture is, or can be, transformed from traditional to modern.

Schultz (*op. cit.*, pp.3-4) puts the problem as follows: "The man who farms as his forefathers did cannot produce much food no matter how rich the land or how hard he works. The farmer who has access to land and knows how to use what science knows about soils, plants, animals, and machines can produce an abundance of food though the land be poor. Nor need he work nearly so hard and long. He can produce so much that his brothers and some of his neighbors will move to town to earn their living. Enough farm products can be produced without them. The knowledge that makes this transformation possible is a form of capital whenever it is an integral part of the material inputs farmers use and whenever it is part of their skills and what they know....Farming based wholly upon the kinds of factors of production that have been used by farmers for generations can be called traditional agriculture....How to transform traditional agriculture, which is niggardly, into a highly productive sector of the economy is the central problem....Basically this transformation is dependent upon investing in agriculture." Under what circumstances will the kind of investment need to effect the *agricultural transformation*, as this process is called, be forthcoming endogenously in a developing economy and under what circumstances must outside forces, exogenous to the agricultural sector, come into play?

The view that Schultz seeks to counter is stated by him in rather stark terms (*op. cit.*, p.8): "... the opportunity for growth from agriculture is among the least attractive of the sources of growth; agriculture can provide a substantial part of the capital that is required to mount industrialization in poor countries; it can also provide an unlimited supply of labor for industry; it can provide much labor at zero opportunity costs because a considerable part of the labor force in agriculture is redundant in the sense that its marginal productivity is zero; farmers are not responsive to normal economic incentives but instead often respond perversely, with the implication that the supply curve of farm products is backward sloping; and large farms are required in order to produce farm products at minimum costs."

In contrast, Schultz (*op. cit.*, p.16, *ad passim*) proposes that: "...the agricultural sector in a large class of poor countries is relatively efficient in using the factors of production at its disposal....Farm people who have lived for generations with essentially the same resources tend to approximate the economic equilibrium of the stationary state. When the productive arts remain virtually constant over many years, farm people know from long experience what their own effort can get out of land and equipment. In allocating the resources at their disposal, in choosing a combination of crops, in deciding on how and when to cultivate, plant, water and harvest, and with what combination of tools to use with draft animals and

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[29] Lewis, W. A., "Economic Development with Unlimited Supplies of Labour," *Manchester School of Economics and Social Studies, 22*: 139-91, 1954.
Lewis, W. A., "Unlimited Labour: Further Notes," *Manchester School of Economics and Social Studies, 26*: 1-31,1958.
Ranis, G., and Fei, J.C.H., "A Theory of Economic Development," *American Economic Review, 51*: 533-565, 1961.
Jorgenson, D.W., "The Development of the Dual Economy," *Economic Journal, 71*: 309-34, 1961.

[30] Tax, Sol, *Penny Capitalism*. Chicago: University of Chicago Press, 1963. (First published in 1953 by the Smithsonian Institution.)

simple field equipment -- these choices will embody a fine regard for marginal costs and returns. These farm people also know from experience the value of their household production possibilities; in allocating their own time along with material goods within the domain of the household, they too are finely attuned to marginal costs and returns. Furthermore, children acquire the skills that are worthwhile from their parents as children have for generations under circumstances where formal schooling has little economic value."

Despite the clarity of Schultz's arguments, I do not believe that his characterization of what it means to be poor have been widely appreciated by theorists of economic growth, not because the vast majority, unlike Ted himself, have not themselves been very poor, but because Ted did not cast his argument in "modern" mathematical form. I think it is worthwhile to spell out his characterization in some detail because the breathtaking simplicity of his vision does not seem to have penetrated current discussions of growth.

Schultz (*op. cit.*, especially Chapter 6) spends a great deal of effort arguing that the costs of the income streams yielded by net new investments in traditional forms of capital in traditional agriculture are very high in terms of foregone consumption. The rate of time preference in traditional societies is high. This is because people are very poor; the value of current consumption is high relative to future consumption when it spells the difference between life or death for people "living on the edge."

The implications of allocative efficiency, stationary equilibrium, and high rates of time preference in traditional agriculture are responsible for the apparent stagnant quality of traditional agriculture and low or zero rates of investment in physical and human capital and knowledge. In the technical appendix to this section, I present a simple (mathematical) model of investment in a traditional society in stationary equilibrium, which illustrates these implications:

• Given the state of agricultural knowledge and the relative scarcities of each quality of each factor of production, factors are allocated efficiently in the sense that all are fully employed up to the point at which their marginal value products (*shadow prices* in modern terminology) are equal in every use. It follows that agricultural output cannot be increased by reallocating factors of production.

Think of every factor of production as the flow of services from a stock of capital available to society at the beginning of each period: this may be the human population with individuals' embodied skills and knowledge, tools, buildings, ditches, fences and other physical capital, land and its qualities, or the stock of general knowledge. The flows of services from these stocks yield a flow of output or *gross income* during the period (according to some production function) but are wholly or partially used up in the process. Tools wear out, ditches silt up, seed germinates and is transformed. Thus, in order to maintain the stocks of capital and corresponding flows of services in the next period, some current output must be devoted to replenishing them, that is, some potential consumption must be foregone. The aggregate of consumption foregone in order to maintain stocks of capital is *depreciation.* Similarly, human beings die and must be replaced by children, the rearing of whom is not costless. The difference between gross income and the amount of output available to society for consumption if capital stocks are to be maintained is *net income.* In a society in stationary equilibrium, stocks are just maintained and are the same at the beginning of every period; consumption each period is equal to net income. In order to augment any stock of capital and its associated flow of services, some additional consumption would have to be foregone; the difference between net income and consumption is *net new investment. Gross investment* is the sum of net new investment and depreciation.

• Traditional agriculture is in a state of stationary equilibrium, that is to say, given the state of knowledge and relative factor scarcities, farmers not only have no incentive to change the allocation of factors, they have little incentive to invest in augmenting the supply of any factor. Any incremental increase in any factor of production will bring only a return equal to its shadow price, which is in common with every other factor. If the stock of agricultural knowledge embodied in farm people is regarded as a factor of production like other material factors, it too has a shadow price equal to all others and, in

equilibrium, its shadow price represents the return to its incremental augmentation.[31] The implication of optimal allocation in traditional agriculture is that we might as well think of a single factor of production, which is the flow of services yielded by the stock of a single type of capital.

Human beings represent a profound complication in the analysis when fertility is endogenous, since they are both a produced factor of production and the ultimate consumers of output. In the following exposition of Schultz's characterization of traditional agriculture, I neglect this complication by assuming that population is exogenously determined and constant from one generation to the next. (Schultz did not neglect the complication and, indeed was much concerned with the endogeneity of population growth in subsequent work. See section 3 above.) The simplification of a single type of capital and a single factor of production is then possible without loss of significant generality.

• Because the traditional agricultural sector is in equilibrium, the demand for investment in the stock of capital, which includes human capital and knowledge, is essentially a replacement demand. The marginal product of a factor of production, which is best thought of as the marginal product of the flow of services yielded by a corresponding capital stock, may be large or small, but the expected returns from *net new investment* in that stock must be very small relative to the community's rate of time preference, i.e., the equilibrium rate at which the possibility of additional future consumption is traded off against the reality of present consumption, by the representative individual.[32] In traditional agriculture, the expected returns from net new investment are low relative to the costs, in terms of foregone consumption, of making such investments, and the rate of time preference is high. In stationary equilibrium there is no net new investment.[33] Consequently, traditional agriculture appears stagnant.

The implication of Schultz's analysis for the modernization of traditional agriculture, is that something exogenous must happen to disturb the equilibrium of traditional agriculture. That something could be the discovery of new technology and knowledge and new opportunities for net investment, which would yield greater possibilities for future consumption than can be realized by investing in traditional factors of production and knowledge. Or it could be a response to population growth *a la* Boserup.[34]

A general formal analysis of these propositions is difficult because consumption and income streams, as well as costs may vary over time and because time preference is not simple to characterize in a multiperiod context. Stationarity helps to simplify matters a great deal because it means that each pair of periods is like any other pair and population is unchanging. In a technical appendix to this section, I give an analysis of the stationary case, in which some additional simplifying assumptions are introduced. I think to the mathematically literate this Appendix will clarify what Schultz says.

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[31] The difference between skills and knowledge embodied in the human agent and other forms of knowledge and stocks of physical capital is that the rate of return to embodied human capital is very sensitive to the expectation of life; see "Life Span, Health, Savings, and Productivity," with Rati Ram, 1979. Moreover, such embodied human capital needs constantly to be replaced as each generation gives way to the next; the vessels in which it is stored must be constantly replenished as well.

[32] Knowledge and skills, whether embodied or not, obviously represent a special category of capital in this respect, since the returns to a quantum jump in the stock of such capital are inherently unknowable by those potential investors who must decide whether to augment such a stock rather than merely replacing it.

[33] That *net new investment* is essentially a *disequilibrium* phenomenon was first cogently put, to the best of my knowledge, by Trygve Haavelmo, *A Study in the Theory of Investment.* Chicago: University of Chicago Press, 1960.

[34] Boserup, Ester, *The Conditions of Agricultural Growth.* Chicago: Aldine Publishing Co. Chaps 1-4, pp. 15-42,1965.
Idem, Population and Technological Change. Chicago: University of Chicago Press. Chapters 1-7, pp. 3-90, 1981.
Idem, Economic and Demographic Relationships in Development. Baltimore: The Johns Hopkins University Press. Part I, pp. 11-90, 1990.

A Personal Note

I hope I may be excused for closing this essay on Ted Schultz on a personal note.

I last saw Ted in March, 1997, just short of a year before his death. In those last years, my wife and I had made it a practice to visit Ted during our annual trips to Evanston to spend time with my grandchildren. Not long before, I had returned from a month long visit to Côte d'Ivoire, Mozambique and Kenya and had written an extended report of my visit which I wanted very much to discuss with him.[35] In particular, I was concerned that the widely prevailing view in the development community that sub-Saharan Africa was a basket case, essentially hopeless, because of poor resources and the prevalence of disease, did not square with my observations or with my "sense" of the situation. Ted was in a wheelchair convalescing from a broken hip; he wheeled himself up to a table piled with books and fished out a copy of Edward Steichen's book of photographs, *The Family of Man*; turning to a photo showing the bright and smiling faces of African children, he said, "There's the hope and the future of Africa. Can you look at those faces and say that Africa is hopeless?" His faith in the human spirit and his belief that humanity is the ultimate resource persisted until the end.

Bibliographic Notes[36]

The Schultzian corpus is enormous. What follows is a limited and somewhat personal selection:

In two volumes published near the end of his life, Ted collected many of his earlier papers, which he considered important and some of which were published in obscure places, hard to obtain, or unpublished. These are:

Origins of Increasing Returns, Oxford: Basil Blackwell, 1993.*

The Economics of Being Poor, Oxford: Basil Blackwell, 1993.**

Not all of the papers listed separately below are reprinted in these two volumes; those that are are marked * or **.

Ted "recycled" a number of earlier papers, but recombined and so transmogrified the originals that the earlier work is hardly recognizable, in

Restoring Economic Equilibrium: Human Capital in the Modernizing Economy , Oxford: Basil Blackwell, 1990.

His most famous book, the one specifically mentioned in the Nobel prize announcement, was:

Transforming Traditional Agriculture, New Haven: Yale University Press, 1964.

Among the other volumes he published over the years, the following should be mentioned:

Investing in People: The Economics of Population Quality, Berkeley: University of California Press, 1981.

Investment in Human Capital: The Role of Education and of Research, New York: The Free Press, 1971.

Education and Productivity, Washington, DC: GPO, Superintendent of Documents, 1971.

Economic Growth and Agriculture, New York: McGraw-Hill, 1968.

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[35] "In and Out of Africa, July 27 - August 23, 1996: A Journal," available at http://www.arec.umd.edu/mnerlove/mnerlove.htm

[36] As far as I am aware a comprehensive bibliography of Ted Schultz's writings does not exist. I have assembled this one from various sources and hope it may prove useful to Schultz connoisseurs.

Economic Crises in World Agriculture, Ann Arbor, MI: University of Michigan Press, 1965.

The Economic Value of Education, New York: Columbia University Press, 1963.

The Economic Organization of Agriculture, New York: McGraw-Hill, 1953.

Production and Welfare of Agriculture, New York: Macmillan, 1949.

Agriculture in an Unstable Economy, New York: McGraw-Hill, 1945.

Many of Ted's important articles are included in some form in the three books published in 1990 and 1993, cited above. But he edited many volumes and special issues of the *Journal of Political Economy,* and his introductions to these volumes are gems:

Distortions of Agricultural Incentives, Bloomington, IN: University of Indiana Press, 1978.

Economics of the Family: Marriage, Children and the Family, Chicago: University of Chicago Press, 1974.

Investment in Education: The Equity-Efficiency Quandary, Chicago: University of Chicago Press, 1972.

Food for the World: The Harris Foundation Lectures, Chicago: University of Chicago Press, 1944.

Ted was a great contributor of "occasional" pieces. Many of these are included in the selection listed below, but many are not. Papers included in the two collections published in 1993 are marked * or ** as indicated above.

"Value of U. S. Farm Surpluses to Underdeveloped Countries, " pp. 53-63 in V. W. Ruttan, ed., *Why Food Aid?,* Baltimore: Johns Hopkins University Press, 1993.

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TECHNICAL APPENDIX TO SECTION 4

Let K_0, K_1, K_2, K_3, ... be the stocks of capital available to society in the current and subsequent periods. In each period, the stock K yields a flow of services that can be transformed in to output = gross income y by the function

(1) $$y_n = f(K_n), n = 0,1,2,\ldots \ .$$

Let the cost, in terms of foregone consumption in the current period, of augmenting the stock of capital by one unit be $I_0 \geq 0$, and let the depreciation of the stock between period 0 and period 1 be d_0. If the stock of capital is just maintained between the two periods, consumption can be equal to net income, i.e., gross income minus depreciation:

(2) $$c_0 = y_0 - d_0 \ ,$$

whereas, if the capital stock is augmented by one unit in the next period, consumption can be only

(3) $$c_0^{\bullet} = y_0 - d_0 - I_0 \ .$$

The difference between the two values, I_0, is foregone consumption. If the new stock of capital is maintained at K_1 gross income will be y_1 in all subsequent periods but depreciation will increase to d_1 so that potential consumption in the next and all subsequent periods will be only

(4) $$c_1 = y_1 - d_1 \ .$$

But c_1 is certainly larger than c_0 -- otherwise what's the point?

Let me now assume that a representative individual's utility in this society for his consumption and that of all his progeny and himself in future periods, that is, the consumption stream, $c_0, c_1, c_2, \ldots$, is characterized by an additively separable, recursive utility function, such that today's utility of the stream is

(5) $$V(c_0, c_1, c_2 \ldots) \equiv U(c_0) + \rho V(c_1, c_2, c_3, \ldots), \text{ where } 0 \leq \rho \leq 1.$$

It is well-known that this formulation is equivalent to

(6) $$V(c_0, c_1, \ldots) = \sum_0^{\infty} \rho^n U(c_n) \ .$$

Time preference in this formulation is measured by how much present consumption an individual is willing to give up in order to get a little bit more in future and retain the same utility level

$$dV = 0 = \rho^n U'(c_n) dc_n + \rho^{n+1} U'(c_{n+1}) dc_{n+1} \ ,$$

that is,

$$-\frac{dc_n}{dc_{n+1}} \equiv \rho \frac{U'(c_{n+1})}{U'(c_n)} = r \ ,$$

where, under stationary conditions, r is a constant >0 but <1, since $0 < \rho < 1$, and assuming diminishing marginal utility of consumption. r will be smaller the greater is the rate at which the future is discounted,

that is the smaller is ρ, and the faster the marginal utility of consumption is diminishing.[37] The smaller is r, the greater the *rate of time preference*, that is the greater is the preference for present versus future consumption.

Now let us consider the utility of the representative member of society for these two consumption streams: c_0 forever versus c_0-I_0 then c_1 ever after. We will also need a measure of the utility of the stream c_1, c_1, c_1, ... forever:

$$V_0 = V(c_0, \ldots) = \sum_0^\infty \rho^n U(c_0) = \frac{U(c_0)}{1-\rho}$$

$$V_1 = V(c_1, \ldots) = \frac{U(c_1)}{1-\rho}$$

$$V^* = U(c_0 - I_0) + \rho \sum_0^\infty \rho^n U(c_1) = U(c_0 - I_0) + \rho V_1 \quad .$$

Now if I_0 is small relative to c_0, but not necessarily small relative to c_1-c_0,

$$U(c_0 - I_0) \cong U(c_0) - U'(c_0) I_0 \quad ,$$

so that

$$V^* - V = \rho[V_1 - V_0] - U'(c_0) I_0 \quad , \tag{7}$$

which is greater than, equal to, or less than zero, according as

$$r\left[\frac{V_1 - V_0}{U'(c_1)}\right] \text{ is greater than, equal to, or less than } I_0 \; . \tag{8}$$

It follows that the gain in utility for the representative member of society is likely to be negative when I_0 is large relative to the difference in the utilities of the consumption streams c_1, ... versus c_0, ... , respectively, when the rate of time preference is great (r is small), and the larger is the single-period marginal utility of consumption relative to the difference V_1-V_2.

I think this is what Schultz had in mind.

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[37] My colleague, Robert Chambers, suggests that this argument can be made more simply and more generally in graphical terms without introducing r; however my formulation gets us where I want to go, so I let it stand.