

# Catching Up with the Economy<sup>†</sup>

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In his Presidential Address five years ago, Zvi Griliches (1994) called attention to the severe difficulties that beset current attempts to measure the growth of labor productivity in the American economy. Because of these difficulties, it is likely that the true rate of economic growth is substantially underestimated. The root of the problem is the difficulty in measuring output in the service sector which now represents two-thirds of the economy. In such sectors as health care and information services, the contribution to gross domestic product (GDP) is measured by inputs rather than outputs, a procedure that makes it impossible to gauge accurately improvements in the quality of output. Thus, in the case of computers, which are transforming American society, economists have been unable, so far, to find a measurable contribution of computers to the rise in labor productivity—an astonishing paradox.

I want to follow up on this problem of mis-measurements. My thesis is that the profession

is lagging behind the economy more than it has to. We are, to some extent, entangled in concepts of the economy and in analytical techniques that were developed during the first third or so of the century, when economics emerged as a modern discipline. The range of the discipline did not expand greatly during the middle decades of the century, due partly to a concentration on the reformulation of the previous analytical concepts and techniques in more sophisticated and more general mathematical models. Although the dividends from these efforts were high and have contributed to the flexibility and capacity of economics, they did not encourage a reconsideration of some of the received assumptions about the scope and focus of economic analysis. There has been a significant broadening of the scope of economics during recent decades, with the emergence of such fields as the new household economics, the new institutional economics, the economics of aging, and medical economics, but much remains to be done.

The balance of this address is divided into four sections. I begin with the inadequate attention to the *accelerating* rate of technological change, the implications of this acceleration for the restructuring of the economy, and its transforming effect on human beings. I then consider the neglect of the nonmarket sector of the economy, the implication of that neglect for the measurement of consumption, and for the analysis of economic growth. The third section deals with the need to shift the focus of economic analysis from cross-sectional to life-cycle and intergenerational data sets, especially in connection with forecasting. The final section points to the impact of cultural lag in the treatment of material inequality, and the neglect of the more severe problem of spiritual inequality. I use the word spiritual not in its religious sense but as a reference to commodities that lack material form. Spiritual or immaterial commodities make up most of consumption in the United States and other rich countries today.

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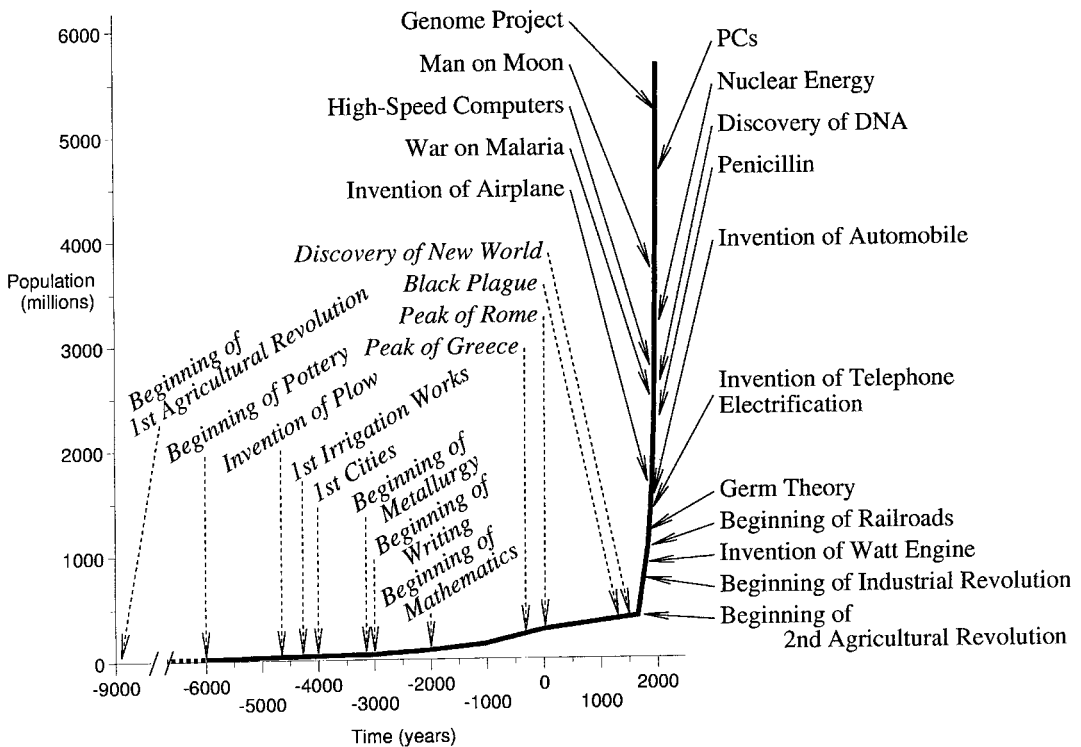


FIGURE 1. THE GROWTH OF THE WORLD POPULATION AND SOME MAJOR EVENTS IN THE HISTORY OF TECHNOLOGY

*Notes:* There is usually a lag between the invention of a process or a machine and its general application to production. "Beginning" means the earliest stage of this diffusion process.

*Sources:* Carl W. Bishop, 1936; T. K. Derry and T. I. William, 1960; Graham Clark, 1961; B. H. Slicher von Bath, 1963; Stuart Piggott, 1965; Glenn T. Trewartha, 1969; William McNeill, 1971; Jacob Bronowski, 1973; Carlo M. Cipolla, 1974; B. M. Fagan, 1977. See also E. A. Wrigley, 1987; Robert C. Allen, 1992, 1994.

## I. Some Implications of Technophysio Evolution

The rapid acceleration in technological change is apparent in the decline in mortality rates during the twentieth century. Study of the causes of this decline point to the existence of a synergism between technological and physiological improvements that has produced a form of human evolution that is biological but not genetic, rapid, culturally transmitted, and not necessarily stable. This process, which is still ongoing in both rich and developing countries, has been called "technophysio evolution."

Unlike the genetic theory of evolution through natural selection, which applies to the whole history of life on earth, technophysio

evolution applies only to the last 300 years of human history, and particularly to the last century. Despite its limited scope, technophysio evolution appears to be relevant to forecasting likely trends over the next century or so in longevity, the age of onset of chronic diseases, body size, and the efficiency and durability of vital organ systems. It also has a bearing on such pressing issues of public policy as the growth in population, in pension costs, and in health-care costs (Fogel and Dora L. Costa, 1997).

Technophysio evolution implies that human beings now have so great a degree of control over their environment that they are set apart not only from all other species, but also from all previous generations of *Homo sapiens*.

This new degree of control has enabled *Homo sapiens* to increase its average body size by over 50 percent, to increase its average longevity by more than 100 percent, and to improve greatly the robustness and capacity of vital organ systems.<sup>1</sup>

Figure 1 helps to point out how dramatic the change in the control of environment after 1700 has been, and it highlights the astounding acceleration of technological change over the past two centuries. The advances in the technology of food production after the Second Agricultural Revolution (which began about 1700 A.D.) were far more dramatic than those associated with the First Agricultural Revolution since they permitted population to increase at so high a rate that the line of population appears to explode, rising almost vertically. The new technological breakthroughs in manufacturing, transportation, trade, communication, energy production, leisure-time services, and medical services were in many respects even more striking than those in agriculture. Figure 1 emphasizes that prior to 1600, centuries elapsed between major technological advances and the process of diffusion was even more extended, continuing over several millennia. Studies of the origin and diffusion of the plow, for example, show how little improvement there was in its design between its original development in the Mesopotamian valley around 4000 B.C. and its diffusion across the Mediterranean Sea and northward in Europe down to the beginning of the second millennium (Bishop, 1936; E. Cecil Curwen, 1953).

To my mind nothing better illustrates this amazing acceleration in technological change than the realization in the twentieth century of humankind's ancient desire to fly. The first successful motor-driven flight took place in 1903, but the fragile aircraft of Wilbur and Orville Wright traveled only a few hundred feet. Just 66 years later, an astronaut was standing on the moon, talking to another astronaut on earth, and hundreds of millions of

<sup>1</sup> Between circa 1775 and 1995 weight in England increased by about 40 percent, while weight in France increased by about 60 percent (cf., Fogel and Roderick Floud, 1999).

TABLE 1—A COMPARISON OF ENERGY AVAILABLE FOR WORK DAILY PER CONSUMING UNIT IN FRANCE, ENGLAND AND WALES, AND THE UNITED STATES, 1700–1994 (IN KILOCALORIES)

| Year              | France | England and Wales | United States |
|-------------------|--------|-------------------|---------------|
|                   | (1)    | (2)               | (3)           |
| 1700 <sup>a</sup> |        | 720               | 2,313         |
| 1705              | 439    |                   |               |
| 1750              |        | 812               |               |
| 1785              | 600    |                   |               |
| 1800              |        | 858               |               |
| 1840              |        |                   | 1,810         |
| 1850              |        | 1,014             |               |
| 1870              | 1,671  |                   |               |
| 1880              |        |                   | 2,709         |
| 1944              |        |                   | 2,282         |
| 1975              | 2,136  |                   |               |
| 1980              |        | 1,793             |               |
| 1994              |        |                   | 2,620         |

Source: Fogel and Floud (1999).

<sup>a</sup> Prerevolutionary Virginia.

people around the world overheard and watched that conversation.

Worldwide, the most important aspect of technophysio evolution is the continuing conquest of chronic malnutrition, which was virtually universal three centuries ago.<sup>2</sup> Table 1 shows that in rich countries today some 1,800 to 2,000 or more kilocalories (kcal) of energy are available for work daily per equivalent adult male, aged 20–39.<sup>3</sup> At the beginning of the eighteenth century, however, France produced less than one-fifth of the current U.S. amount of energy available for work. And England was not much better off. Only the United States provided potential energy for work equal to or greater than late-twentieth-century levels during the eighteenth and early nineteenth centuries, although some of that energy

<sup>2</sup> Even the English peerage, with all its wealth, had a diet during the sixteenth and seventeenth centuries that was deleterious to health. Although abundant in calories and proteins, aristocratic diets were deficient in some nutrients and included large quantities of toxic substances, especially alcoholic beverages and salt (Fogel, 1986).

<sup>3</sup> Procedure for construction of Table 1 are described in Fogel and Floud, 1999.

was wasted due to the prevalence of diarrhea and other conditions that undermined the body's capacity to utilize nutrients (Fogel and Floud, 1999).

One implication of these estimates of caloric availability is that mature adults of the eighteenth and much of the nineteenth century must have been very small by current standards and less physically active. Today the average American male in his early thirties is about 177 cm (70 inches) tall and weighs about 78 kg (172 pounds). Such a male requires daily about 1,800 kcal for basal metabolism and a total of 2,300 kcal for baseline maintenance. If either the British or the French had been that large during the eighteenth century, virtually all of the energy produced by their food supplies would have been required for personal maintenance, with little available to sustain work. To have the energy necessary to produce the national products of these two countries circa 1700, the typical adult male must have been quite short and very light (Fogel, 1997).

Recent studies have established the predictive power of height and weight at early ages with respect to onset of chronic diseases and premature mortality at middle and late ages. Variations in height and weight appear to be associated with variations in the chemical composition of the tissues that make up vital organs, in the quality of the electrical transmission across membranes, and in the functioning of the endocrine system and other vital systems. Nutritional status thus appears to be a critical link connecting improvements in technology to improvements in human physiology (Fogel and Costa, 1997).

So far I have focused on the contribution of technological change to physiological improvements. The process has been synergistic, however, with improvement in nutrition and physiology contributing significantly to economic growth and technological progress in a manner described elsewhere (Fogel, 2000). Here I merely want to point out the main conclusion. Technophysio evolution appears to account for about half of British economic growth over the past two centuries. Much of this gain was due to the improvement in human thermodynamic efficiency. The rate of converting human energy input into work out-

put appears to have increased by about 50 percent since 1790 (cf., Partha Dasgupta, 1993).

Technophysio evolution calls into question a number of easy and frequent assumptions in economic analyses such as: tastes are fixed; needs are fixed or exogenously determined; existing life tables are adequate to forecast future pension costs in 2030 or 2075; and the rate of aging is genetically controlled and unchanging from one generation to another.

Technophysio evolution also calls into question such frequently used theoretical assumptions as fixed utility functions, fixed rates of time preference over the life cycle, and the related assumption that, except for risk differentials, economic phenomena should generally be subject to the same rate of discount. Yet the rate of discount varies over the life cycle; children, after all, have much higher time preferences than adults. It may also vary by religion. Some individuals are prepared to wait for their reward in heaven while others want it here and now. Moreover, these differences may be evolving and multiplying more rapidly than is now presumed, as is indicated by the debates over the impact of greenhouse gases. Rethinking of the issue is now underway (see William D. Nordhaus, 1997; cf., Peter Koslowski, 1992; Nazli Choucri, 1993; Marc Fleurbaey and Philippe Michel, 1994; Michael Toman, 1994) but the profession can benefit from an increased allocation of resources to this problem.

Technophysio evolution requires not just marginal adjustments, but major leaps in economic theory. We are slow in pondering such grand questions as the implications of the Human Genome Project, which is now nearing completion, and the emergence of molecular medicine for the future of economic life. We have entered an era in which purposeful intervention in evolutionary processes is passing beyond plant and animal breeding. The new growth economics needs to incorporate at least some aspects of directed, rapid human evolution. Endogenous technological change needs to extend to the fundamentals of human behavior. Theorists also need to grapple with the ethical implications of technological changes that, whatever their positive aspects, threaten to undermine the mystery of human life by transforming people into "material" that is

transplanted, cloned, arbitrarily altered in external appearance, artificially changed in personality and intelligence, and otherwise manufactured in ways that challenge the definition of a human being (cf., Zbigniew Brzezinski, 1996).

## II. The Growth of the Nonmarket Sector<sup>4</sup>

One aspect of technophysio evolution has been a change in the structure of consumption and in the division of discretionary time between work and leisure. Perhaps the best index of the growth of the nonmarket sector is the change in the use of time. Changes in hours of work and in the average division of the day have paralleled the changes in the structure of consumption. Table 2 shows the remarkable reduction in the workyear that has occurred for males in the U.S. labor force over the past century. Sleep, meals, and essential hygiene, which are biologically determined, required about 10 hours of the day in 1880, as they do today. The remaining 14 hours represent "discretionary" time.

The most notable feature of Table 2 is the large increase in leisure available to the typical male worker. His leisure time has tripled over the past century, as his workyear declined from about 3,100 hours to about 1,730 hours today. Table 2 also forecasts the division of the average day in 2040, indicating that by that date more than half of the discretionary day will be devoted to leisure activities. The forecast is for a reduction of the workyear from the current average of about 1,730 hours to just 1,400 hours, with the average workweek down to 30 hours.

The pattern of change among women was similar to that among men (cf., Claudia Goldin, 1990; Stanley Lebergott, 1993). The workday of women in 1880 was somewhat longer, and in some respects may have been more arduous, than that of men. In households of working farmers, artisans, and manual laborers, wives rose before their husbands and continued working until bedtime at 10 or 11 P.M. That routine suggests a workday that

TABLE 2—SECULAR TRENDS IN TIME USE: THE AVERAGE HOURLY DIVISION OF THE DAY OF THE AVERAGE MALE HOUSEHOLD HEAD (BASED ON A 365-DAY YEAR)

|                                 | c.1880 | c.1995 | c.2040 |
|---------------------------------|--------|--------|--------|
| Sleep                           | 8      | 8      | 8      |
| Meals and essential hygiene     | 2      | 2      | 2      |
| Chores                          | 2      | 2      | 2      |
| Travel to and from work         | 1      | 1      | 0.5    |
| Work                            | 8.5    | 4.7    | 3.8    |
| Illness                         | 0.7    | 0.5    | 0.5    |
| Subtotal                        | 22.2   | 18.2   | 16.8   |
| Residual for leisure activities | 1.8    | 5.8    | 7.2    |

may have run about 15 minutes longer than that of males, implying an annual workyear of perhaps 3,200 hours.

As a result of the mechanization of the household, smaller families per household, and the marketing of prepared foods, the typical nonemployed married woman today spends about 3.4 hours per day engaged in housework; and if she is employed the figure for housework drops to 2.2 hours. However, women in the labor force average about 4.4 hours per day as employees. Hence combining "work" with "chores," men and women work roughly equal amounts per day, and both enjoy much more leisure than they used to. The principal difference is that the gains of women have come exclusively from the reduction in hours of housework, while the gains of men have come from the reduction in the hours of employed work (cf., John P. Robinson and Geoffrey Godbey, 1997).

I have so far retained the common distinction between work and leisure, although these terms are already inaccurate and may soon be obsolete. The distinction was invented when most people were engaged in manual labor for 60 or 70 hours per week and was intended to contrast with the highly regarded activities of the English gentry or their American equivalent, Thorsten Veblen's (1899) "leisure class." However, it should not be assumed that members of the leisure class were indolent. In their youth they were students and athletes. In young adult years they were warriors. In middle and later ages they were judges,

<sup>4</sup> This section draws on Fogel, 2000.

TABLE 3—ESTIMATED TREND IN THE LIFETIME  
DISTRIBUTION OF DISCRETIONARY TIME

|                              | c. 1880 | c. 1995 | c. 2040 |
|------------------------------|---------|---------|---------|
| Lifetime discretionary hours | 225,900 | 298,500 | 321,900 |
| Lifetime earnwork hours      | 182,100 | 122,400 | 75,900  |
| Lifetime volwork hours       | 43,800  | 176,100 | 246,000 |

bishops, merchant princes, and patrons of the arts. Whatever they did was for the pleasure it gave them since they were so rich that earning money was not their concern.

Hence, leisure is not a synonym for indolence, but a reference to desirable forms of effort or work. As George Bernard Shaw (1928) put it, "labor is doing what we must; leisure is doing what we like; and rest is doing nothing whilst our bodies and our minds are recovering from their fatigue." In order to avoid confusion, in the balance of this address I reserve the word "work" for use in its physiological sense, an activity that requires energy, over and above the basal metabolic rate (BMR). Activity aimed primarily at earning a living I will call "*earnwork*." Purely voluntary activity, even if it incidentally carries some payment with it, I will call "*volwork*."

Why have hours of earnwork declined so much in recent years? The answer to that question is suggested by the fact that it is not just daily and weekly hours of earnwork that have declined. The share of lifetime discretionary hours spent in earnwork has declined even more rapidly. Table 2 only dealt with the hours of earnwork of persons in the labor force. It did not reflect the fact that the average age of entering the labor force is about five years later today than it was in 1880, or that the average period of retirement for those who live to age 50 is about 11 years longer today than it was in 1880 (cf., Lee, 1996). A century ago only one out of five males aged 65 and older were retired. Today, six out of seven are retired.

All in all the lifetime discretionary hours spent earning a living have declined by about one-third over the past century (see Table 3) despite the large increase in the total of lifetime discretionary time. In 1880, four-fifths of

discretionary time was spent earning a living. Today, the lion's share (59 percent) is spent doing what we like. Moreover, it appears probable that by 2040 over three-quarters of discretionary time will be spent doing what we like, despite a further substantial increase in discretionary time due to the continuing extension of the life span (cf., Jesse H. Ausubel and A. Grübler, 1995).

Why this deep desire for volwork? Why do so many people want to forgo earnwork which would allow them to buy more food, clothing, housing, and other goods? The answer turns partly on the extraordinary technological change of the past century, which has not only greatly reduced the number of hours of labor the average individual needs to obtain his or her food supply, but has also made housing, clothing, and a vast array of consumer durables so cheap in real terms that the totality of material consumption requires much fewer hours of labor today than was required over a lifetime for food alone in 1880.

Indeed, we have become so rich that we are approaching saturation<sup>5</sup> in the consumption not only of necessities, but of goods recently thought to be luxuries, or which were only dreams or science fiction during the first third of the twentieth century. Today there is an average of two cars per household in the United States. Nearly every household with a person competent to drive a car has one. On some items such as radios, we seem to have reached supersaturation, since there is now more than one radio per ear (5.6 per household). The point is not merely that we are reaching saturation in commodities that once defined a high standard of living and quality of life but also that the hours of labor required to obtain those commodities have drastically declined. The typical household in 1875 required 1,800 hours of labor in the marketplace to acquire the annual food supply, but today it takes just 260 hours. All in all, the commodities that used to account for over 80 percent of household consumption can now be obtained in greater abundance than previously, with less

<sup>5</sup> "Saturation" in this context means that most purchases are for replacement rather than for new use.

than a third of either the market or the household labor once required (Fogel, 2000).

Table 4 shows how sharply the U.S. distribution of consumption has changed over the past 120 years. Food, clothing, and shelter, which accounted for about three-quarters of consumption in 1875, accounted for just 12 percent in 1995. Leisure, on the other hand, has risen from 18 percent of consumption to 67 percent.<sup>6</sup> As Table 4 shows, the long-term income elasticities of the demand for food and clothing are below 0.5 and the elasticity of the demand for shelter is closer to, but still below, 1.0. On the other hand, the long-term income elasticities for leisure, education, and for medical services are over 1.0.<sup>7</sup>

Table 4 differs from current official tabulations of household consumption in two principal respects. Official tabulations, with minor exceptions, are limited to the out-of-pocket expenditures of households. Table 4, however, adds expenditures for education and health care consumed by households but paid by government, employers, and other third parties. My procedure does little to change the distribution of consumption in 1875 but significantly increases the education and health-care shares of consumption in 1995.<sup>8</sup>

Table 4 also differs from official tabulations by adding to the value of out-of-pocket expenditures on leisure, the value of the time devoted to leisure (volwork). That time is priced at the average hourly rate of compensation of labor. The procedure increases the share of leisure in consumption in both 1875 and 1995. While leisure (volwork) remains a relatively small share of expanded consumption in 1875,

TABLE 4—THE LONG-TERM TREND IN THE STRUCTURE OF EXPANDED CONSUMPTION AND THE IMPLIED INCOME ELASTICITIES OF SEVERAL CONSUMPTION CATEGORIES

| Consumption class | (Percent)<br>Distribution of<br>expanded<br>consumption |         | Long-term<br>income<br>elasticities |
|-------------------|---|---------|-------------------------------------|
|                   | c. 1875   | c. 1995 |                                     |
| Food              | 49  | 5       | 0.2                                 |
| Clothing          | 12  | 2       | 0.3                                 |
| Shelter           | 14  | 5       | 0.7                                 |
| Health care       | 1   | 9       | 1.6                                 |
| Education         | 1   | 5       | 1.6                                 |
| Other             | 6   | 7       | 1.1                                 |
| Leisure           | 18  | 67      | 1.4                                 |

it accounts for two-thirds of expanded consumption in 1995.<sup>9</sup>

The failure to include the value of volwork in the national income and product accounts is perhaps the most glaring example of the cultural lag to which I referred at the beginning of this address. That omission also leads to a significant underestimate of the long-term growth rate of per capita income. Before adjustments for the increased quality of volwork, the growth rate is increased by eight-tenths of a point (from 1.8 to 2.6 percent per annum). But adjustments for improvements in the quality of volwork might substantially increase that figure, since leisure-time activities in 1875 were limited largely to church on Sundays and carousing in bars during the rest of the week (cf., Fogel, 2000). Despite some important contributions to the development of an economics of leisure (cf., Gary S. Becker, 1991; Costa, 1998a, c; Daniel S. Hamermesh, 1998; John Pencavel, 1998), the profession has far to go before it catches up with the economy.

### III. Shifting to Life-Cycle Data Sets for Successive Cohorts and to Intergenerational Data Sets

It is no secret that cross-sectional data sets are cheaper to construct and more abundant

<sup>6</sup> "Other" consists mainly of expenditures on utilities and transportation, and of purchases of the supplies, furnishings, equipment, and services involved in the operation of households.

<sup>7</sup> The elasticities are not adjusted for prices. Since their prices declined, the price-adjusted income elasticities are lower than shown for the first three expenditure categories and the last one. Since the prices of the other three expenditure categories rose, their price-adjusted income elasticities are higher than shown.

<sup>8</sup> I have also excluded savings and taxes. Nordhaus (1997) points out that when account is taken of the increase in health and other forms of human capital, the savings rate has not declined.

<sup>9</sup> This procedure was previously followed by Simon Kuznets (1952) and others who corrected the national income and product accounts for the omission of volwork. See Robert Eisner (1988).

than longitudinal data sets. But whatever their usefulness for other problems, cross-sectional data are often highly misleading guides to trends on such critical economic issues of the new millennium as the prevalence rates of chronic disabilities, expenditures on health care, and pension costs.

Research initiated during the past decade and a half has called into question previous views on the length and fixity of the life span, on the shape of the Gompertz curve (which relates the log of the age-specific probability of dying to age), on the theory of the epidemiological transition,<sup>10</sup> and on the related proposition that longer life expectancy implies worse health among the survivors. It appears that some of the earlier propositions were the consequence of attempts to infer life-cycle behavior from cross-sectional data sets. Such efforts were thwarted by changes in the sampling design of successive cross sections and by changes in technology that led to earlier diagnosis of preexisting conditions (Timothy Waidmann et al., 1995).

The new research also accumulated evidence on the outward movement of the survivorship curve. Väinö Kannisto (1994) (cf., Kannisto, 1996) has shown that, in 14 countries for which the data are adequate, mortality over age 80 has been declining by about 1 percent per annum for about half a century with a significant acceleration in recent decades. John R. Wilmoth (1995, 1997), who examined extreme longevity in five countries, concluded that the right-hand end of the survivorship curve has been shifting outward for two centuries. Moreover, there is additional evidence that the Gompertz curve either levels off or declines at old old ages (James W. Vaupel, 1997; cf., S. Jay Olshansky and Bruce A. Carnes, 1997).

Another development is the continued accumulation of evidence linking events early in life, and reflected in height, weight, and body mass index (BMI), to the onset of chronic con-

ditions.<sup>11</sup> A number of longitudinal studies that were launched in the 1950's and 1960's have recently been extended to cover the entire period of human growth and early adulthood, through follow-up studies. These have confirmed the persistence of central nervous system defects induced by malnutrition in early childhood (Nevin S. Scrimshaw, 1995). Numerous other follow-up studies have shown that malnutrition and smoking in adolescence and in middle ages are risk factors for the early onset of chronic conditions and premature mortality, especially due to coronary heart disease, non-insulin-dependent diabetes, and respiratory diseases (Avita Must et al., 1992; Vincent J. Carey et al., 1997; N. K. Chin et al., 1997; Joan M. Dorn et al., 1997; K. Kotani et al., 1997; Dan S. Sharp et al., 1997; Ralf Bender et al., 1998). These relationships have been established in American, Asian, Australian, European, and Latin American populations—rich and poor. Economists have also discovered a close link between later productivity and height, BMI, and protein consumption (after controlling for caloric intake) (John Strauss and Duncan Thomas, 1995; Thomas and Strauss, 1997).

There has also been an expansion of research into the connection between intrauterine and infant growth and the onset of chronic diseases (or premature mortality). The strongest evidence for such a link that has emerged thus far is with respect to hypertension, coronary heart disease (CHD), and non-insulin-dependent diabetes. A review of 32 papers dealing with the relationship between birth weight and hypertension by Catherine M. Law and Alistair W. Shiell (1996) showed a tendency for middle-aged blood pressure to increase as birth weight declined. Evidence of a connection between birth size and later coronary heart disease has been found in England, Wales, Sweden, India, and Finland.<sup>12</sup>

<sup>11</sup> BMI is measured by the ratio of weight in kilograms to height in square meters ( $BMI = kg/m^2$ ).

<sup>12</sup> See Stephen Frankel et al., 1996; Law and Shiell, 1996; C. E. Stein et al., 1996; Swen-Olef Andersson et al., 1997; D. J. Barker, 1997; Barker and C. N. Martyn, 1997; J. L. Cresswell et al., 1997; T. Forsen et al., 1997; Jan A. Henry et al., 1997; Ilona Koupilová et al., 1997; Scrim-

<sup>10</sup> This theory holds that the prevalence of chronic diseases is unrelated to the prevalence of acute infectious diseases but depends only on the natural process of senescence that precedes mortality.



The accumulation of historical and current biomedical studies on the trends in health, longevity, and human physiology, combined with controlled studies of animal populations, are leading some evolutionary biologists to place increasing emphasis on plasticity in human aging (Michael R. Rose, 1991; Caleb E. Finch, 1997; Hillard Kaplan, 1997). The term "plasticity" refers to the widely varying pattern of aging within species and the ability of the length of the life span to be affected by environmental factors, some of which may operate over several generations (cf., Kenneth W. Wachter and Finch, 1997).

The search for better ways to forecast long-term trends in health-care costs and in pension costs has made it essential for economists to understand the underlying physiological, nutritional, and epidemiological factors that affect the changing demand for health care and retirement. Forecasts about health-care costs are obviously related to assumptions about changes in both life expectancy and age-specific morbidity rates. If current morbidity rates at older ages are presumed to remain constant or to increase over the next 30 to 50 years, and if life expectancy is also presumed to increase, then national health-care costs become astronomic. However, if one takes account of the recent declines in age-specific disability rates, then the share of health-care costs in GDP might remain constant (Kenneth G. Manton et al., 1997b; Manton et al., 1998), provided the demand for health services

(given disability rates) does not increase. If, however, the income elasticity of the demand for health is greater than one, then as income increases, the share of income that is spent on health care could increase even if disability rates decline (see Fogel, 1997). It is quite possible for the demand for medical interventions to increase, even though age-specific morbidity rates decline, for one or more of the following reasons: shifts in the age structure of the population toward ages with high morbidity rates; improvements in medical interventions for a wide range of chronic conditions which alleviate symptoms but do not cure; the replacement of current disease-specific standards of care by new ones based on improved technologies that are much more expensive than those replaced; the elimination of current age restrictions on such expensive procedures as organ replacements (cf., David M. Cutler and Ellen Meara, 1998; Alan M. Garber et al., 1998).

The complexity of the underlying issues in the economics and biodemography of aging has led to a significant shift away from cross-sectional data sets and to a concentration on longitudinal data sets. The earliest of the major longitudinal studies sponsored by the National Institutes of Health (NIH), the Framingham Heart Study, began in 1950 and was focused on the causes and treatment of coronary heart disease rather than on the economics and biodemography of aging. The Retirement History Survey (RHS) followed a cohort of men and women aged 58 to 63 from 1969 to 1979 and then was suspended. Although not initially planned as a longitudinal study, it became the mainstay of retirement research during the 1980's. Linked to the social security file on covered earnings, it provided important insights into the labor-force and retirement behavior of older workers.

In 1990, the National Institute of Aging launched a new Health and Retirement Survey (HRS) focused on the cohort born between 1931 and 1941, and aimed at collecting a much wider set of variables than covered by the older RHS. The new HRS collected numerous measures of health (including cognitive ability), taxable earnings, job characteristics, hours of work, job turnover, family characteristics, pensions, health insurance, and ownership of an array of assets including real estate,

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shaw, 1997; Stein et al., 1997, A. J. C. Ravelli et al., 1998. However, a number of researchers who attempted to replicate the Barker results have been unable to do so (Denny Vågerö and David Leon, 1994; Kaare Christensen et al., 1995; Kannisto et al., 1997). It has also been pointed out that some of the key predictors of a link between fetal and infant development and later chronic disease are often found to be uncorrelated with CHD and other chronic diseases (Ivan J. Perry et al., 1995; Michael S. Kramer and K. S. Joseph, 1996). Nevertheless, the volume of studies confirming the life-cycle connection has increased substantially since 1994. What is agreed on both sides of the debate is the need for studies that take better account of environmental factors *in utero* and between birth and the onset of chronic conditions, including middle-aged variations in nutrition and lifestyle from one population to another, and other confounding factors, such as mother's lifestyle (including smoking) (Nigel Paneth and Mervyn Susser, 1995; Perry et al., 1995; Scrimshaw, 1997).

consumer durables, and financial securities. The most ambitious social science project ever undertaken, the first wave of HRS cost \$14,000,000 and the second wave was budgeted for \$17,000,000. A third wave is currently under way collecting information on the birth cohorts of 1942–1947 (F. Thomas Juster and Richard Suzman, 1995).

NIA launched a second longitudinal survey aimed at cohorts born in 1924 or earlier years. This sample, which is called Asset and Health Dynamics. Among the Oldest Old (AHEAD), consists of persons aged 70 years and older in 1994, when the first wave was undertaken. Although the questions in AHEAD overlap with HRS, functional ability is investigated intensively and labor-market activity is covered lightly.

Both HRS and AHEAD have made it possible to examine a wide range of issues with more reliable and more detailed evidence than previously available. James P. Smith and Raynard Kington (1997), for example, have used AHEAD to examine disparities in functional status and to relate them to socioeconomic status (SES variables). They discovered strong feedback effects not only from health to SES variables but from SES variables to health. To disentangle these effects they broke household income and wealth into various categories made possible by the data and examined the effects by age. They were also able to make use of a range of variables bearing on the health and socioeconomic status of relatives in three generations (parents, siblings, and children). Their analysis indicated that current-period health and income are attributes of past, concurrent, and future generations. Measuring the full extent of these influences, the direction of causation, and complex interactions requires the study of life-cycle histories from birth to very old age. It would be inappropriate, they concluded, to use SES variables to explain variations in late-age health without taking account of the feedback mechanisms or identifying within-period innovations in the stock of health (cf., John Bound et al., 1998).

Such findings point to the usefulness of creating a prospective life-cycle sample for an extinct cohort (the veterans of the Union Army) by utilizing military, pension, and census records

in archives. This procedure not only creates a longitudinal data base in a small fraction of the time required to trace a living cohort, but can be done at less than a tenth of the normal cost. Such a project was launched by NIA in 1996 (cf., Clayne L. Pope and Larry T. Wimmer, 1998).

Based on 11 different data sets, the fully linked life histories contain over 10,000 variables on each recruit, including socioeconomic, ecological, and health variables. Called "Early Indicators of Later Work Levels, Disease, and Death," this project provides a comprehensive data set on the life course of over 39,000 Union Army veterans. Born mainly between 1835 and 1845, these men represented the first cohort to reach age 65 in the twentieth century, and can be compared with the veterans of World War II.

The preliminary comparisons revealed that at the same ages the prevalence of chronic diseases was much higher among elderly Union Army veterans than among veterans of World War II. Musculoskeletal and respiratory diseases were 1.6 times as prevalent, heart diseases were 2.9 times as prevalent, and digestive diseases were 4.7 times as prevalent among elderly veterans in 1910 than in the mid-1980's (cf., Sven E. Wilson and Louis L. Nguyen, 1998). Moreover, young adults born during the second quarter of the nineteenth century who survived the deadly contagious diseases of childhood and early adolescence were not freer of degenerative diseases than persons of the same ages today, as propounded by the theory of epidemiological transition, but were more afflicted. Hernia rates at ages 35–39, for example, were more than three times as prevalent in the 1860's as in the 1980's.

Although the analysis of the data in the Union Army sample is still in progress, some of the initial findings have a bearing on forecasts of long-term trends in health status. Costa (1998b) has reported that early-age socioeconomic and biomedical stress had a substantial impact on the likelihood that Union Army veterans would have disabling chronic health conditions by age 60. Thus, veterans raised in a county with high mortality rates were, half a century later, at elevated risks of suffering from disabling respiratory disease, circulatory disease, and musculoskeletal problems (cf., Lee, 1997). Episodes of acute diseases experienced as young adults, such as respiratory

infections, work-related injuries, and extended bouts of diarrhea, also increased the odds of suffering from chronic disabilities by age 60. Costa concludes that about 15 percent of the decline in the prevalence of joint problems and 75 percent of the prevalence of back problems between 1910 and 1980 was due to shifts in the occupational structure from manual to white-collar jobs. Moreover, a comparison of rates of decline in disabilities before and after 1980 indicates that disabilities are declining at an accelerating rate (cf., Manton et al., 1997a; Cutler and Elizabeth Richardson, 1998).

The mounting evidence of substantial interactions over the life cycle that influence the process of aging, the acceleration of technological change which has profoundly affected the context in which aging occurs, and the increasing evidence that environmental influences on the aging process begin *in utero*, has led to the initiation of a new life-cycle project called "Fetal, Infant, and Later Aging Markers, Cohort b. 1910–35." The acronym for this project is FILAM.

The central objective of FILAM is the creation of a life-cycle sample of persons born between 1910 and 1935 that would make it possible to compare changes in the aging process over the period of 70 years that separate this new sample from the aging experiences of the Union Army cohort. The FILAM cohort is important not only because it studies individuals currently between ages 63 and 89, but also because of the dramatic environmental and early life-style changes they experienced. These changes include the rise and partial decline of smoking, the decline and the new rise of alcohol consumption, the replacement of horses by internal combustion engines as the main source of urban vehicular power, the cleaning up of the water and milk supplies, and the emergence of a wide range of effective medical interventions.

The sample will be drawn from the birth records of 10,000 men and women of differing ethnicities and races who were born in Boston, New York City, Baltimore, Chicago, Iowa City, and San Francisco. Approximately half of the neonates will not have survived to the present day and these men and women will be linked to their death certificates. The survivors will be traced and interviewed to determine the

presence of chronic conditions, socioeconomic status, and family and own health history. Survivors will be linked to social security, census, military, and tax records, subject to their written consent.

FILAM will make it possible to investigate the predictive power of fetal, neonatal, and early childhood measures of retarded growth such as weight for gestational age, ratio of placental weight to birth weight, infant weight gain, thinness at birth, and shortness at birth relative to head size, on the risk of developing specific chronic conditions at mid-adult and late ages. Among the chronic conditions that will be examined are coronary heart disease, hypertension, stroke, obstructive lung disease, non-insulin-dependent diabetes, and autoimmune thyroiditis. FILAM will also make it possible to investigate how the interaction of fetal and infant developments with various risk factors at later childhood, young adult, and middle ages may intensify or moderate risks of chronic conditions and early death after age 65. Another objective is the analysis of differences in the health histories, occupational histories, and retirement pattern between FILAM and the Union Army sample, with special emphasis on the similarities and differences of predictors of later work levels, morbidity, and waiting time until death.

The HRS, AHEAD, Union Army sample, and FILAM all contain information on the parents and children of the individuals under study. Hence, they make it possible to address some factors that may be transmitted intergenerationally. An effort to utilize archival data to study intergenerational processes is also under way. Pope (1992) is linking a large sample of genealogies to the life-cycle sample of Union Army recruits. There are at least 60,000 published family histories that contain information on over 100,000,000 people who ever lived in North America. Pope is drawing a subsample of these histories containing 10,000 men of military age at the time of the Civil War. It is estimated that 40 percent of these men served in the Union Army. This new sample (called ILAS, for intergenerationally linked aging sample) will be linked to the military, pension, medical, and census data sets previously discussed.

ILAS will make it possible to control for the effect of wartime stress by comparing subsequent morbidity and mortality among those who served in the Union Army with relatives who did not. It will also be possible to measure family effects on aging and mortality experience. This will be done by including parents' occupation, wealth, residential history, number of children, place or region of birth, and migration history. Brothers in ILAS share a common prewar environment as well as a common genetic heritage. They may also share a common war experience (see D. S. Lauderdale and P. J. Rathouz, 1998). This common genetic heritage and environment is not fully captured by the aforementioned intergenerational variables because heritability is composed of the many different dimensions included in genetics and environment. However, common family effects may be measured by using independent variables to "sweep out" the effects of observed variables on death age. The covariance of the errors in that regression with brothers' estimated death ages is then a measure of the common family effect on death age. As an alternative to the residual-covariance approach, a kindred-frailty model (Vaupel, 1990) could be used where brothers share a level of frailty. Then, with assumptions about the structure of the frailty distribution, the parameters of a hazard function and a frailty distribution could be estimated (cf., James J. Heckman and Christopher R. Taber, 1994).

#### IV. The Production and Distribution of Spiritual Assets

There is, finally, the issue of spiritual or immaterial assets. A good place to begin is with Socrates' question: What is the good life? That was a critical question not only for the sons of rich Athenians but for sons of the landed rich throughout history. Freed of the need to work in order to satisfy their material needs, they sought self-realization in public service, military adventures, philanthropy, the arts, theology, ethics, and moral philosophy. Their preoccupation with immaterial commodities led Adam Smith to argue that the landed aristocracy ignored their property and lacked interest in advancing methods of cultivation. "The situation of such a person," he wrote, "naturally disposes him to attend rather to or-

nement which please his fancy, than to profit for which he has so little occasion" (Smith, 1937 pp. 364, 891–892).

In a world in which all but a small percentage are lacking in adequate nutrition and other necessities of life, self-realization may indeed seem like a mere ornament, but not in a country where even the poor are rich by past or Third World standards. That is the case in America today since the poverty line is at a level of real income that was attained by only those in the top 10 percent of the income distribution a century ago<sup>13</sup> (Fogel, 2000). Technophysio evolution has made it possible to extend the quest for self-realization from a minute fraction of the population to almost the whole of it. Although those who are retired will have more time to pursue self-realization, even those still in the labor force will have sufficient leisure to seek it either within their professional occupations or outside of them (Peter Laslett, 1991; Hans Lenk, 1994).

Some proponents of egalitarianism insist on characterizing the *material* level of the poor today as being harsh. They confound current and past conditions of living. Failure to recognize the enormous *material* gains over the last century, even for the poor, impedes rather than advances the struggle against chronic poverty in rich nations, the principal characteristic of which is *spiritual estrangement* from the mainstream society. Although material assistance is an important element in the struggle to overcome spiritual estrangement, such assistance will not be properly targeted if one assumes that improvement in material conditions naturally leads to spiritual improvement.

That proposition, so widely embraced by the more secular of the economic reformers of the twentieth century, did more to promote the consumerism of the 1920's and 1930's than to produce spiritual regeneration. The middle and working classes became preoccupied with the acquisition of automobiles and those household appliances made possible by electricity:

<sup>13</sup> This calculation neglects a variety of goods and services, such as heart bypass operations, that are available today through Medicaid, but which were unavailable at any income a century ago.

irons, lamps, telephones, toasters, refrigerators, radios, and washing machines. It was this consumerism that led such progressive critics of the era as Vernon Louis Parrington, pioneer in the development of intellectual history, to decry the “cash-register” mentality of modern urban life (Parrington, 1930 p. 81).

The economist’s traditional measures of income inequality are inadequate measures of both egalitarian gains and egalitarian failures (cf., Amartya K. Sen, 1996). They focus on a variable—money income—that currently accounts for less than half of real consumption and which in a generation may slip to just a quarter of real consumption. The most serious threats to egalitarian progress—certainly the most intractable forms of poverty—are related to the unequal distribution of spiritual (immaterial) resources (cf., William Julius Wilson, 1996).

Realization of the potential of an individual is not something that can be legislated by the state, nor can it be provided to the weak by the strong. It is something that has to develop within each individual. Moreover, which aspect of one’s potential an individual chooses to develop most fully, such as choosing a profession, is purely an aesthetic consideration. John Dewey and one of his chief disciples, Richard Rorty of the University of Virginia, contend that in a democracy self-realization is “a particularized creative project of individual growth” (Richard Shusterman, 1994 pp. 396–97). The emphasis on individual choice does not mean that other individuals and institutions play no role in shaping those choices. Quite the contrary, the quality of the choices and the range of opportunity depends critically on how well endowed an individual is with spiritual resources. But the spiritual resources needed for personal development are unequally distributed among young and old, among men and women, among various ethnic groups, and among rich and poor. Those rich who are continuously preoccupied with sensual gratifications are as likely to fail in self-realization as the poor who share that preoccupation. Although the rich may have the wealth to buy the treatment needed from highly trained professionals, inexpensive character and religious counseling may serve as well, if not better, for the addicts of all classes.

The full list of maldistributed spiritual resources is too long to discuss adequately here but I have in mind such vital assets as a vision of opportunity and a work ethic. A common characteristic of such assets is that they are transferred from one individual to another mainly very early in the life of the recipient. Self-esteem and a sense of family solidarity begin to be transferred to children along with mother’s milk and with pabulum. Other spiritual resources begin to be transferred during the toddler and toilet-training stages, including a sense of discipline, a capacity to resist or control impulses, and a sense of community. Telling nursery rhymes such as “This little piggy went to market,” recounting the autobiographies of the mother and father, and family histories going back two or three generations convey such spiritual resources as a work ethic, a sense of the mainstream of work and life, an ethic of benevolence, a vision of opportunity, and a thirst for knowledge.

Although these early transfers of spiritual resources are enriched and expanded by primary, secondary, and college education, and by occupational and other later-life experiences, the salience of these later transfers depends in no small measure on what happens at home before formal education begins. It is, therefore, necessary to remedy the maldistribution of spiritual resources early in life, because the most spiritually deprived infants will often be born to single, teenaged mothers who are themselves spiritually deprived.

Some young mothers are too deprived, or too young, to call on their own life experiences to transmit a sense of discipline and of opportunity, a work ethic, a family ethic, a sense of self-esteem, and a knowledge of the mainstream of work and life. The deprivation can be addressed by promoting a system of mentoring, taking advantage of the increasingly large number of retired men and women who have abundant spiritual resources. Such mentoring programs would be useful, not only for the toddlers and their mothers and fathers, but also for the elderly who are looking for ways to enrich their retirement years.

Despite the improvements in their material conditions of life, including comfortable stocks of consumer durables, the elderly today suffer from a maldistribution of immaterial

resources that traces back to the conditions of their youth. Persons aged 80 today were born in 1918 or 1919. Only 43 percent of that cohort graduated from high school and less than 15 percent entered college. Even among the youngest cohort of the elderly, those born in 1933 and 1934, only half graduated from high school and about 20 percent entered college (U.S. Bureau of the Census, 1975 p. 379). These cohorts also suffered from high infant death rates, poor nutrition in early infancy, and early onset of chronic diseases, as compared with cohorts born since World War II.

Hence, despite their relatively high levels of income and stocks of consumer durables, the maldistribution of spiritual resources is substantial. Depression, alienation, and substance abuse are common (S. C. Samuels, 1997). Those who are most afflicted are lonely, have few communal contacts, live in retirement homes rather than in their own households, and sense a loss of control over their personal lives (W. L. Fletcher and R. O. Hansson, 1991; K. Pahkala et al., 1992; K. Yamashita et al., 1993). Recent studies also indicate that those who lacked immaterial resources early in life have difficulty in attaining self-realization after retirement (J. C. Henretta, 1997; J. E. Mutchler et al., 1997).

I have emphasized the level of education because recent studies indicate that the capacity of the elderly to engage effectively in physical activity was strongly correlated with education early in life. Education also affects cognitive ability and the rate of illness (J. W. Rowe and R. L. Kahn, 1997). Consequently, individuals who were deprived of adequate education in youth are, for that reason among others, relatively deprived of both physiological and spiritual resources in late life.

Despite the long reach of youthful deprivation, there are enough other factors affecting the quality of elderly life to permit redistributions that compensate for previous deficits. On the physiological side, for example, there are effective medical interventions that can increase the quality of life and longevity. Although the elderly are eligible for Medicare to pay for treatment, the quality of treatment is variable, and many individuals may be shunted to low-quality care. Moreover, some interventions are denied, or are more reluc-

tantly ordered, for the elderly than for the middle aged.

Because spiritual resources are so unequally distributed among the elderly, different programs are needed for different strata. The minority of the current elderly who are well educated, the 14 percent with at least bachelor's degrees, most of whom had professional careers, have developed some innovative programs (U.S. Bureau of the Census, 1997 p. 160). In Great Britain one of these is called the "University of the Third Age." This educational program is not aimed at providing credentials for those about to embark upon new careers, but at satisfying the thirst for knowledge. It is based on the proposition that education, and the acquired knowledge and skills, are a source of self-satisfaction, even if they do not enhance an individual's employability. As Laslett (1991 pp. 171-71) put it:

Reading in a literature, mastering a language, unraveling a point in logic or philosophy, understanding the objectives set for themselves by poets, painters, novelists or architects, these things extend your appreciation and your mastery of your world, your objective and your subjective world as well. They are fulfilling, and adding to other people's knowledge is the most fulfilling of all.

Programs such as the University of the Third Age will become increasingly important as the baby boomers and others of the more highly educated cohorts of the post-World War II era begin to retire. However, today and for the next decade, the bulk of the elderly lacks the skills to create and participate in such high-level programs as the University of the Third Age. A recent survey of adult literacy revealed that more than half of the elderly population suffers from functional illiteracy. These individuals may be able to sign their name or read very simple material, but they cannot follow instructions for taking medicines or cope with a variety of documents encountered in daily living (R. Boling, 1998).

Those who suffer from low levels of literacy are educable. Engaging them in intellectual activities has a significant influence on their physiological performance. Recent studies re-

veal more physiological plasticity than was previously suspected. The capacity for self-improvement continues into old age and appropriately designed programs can return diminished individuals to earlier levels of functioning (Rowe and Kahn, 1997; cf., Wachter and Finch, 1997).

Peer tutoring has a two-way effect, since it is beneficial both to the learner and to the tutor. Both gain from involvement in social networks that enhance mood, combat depression, and reduce the risk of suicide. For widowed men, the benefits are physiological as well as psychological. Men in situations that provide higher social support have significantly lower losses of cortisol, epinephrine, and norepinephrine (hormones that reduce pain, stimulate the functioning of the heart, and improve electrical transmission across cells). Statistical analysis indicates a positive relationship for both men and women between social support and physical performance. For the tutors, being active in such productive and emotionally rewarding activities serves to retain a sense of relative youthfulness. Thus volwork, because it is effective, because it is emotionally rewarding, and because it is what the tutors want to do, adds significantly to national product.

Use of fiscal policy to correct the maldistribution of income is based, explicitly or implicitly, on the ethical proposition that those households at the top of the income distribution have more income than they ought to have. What about the case of spiritual redistributions? Are spiritual resources maldistributed because virtue is too heavily concentrated? Government cannot legislate the transfer of virtue as it does with money income. Even if they desired to do so, those rich in virtue or in the family ethic, or in benevolence, could not transfer spiritual resources by writing out checks denominated in virtue, benevolence, or family solidarity. Those poor in these spiritual resources acquire more of them only through the process of self-realization, through a concerted effort to develop as fully as possible the virtuous aspects of their nature.

Those rich in spiritual resources can help those who are spiritually deprived by counseling them, by providing spiritual companion-

ship and moral support, by informing and teaching those who are deprived about existing opportunities and procedures, and by helping to raise their self-esteem. But this process of correcting the maldistribution of spiritual resources not only leaves those who are deprived better off, it also increases the spiritual resources of those who have virtue in abundance. In contrast to income redistribution, spiritual redistribution is not a fixed-sum game in which some people can become better off only if other people are made worse off. It is a game in which total resources increase and the share of the deprived in this larger total may also increase without in any way diminishing those who have a superabundance of spiritual resources.

Some economists may be astonished by my claim that in some respects the discipline has fallen seriously behind the economy. After all, if it were so, who would know about it before them? The answer lies in the subtext of this address. To understand where the economy is and how it is evolving one needs to study not only the present but the past. In the 1940's, Kuznets (1941), musing about some of the analytical mistakes made in the aftermath of the Great Depression said: "A broader historical background might have prevented some economists from ignoring the dependence of their generalizations upon transient historical conditions." That advice is as good today as it was a half century ago.

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