COST OF DISEASE AND ILLNESS IN THE UNITED STATES IN THE YEAR 2000

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Contributors to this report include

Selma J. Mushkin, *PhD*
Mary Smelker, *PhD*
David Wyss, *PhD*
Charles L. Vehorn, *PhD*
Douglas P. Wagner, *PhD*
Aviva Berk, *MA*
J. Steven Landefeld, *MA*
Cynthia Resnick, *MEd*
Robert S. Rycroft, *PhD*
Margot Louria, *PhD*

Assisted by

Roberto de Magalhaes
Lisa Hoffman
Thomas Hrdy
Chungsoo Kim
Lynn Norman
Anthony Zayden

Foreword

The health sector of the national economy has become the third largest industry in the country and now accounts for 8.8 percent of the nation's total goods and services. In this Supplement reasons are given for expecting that share to rise to as much as 12 percent of GNP by 2000 AD. Health costs have increased nearly threefold since 1970, reaching $163 billion in 1977. There is mounting public concern about national health policies. Cost containment (including elimination of fraud and mismanagement), resource allocation, improved delivery systems, preventive medicine, the development of new disease controls—these are problems not only for policy makers and practitioners, they profoundly affect the quality of life and the pocketbook of every citizen taxpayer.

Biomedical research is the hub of the complex system which provides health care in present day society. The knowledge generated by this research has been accumulating at an exponential rate which makes assessment of its impact on health care today and in the future an onerous task. But a necessary one.

Statistical evidence, such as the increase in life expectancy from 47 years in 1900 to 72 years in 1975, abounds to demonstrate advances in health status generally. But the linkage between basic research and patient well-being is not easily discerned. Recently, age-sex-race-adjusted death rates from cardiovascular diseases have declined. But which discoveries or changes in diagnosis or treatment have been factors in this advance?

Advances in health growing out of research achievements tend to follow so long after the advance in knowledge and to become so much a part of daily living that their origins in research are forgotten. The virtual disappearance of smallpox, the diminution of the threat of poliomyelitis to near zero, and the dramatic decline in the infant death rate are all accepted as a norm of living as people concentrate attention on remaining ills.

Advances against mortality and morbidity are generated by several factors. In addition to research, the rise in the standard of living, revolutionary changes in the past few decades in the health care delivery system, and the widespread introduction of third-party payments—public and private—for medical care are among the social and economic factors which have fashioned the health care system as we know it today.

It is a system which is being critically scrutinized. Questions are raised as to the impact of medical care on health status. The very size of the health industry and its great cost has made it vulnerable to public questioning.

The very natural and rational inquiry into health care as a whole extends to a questioning of the value of health research. It is difficult to validate the commitment of scarce public resources to what is often not an immediate social gain but an investment in future knowledge.

In response to continual public pressure to show returns from biomedical research, the National Institutes of Health (NIH) has mounted a number of studies of the process by which research findings proceed from laboratory bench to patient's bedside and into the homes of more or less healthy families[1] and of the payoff in social and economic terms of the national investment in accumulating an ever-growing store of knowledge about health. One study focuses on trends in the cost of all types of illness and conditions of ill health over the 20th century to provide a methodologically consistent set of cost estimates favoring intertemporal comparisons over the century. This study also provides a look at the economic cost of the likely state of the national ill health far enough in advance to be altered by findings from research funded in the next few years.

[1] "Further Analyses of the Characteristics of Research Resulting in Clinical Advances from Inception to Clinical Usage" February 29, 1977 (Contract No. N01-0D-6-2125), Battelle Columbus Laboratories for the National Institutes of Health. This is a development of Battelle Laboratories' "Analysis of Selected Biomedical Research Programs for the President's Biomedical Research Panel of January 31, 1976." Also Julius H. Comroe, Jr., "The Road from Research to New Diagnosis and Therapy" Science 200: 931, No. 4344, May 26, 1978.

Preface

It seems axiomatic that assessment of the future payoff to biomedical research should take account of changing demographic trends in the society and of the changing characteristics of a more or less slowly growing national economy as it responds to changing socioeconomic practices such as the growing participation of women in the labor force. All of these changes will affect, toward the end of the century, the costs of treating or preventing ill health, and the proportions of the costs attributable to various diseases and conditions. And these changes will also affect the future payoff to successful applications of new health knowledge.

In this Supplement Professor Mushkin addresses the question: What will likely be the cost of health care by disease category in 2000 AD? The answer is intended to provide the final benchmark measurement to compare with estimates of the cost of disease in 1900, 1930, 1963 ,and 1975,[2] and she will be using the history and projections in assessing the past payoff to biomedical research and the prospects for such payoff in the future.

NIH is not alone in the Public Health Service in seeking to assess future payoffs to public expenditures on health. Undoubtedly other health planning units in government and in the private sector have need to consider their problems against the background of much the same data base. NIH is pleased to share the expert view of the future of health care costs presented in this Supplement with others of the community concerned with national health problems.

Herbert B. Woolley, Ph.D.
Economist, Office of the Director
National Institutes of Health

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[2] Consistently prepared estimates of economic (direct and indirect) cost of ill health by disease category for years 1900, 1930, and 1975 are available from the National Technical Information Service. The set of three papers are available as NTIS No. PB 280 297/SET. Papers are available individually as 1975–PB 280 298/AS, 1930–PB 280 299/AS, and 1900–PB 280 300/AS.

This report, "Cost of Disease and Illness in the United States in the Year 2000" is a product of a larger study of the costs of illness over the 20th century undertaken by the Public Services Laboratory with the financial assistance of the National Institutes of Health. The purpose of the larger study is to examine the changes over the century in total cost of illness and in the composition of that total in terms of diseases that afflict the population.

The purpose of this report is to project the cost of illness to the year 2000, a reasonable and identifiable benchmark for long range planning. Within the limitations of forecasting in an era of change and uncertainty, our aim is to estimate economic growth and resources for health care 25 years hence.

We are indebted to many persons for their help in this research effort. The staff and research associates involved in it are listed heretofore. The counsel and support of Dr. Herbert Woolley of the Institutes' Division of Program Analysis was invaluable.

A number of experts in the health care field were most helpful in commenting on earlier drafts of the study. We are grateful for their time and thoughtfulness. They are Dr. Odin Anderson, Director of the Center for Health Administration Studies, University of Chicago; Prof. Robert Grosse, Professor of Health Planning, School of Public Health, University of Michigan; Prof. Judith Lave, Carnegie-Mellon University, School of Urban Affairs; Ms. Dorothy Rice, Director, National Center for Health Statistics. Marian Priest Tebben, along with her staff, deserve our appreciation for their excellent editorial assistance and shepherding of the manuscript through the final publication phase. Mr. Thomas Hodgson, Division of Analysis, NCHS and Ms. Marilyn C. Hiller, Special Assistant for Plannnig and Evaluation, National Institute of Arthritis, Metabolism, and Digestive Diseases also assisted.

Our very special thanks go to Alva Wood, not only for her expertise as a typist but for her patience and forebearance of our demands. Ann Guillot was a model of taskmistress and ally in channeling the flow of work.

S.J.M.

PUBLIC HEALTH reports

SPECIAL SUPPLEMENT TO PUBLIC HEALTH REPORTS

Cost of Disease and Illness in the United States in the year 2000

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Chapter 1. Projecting the Economic Cost of Illness: Introduction

The year 2000 offers an attractive target for long range planning. To plan effectively, it is useful to know—or at least to estimate carefully—prospective rates of economic growth and the resources likely to be at the nation's disposal 25 years hence. Estimates are helpful, but it must be admitted at the outset that there is almost as much speculation as there is science in projecting economic activity a quarter of a century away.

Following are some of our estimates for the year 2000:

- Diseases of the circulatory system, cancer, and mental diseases will continue to absorb relatively large shares of the total cost of illness in contrast to their shares in 1900 and 1930.
- Total costs of premature death will rise by between $87.2 and $174.9 billion, depending on the discount rate.
- The real economic costs of illness will be more than double the 1975 costs by the year 2000.
- Total economic costs of illness will exceed $2 trillion in year 2000.
- Direct costs of health care will rise faster than the GNP and reach 11 to 12 percent of the GNP by year 2000.

There has been marked progress in medicine in the United States since 1900. A customary indication of that progress is the lengthened life expectancy at birth, from 47 years in 1900 to 72 years in 1975. Another indication is the difference by age groups in the concentration of deaths. Today, about two-thirds of the deaths occur among persons 65 and older, but in 1900 those under 15 years accounted for 45 percent of all deaths and those 65 and older for only 17 percent (*1*).

This report seeks to put the year 2000 in perspective (the yearly period is always the fiscal year). Historically, two factors have greatly affected the costs of illness and disease. One is personal health care and the other is environmental services, including traditional public health work. Personal health care has been dramatically altered since 1900 by changes in methods of providing and organizing health care. The changes include the emergence of hospital centers, greater specialization of providers, multiplication of health occupations, new diagnostic procedures, and decreased significance of the family physician, the corner pharmacy, and the private duty nurse. Underlying many of these changes is the emergence of insurance against the costs of medical care and the rise in the share of personal health care financed by third-party payments. In 1975, more than 90 percent of hospital expenditures and 50 percent of physician expenditures were financed by third parties. For all health services, third-party coverage in 1975 averaged 57.2 percent. In the projections for the year 2000, third party payments have been assumed to rise alternatively to 75 and 85 percent of expenditures for personal health care.

Public health policies concerning the environment, uch as safe water supplies, sanitation, control of milk supplies, and regulation of food contaminants, have been responsive to various problems resulting in shifts in personal health services.

At the beginning of this century, death rates among children 1–4 years of age were 19.8 per 1,000; the Office of the Actuary, Social Security Administration, projects that at the close of the century the rate will be 0.6 per 1,000 (*2*). The gains reflect reductions in childhood diseases through vaccinations and immunizations and public health measures affecting the environment.

New vaccines and therapeutic products eliminated many infective and communicable diseases and provided means of treating others. Diseases considered major at the beginning of the century, such as smallpox, diphtheria, and hookworm have been practically wiped out. Infective diseases were major causes of illness and death in the population of 1900. By the close of the century, these diseases are likely to be relatively rare.

Infective and parasitic diseases that in 1900 accounted for one-third of total illness costs dropped to 2 percent or less of the total by the years 1975 and 2000. Similarly, diseases of the respiratory system

dropped in relative importance over the century. Chronic diseases, diseases of the circulatory system, neoplasms, and mental disorders increased over the century (table 1).

Experts who were queried about their views on trends in major causes of death indicated that new therapies and preventive health measures are likely, for some groups in the population, to be counterbalanced in the year 2000 by new environmental problems—increased use of toxic chemicals by industry, greater volumes of contaminants in the air and on the ground, greater stress, particularly among women engaged in employment competition with men, and increased rather than reduced smoking and use of alcohol, particularly by women. The gains in health status already made by 1975 narrow the potential improvement for many of the population in the decades ahead. The diseases that generate great cost are complex, and basic knowledge of their etiology is sometimes lacking. Cause and effect relationships in communicable diseases are now relatively easy to find, but the effects on health of chemicals, environmental impurities, and noise are poorly understood. Changes in industrial production methods and in final products include the use of many new toxic substances. As one chemical's effect on health comes to be understood, others are used in an ever widening spiral that eludes the timing and resources of scientific probing by the National Institutes of Health, Food and Drug Administration, Environmental Protection Agency, or the Occupational Safety and Health Administration.

Total Economic Costs of Illness

Costs of illness have traditionally been divided into direct and indirect costs. The direct costs represent outlays for services within the health care sector. These include hospital fees, fees for physicians' services, drugs, and so forth. The indirect costs include both morbidity and mortality costs; morbidity costs reflect loss of productive activity and mortality costs, loss of expected future earnings due to premature death. In the economy of 1900 the total cost of illness and diseases was $4.6 billion; in 1975, the comparable figure is estimated at $322.6 billion (fig. 1).

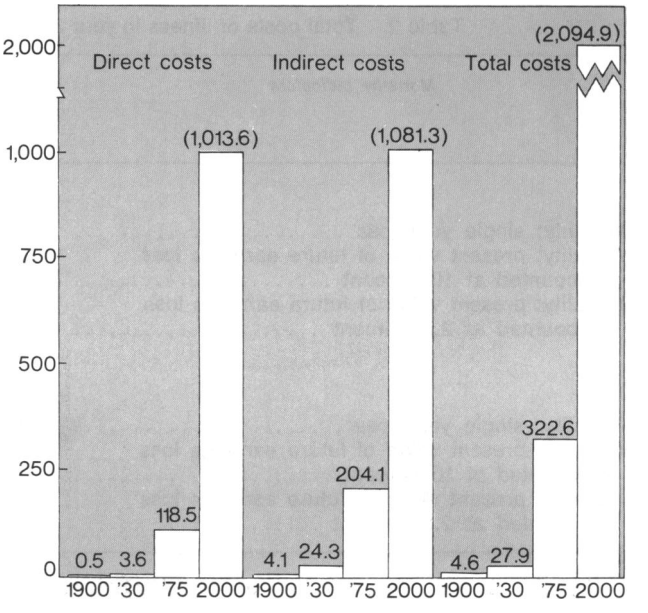
Projecting to the year 2000, the cost of illness to the nation is estimated to be more than double the 1975 estimates if this increase is measured in 1975 dollars. In year 2000 prices, the increase is far greater (table 2). Direct health expenditures represent $416.4 billion of the total costs in 1975 dollars. Another $89.5 billion is estimated as the morbidity costs which result when illness prevents a person from working either at his place of employment or in the home. An additional $5.2 billion is estimated as the single year cost of premature death in the year 2000. However, the losses due to death estimated for the single year 2000 do not reflect future losses of output. When this adjustment is made, the estimates of the total cost of death range from $87.2

Table 1. Percent distribution of the total costs of illness by various disease categories for selected years (discount rate of 2.5 percent)

Disease category, ranked by importance in 1975	*2000*	*1975*	*1930*	*1900*
All costs	100.0	100.0	100.0	100.0
Diseases of the circulatory system	17.5	17.9	10.9	6.7
Accidents, poisonings, and violence	14.6	17.6	13.5	5.9
Neoplasms	8.1	8.7	3.9	1.0
Diseases of the digestive system, oral cavity, salivary glands, and jaws	8.9	7.7	11.3	5.4
Diseases of the respiratory system	7.4	6.9	13.8	20.4
Mental disorders	6.8	6.3	2.8	1.3
Infective and parasitic diseases	2.0	1.8	16.0	33.0
All other	34.7	33.1	27.8	26.3

Figure 1. Current dollar costs of illness for selected years

(In billions of dollars)



to $174.9 billion, depending on the discount rate. The reason for discounting is that it allows for a comparison of future dollars in present-value terms. Rates of 2.5 and 10 percent were chosen because economists disagree on the appropriate discount rate.

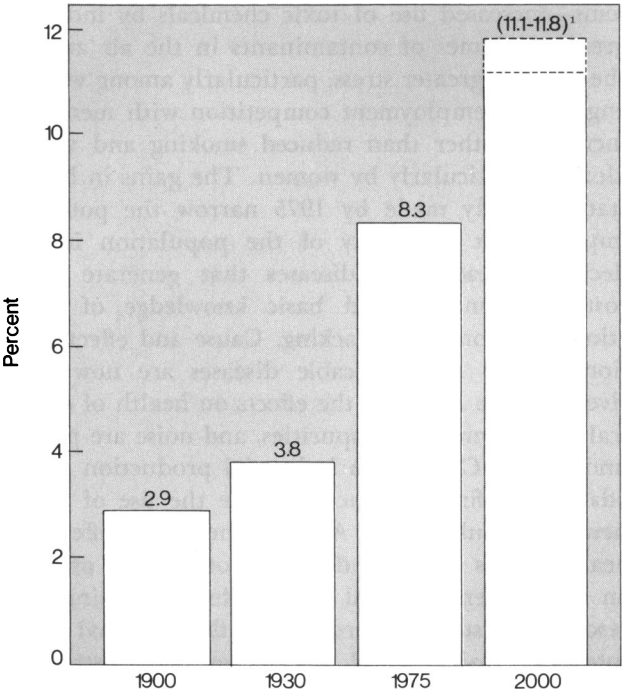
The costs of illness in year 2000 dollars, allocated by disease categories, are shown in tables 3 and 4. Diseases of the circulatory system account for the greatest proportion of the total costs of illness. Deaths in the year 2000 due to circulatory diseases are predicted to far outrank any other cause, accounting for 55.1 percent of all deaths. If one uses the 2.5 percent discount rate for mortality loss, accidents, poisonings, and violence rank second in cost, followed by diseases of the digestive system, neoplasms, and diseases of the respiratory system.

The cost distribution among diseases for 2000 does not differ greatly from that for 1975. The share of the total assigned to accidents, poisonings, and violence is down, but this decrease reflects the altered age distribution of the population with fewer adolescents and other young persons in the population relative to older age groups. Similarly, diseases of the digestive system reflect primarily the difference in age composition of the 1975 and year 2000 populations.

Trends in Direct Outlays for Health Care

Throughout the past 78 years, direct outlays for health services have grown faster than the GNP. In 1900, outlays for physicians, hospital care, nursing services, dental care, drugs, public health work, and other components of national health expenditures amounted to less than 3 percent of GNP (fig. 2). By 1930, direct outlays reached 3.8 percent of GNP, a rise over the three decades of less than 1 percent of the GNP. National health expenditures advanced markedly with the advent of Medicaid and Medicare

Figure 2. Direct costs of illness as a percent of the GNP for selected years



[1] Reflects projections using the aggregate and disaggregated models of Chapter 5.

Table 2. Total costs of illness in year 2000, in billions of 1975 dollars and year 2000 dollars[1]

Mortality indicators	Indirect costs			Direct costs	Total costs
	Mortality	Morbidity	Total		
	Year 2000 dollars				
Mortality: single year loss	$ 21.5	$366.1	$ 387.6	$1,013.6	$1,401.2
Mortality: present value of future earnings loss discounted at 10 percent	356.4	366.1	722.5	1,013.6	1,736.1
Mortality: present value of future earnings loss discounted at 2.5 percent	715.2	366.1	1,081.3	1,013.6	2,094.9
	1975 dollars				
Mortality: single year loss	$ 5.2	$ 89.5	$ 94.7	$ 416.4	$ 511.1
Mortality: present value of future earnings loss discounted at 10 percent	87.2	89.5	176.7	416.4	593.1
Mortality: present value of future earnings loss discounted at 2.5 percent	174.9	89.5	264.4	416.4	680.8

[1] Assuming constant labor force participation rates and including household values. Direct costs deflated by the medical care price index and indirect costs deflated by an index of average earnings. Productivity increase of 2 percent assumed.

Table 3. Total costs of illness, in billions of year 2000 dollars, and percentage distribution of the costs [1]

Disease category	Total	Direct costs	Indirect costs		
			Total	Morbidity	Mortality: Present value of future earnings discounted at 2.5 percent
	Billions of dollars				
Infective and parasitic diseases	$ 41.1	$ 17.4	$ 23.7	$ 12.0	$ 11.7
Neoplasms	170.8	49.3	121.5	7.6	113.9
Endocrine, nutritional and metabolic diseases	49.2	28.9	20.3	9.2	11.1
Diseases of the blood and blood-forming organs	11.0	6.2	4.8	1.9	2.9
Mental disorders	142.5	85.7	56.8	47.6	9.2
Diseases of the nervous system and sense organs	109.0	61.1	47.9	33.4	14.5
Diseases of the circulatory system	366.1	136.2	229.9	48.3	181.6
Diseases of the respiratory system	155.3	67.0	88.3	57.8	30.5
Diseases of the digestive system, oral cavity, salivary glands and jaws	186.3	125.6	60.7	22.3	38.4
Diseases of the genitourinary system	173.8	51.6	22.2	14.6	7.6
Complications of pregnancy, childbirth and puerperium	34.8	31.9	2.9	2.3	0.6
Diseases of the skin and subcutaneous tissue	23.0	19.2	3.8	3.1	0.7
Diseases of the musculoskeletal system and connective tissue	96.8	48.1	48.7	46.5	2.2
Congenital anomalies and certain causes of perinatal mortality	67.0	4.6	62.4	2.6	59.8
Symptoms and ill-defined conditions	65.3	27.3	38.0	11.1	26.9
Accidents, poisonings and violence	306.3	62.1	244.2	40.4	203.8
Other	62.1	56.7	5.4	5.4	..
Unallocated	135.1	135.1	..	..	..
Total [2]	2,094.9	1,013.6	1,081.3	366.1	715.2
	Percentage distribution				
Infective and parasitic diseases	2.0	1.7	2.2	3.2	1.6
Neoplasms	8.1	4.9	11.2	2.0	15.9
Endocrine, nutritional and metabolic diseases	2.4	2.9	1.8	2.5	1.5
Diseases of the blood and blood-forming organs	0.5	0.6	0.4	0.5	0.4
Mental disorders	6.8	8.5	5.2	13.0	1.2
Diseases of the nervous system and sense organs	5.2	6.0	4.4	9.1	2.0
Diseases of the circulatory system	17.5	13.4	21.2	13.1	25.3
Diseases of the respiratory system	7.4	6.6	8.1	15.7	4.2
Diseases of the digestive system, oral cavity, salivary glands and jaws	8.9	12.4	5.6	6.1	5.3
Diseases of the genitourinary system	3.5	5.1	2.0	3.9	1.0
Complications of pregnancy, childbirth and puerperium	1.7	3.1	0.2	0.6	[3]
Diseases of the skin and subcutaneous tissue	1.1	1.9	0.3	0.8	[3]
Diseases of the musculoskeletal system and connective tissue	4.6	4.7	4.5	12.7	0.3
Congenital anomalies and certain causes of perinatal mortality	3.2	0.5	5.7	0.7	8.3
Symptoms and ill-defined conditions	3.1	2.7	3.5	3.0	3.7
Accidents, poisonings and violence	14.6	6.1	22.5	11.0	28.5
Other	3.0	5.6	0.5	1.4	..
Unallocated	6.4	13.3	..	..	..
Total [2]	100.0	100.0	100.0	100.0	100.0

[1] Assuming constant labor force participation rates and including household values.

[2] Totals may not add due to truncation of numbers.

[3] Less than 0.1 percent.

coverages under public programs. Direct costs in fiscal year 1975 reached 8.3 percent of GNP and rose even more to 8.8 percent of GNP by fiscal year 1977. We predict that this spending rate will not abate; on the contrary, it will reach nearly 12 percent of GNP by the year 2000, growing 8.6 percent per annum from 1975 to year 2000 (fig. 3).

Why have health expenditures risen so rapidly over the last 45 years? Some claim that technical advances have raised costs instead of reducing them; others believe that changes in the method of financing payment for care, from direct to third-party payments, have reduced constraints in the system. Still others think that changes in consumers' demand, the supply of providers, and the environment account for most of the rising costs. An underlying share of the increase, most agree, is attributable to the growth in population. Population is estimated to reach 263 million, 23 percent above the population of 1975 (*3*). The number of those over 65 grows at an even faster rate than total population as the post-World War II population bulge moves into the older age groups. (By the year 2000 the post-World War II babies will be more than 50 years old.)

In addition to demographic factors, the basic economics of demand may be expected to enlarge outlays. Health insurance coverage is assumed to increase and raise outlays, particularly for physicians' services. Higher real income would also mean higher health expenditures if past trends are indicative of future experience. (The impact of these factors on both demand and supply of services in the health sector is discussed at length in Chapter 5.)

The trend in direct costs by type of health care provider also is worth noting. In 1900, the largest shares of personal health care expenditures went for physicians' services and drugs, and hospital care ranked third (fig. 4). As the third-party method of payment became established and as technical advances resulted in more sophisticated treatment procedures, a greater proportion of personal health care expenditures went for hospital care, and by 1975,

Table 4. Total costs of illness with varying assumptions of mortality in year 2000, in billions of year 2000 dollars[1]

Disease category	*Total costs with mortality losses for single year only*	*Percent distribution*	*Total costs with mortality based on present value of future earnings discounted at 10 percent*	*Percent distribution*
Infective and parasitic diseases	$ 29.6	2.1	$ 33.2	1.9
Neoplasms	61.8	4.4	130.2	7.5
Endocrine, nutritional and metabolic diseases	38.5	2.8	44.6	2.6
Diseases of the blood and blood-forming organs	8.2	0.6	9.3	0.5
Mental disorders	133.5	9.5	137.8	7.9
Diseases of the nervous system and sense organs	94.7	6.8	99.7	5.7
Diseases of the circulatory system	193.5	13.8	309.4	17.8
Diseases of the respiratory system	125.9	9.0	140.7	8.1
Diseases of the digestive system, oral cavity, salivary glands and jaws	149.3	10.7	170.3	9.8
Diseases of the genitourinary system	66.5	4.7	70.5	4.1
Complications of pregnancy, childbirth and puerperium	34.2	2.4	34.4	2.0
Diseases of the skin and subcutaneous tissue	22.3	1.6	22.7	1.3
Diseases of the musculoskeletal system and connective tissue	94.7	6.8	95.8	5.5
Congenital anomalies and certain causes of perinatal mortality	7.3	0.5	12.7	0.7
Symptoms and ill-defined conditions	38.8	2.8	47.4	2.7
Accidents, poisonings and violence	105.6	7.5	180.6	10.4
Other	62.1	4.4	62.1	3.6
Unallocated	135.1	9.6	135.1	7.8
Total[2]	1,401.2	100.0	1,736.1	100.0

[1] Assuming constant labor force participation rates and including household values.
[2] Totals may not add due to rounding of numbers.

this share was more than twice that for physicians' services. Between 1930 and 1975, the growth in hospital care caused decreases in the expenditure share for every category except nursing homes, an institutional arrangement that largely emerged from the public programs for vendor payments.

Relation of Indirect Illness Cost to Direct Expenditures

From some perspectives, direct expenditures may be viewed as the input of the health sector to the economy and reductions in the indirect cost as the output of those expenditures. Resources for health care are viewed as the means to preventive and curative medicine. If diseases were wiped out and death occurred only at an advanced age after retirement, direct expenditures for health services would be at a minimum (required for preventive care only), and indirect costs attributable to premature death and disability would approach zero. Direct outlays would exceed the indirect cost of illness and premature death.

In fact, over the past 75 years death rates have been reduced markedly. Data are insufficient to permit precise determinations about disability over the whole period. However, health expenditures, as is well known, have mounted at an ever advancing pace.

How has the ratio shifted between direct outlays and the indirect cost of illness? In 1900, indirect costs of death and disability were 8 times that for direct

Figure 3. Average annual growth in current dollars in the cost of illness for selected periods

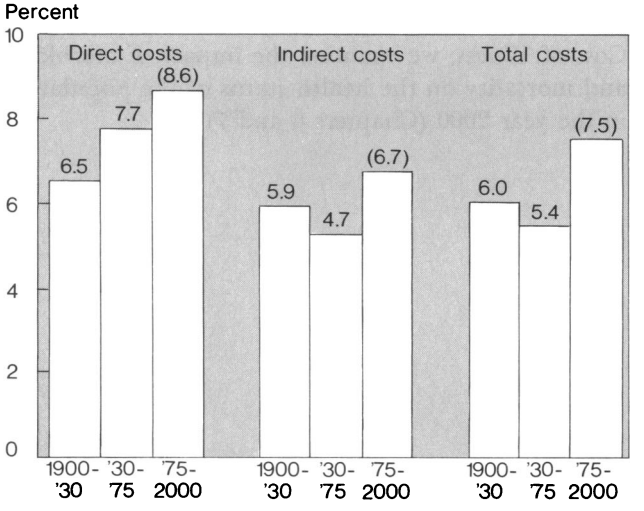
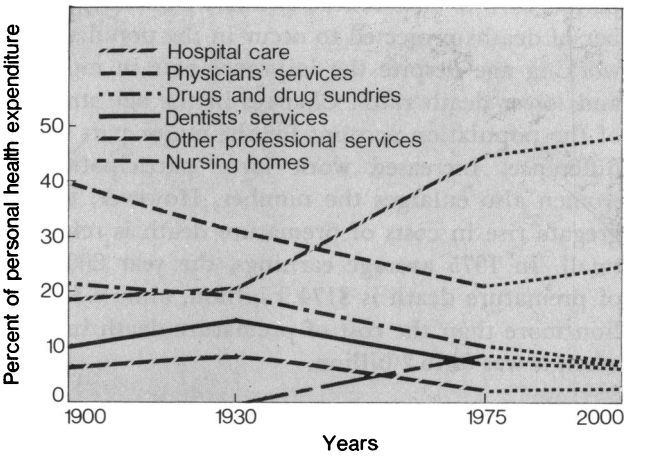


Figure 4. Categories of personal health care expenditures as a percent of total personal health care expenditures for selected years



expenditures for physicians, hospitals, and other providers of care, including public health work. The relative magnitude of the indirect cost dropped slightly by 1930 so that the indirect cost was less than 7 times that of direct expenditures. By the year 1975, the indirect cost was less than twice direct outlays. The year 2000 projection is for a growth in direct expenditures such that the direct and indirect cost components would be about equal in size (fig. 1).

Trends in the Cost of Premature Death and Sickness

To understand the meaning of shifts in the relative importance of direct and indirect cost, the factors implicit in the cost estimates may be reviewed. Cost of death represents about two-thirds of the estimated total indirect cost. Behind the magnitude of this cost is the projection of death rates, total deaths by age and sex, and labor force participation rates.

In the period 1900–30, indirect cost of illness and disease grew at an average annual rate of 5.9 percent (fig. 3). Adjusted for the growth in earnings over the period used to value work time loss (4 percent per annum), this rate would be reduced to 1.9 percent per year. Indirect cost growth slowed in the subsequent 45 years. One reason for the difference in growth rates is the demographic change between the periods. The population expansion between 1900 and 1930 enlarged the total number of deaths despite the sharp decrease in death rates, particularly among children. The small growth in the adult population between 1930 and 1975, when immigration of the earlier decades was checked, and the decline

in deaths for young adults are captured in the lower growth rate of the 1930–75 period.

The rise in the growth rate of indirect costs in the period 1975 to 2000 reflects primarily the larger number of deaths projected to occur in the population of working age despite the improvements in mortality and lower death rates. Changes in the age structure of the population account for the major part of this difference. Increased work force participation by women also enlarges the number. However, the aggregate rise in costs of premature death is relatively small. In 1975 average earnings, the year 2000 cost of premature death is $174.9 billion, almost $30 billion more than the cost of premature death in 1975, when it was $146.2 billion.

Economic Cost and Economic Gain

The reduction in death rates in the population and the decline assumed in days of work loss per person in the employed population have a set of consequences for the general economy. There is an impact on the quantity of economic resources, that is the size of the pie of goods and services available, for use in the health sector and elsewhere.

Economic gains are implicit in the projections that have been made. Death rates are projected to decline by the year 2000, enlarging the pool of persons available for work and the amount of working time. Similarly, disability is projected to be less, further reducing the time lost from work due to illness and disease. The figure shown as the indirect cost of illness and disease, $1.1 trillion in 2000 dollars and $264.4 billion at 1975 earnings levels, essentially represents the maximum economic gain that could be achieved. It represents the gain if there were no deaths among the working population age groups and no sickness keeping people from work.

The gain in economic resources through the prevention or cure of diseases and postponement of death to an old age takes the form of added numbers of workers and added work time. Sickness does more than impact on the number of working years; it also affects production. Workers absent due to sickness tend to increase the cost of production. For example, it may be necessary to hire additional workers to cover jobs. If substitutes are not hired, the completion of work is delayed. Under present sick leave pay allowances for many jobs, wages are enlarged by fringe benefits without commensurate productivity increases, except as cash pay is decreased to offset the higher fringes.

The estimates for the year 2000 were made with the assistance of an econometric model. The model chosen was the MIT-Penn-SSRC(MPS) quarterly model of the U.S. economy which has been constructed primarily as a tool for policy analysis and is oriented towards long range planning. It is a simultaneous equation model of the economy and currently contains about 150 exogenous variables and 300 equations, half of which are identities. The exogenous variables are various population measures, Federal expenditures and tax rates, foreign prices and production, and farm output. Of the several large scale econometric models of the economy commonly used for forecasting, the MPS model seems most appropriate for long-run forecasts of the economy.

This report is divided into three parts. Part I, The Economic Model, begins with a broad discussion of major factors affecting long-term economic growth. An outline of the economic model is given, and a specific discussion of central economic factors as they relate to disease costs is presented (Chapters 2–4). Part II, Direct Cost of Illness, uses both aggregate and disaggregate models to project, under various assumptions, the direct cost of illness by type of health care service (Chapter 5). In Part III, Indirect Cost of Illness, we examine the impact of morbidity and mortality on the health status of the population in the year 2000 (Chapters 6 and 7).

PART I. THE ECONOMIC MODEL

Chapter 2. The Long-Term U.S. Economic Growth

Major contributors to Part I were Selma Mushkin, Mary Smelker, and David Wyss.

A GNP of $9.1–10.3 trillion is projected for the year 2000.

Annual growth rates are projected in constant 1972 dollars at 4.9 percent per annum for the period 1977–80, and at 3.3–3.9 percent per annum in subsequent periods:

Period	Annual growth rate (percent)
1980–85	3.4–3.9
1985–90	3.3–3.9
1990–95	3.6–3.7
1995–2000	3.6–3.7

The small range is not to be interpreted as certainty. Indeed, the present epoch has been designated by some economists as the "Age of Uncertainty." Grave problems threaten the U.S. economic advance, including material shortages, population pressures in the developing world, and the growing importance of multinational corporations.

We are unable to anticipate the rate at which new energy sources will be utilized and when new techniques will become economically feasible. Yet, technicians seem confident that these and other technological bottlenecks will be broken in time to permit economic expansion to continue. Indeed, if energy becomes abundant and very cheap, material progress, instead of slowing, could accelerate beyond anything we have yet seen.

To attain the magnitudes of output that we have projected for the year 2000, we have not assumed drastic changes. It is assumed that energy will be available on terms that are not much more expensive than in the past and that the shortages of scarce materials will not become acute. It is also probably necessary to suppose that world population growth will slow greatly so that food shortages and human migrations will not become of overwhelming economic importance.

It also seems probable now that the various economies of the world will become more closely linked and interdependent in the coming period. But analysis of world trends is at present in an early stage and we are not able to incorporate a world view into our projection. We assume that activity in the United States will continue to be largely determined by domestic demand, and imports and exports will continue to account for a relatively small proportion of income and employment.

Since we cannot anticipate the future effects of changes in domestic institutions, in international developments, in weather patterns, or in other disequilibrating factors—although many are certain to occur with a measurable impact—we must assume that these will not be of a severity to cause a sharp break with the past. Statistics drawn from past experience are all we have to inform us of the future, whether the projections are made with a sophisticated econometric model or by some simpler method. The relations between the variables of the model used in this study have been adjusted for structural changes in areas where there is sufficient evidence, but it is sometimes difficult to distinguish between a fundamental change and a temporary aberration.

Our view of the growth in the economy by the year 2000 is regarded as conservative; the path of economic development is smoother and closer to potential rates of activity than is likely to materialize. Shocks, such as international disturbances, droughts, or prolonged strikes, may cause economic growth to fall below potential—similarly, rapid recoveries or booms can cause the long-term potential to be temporarily exceeded. Booms may result in fast expansion rates for a time, but both booms and recessions are likely to cause structural difficulties and problems of adjustment in capital and labor resources.

Although the basic assumptions underlying the projections are conservative, economic activity nevertheless rises faster in our projection for the next

24 years than it did between 1952 and 1976—also a 24-year span. Comparisons are shown in table 5. Much of the reason for this trend lies in the relatively slow growth in the economy during the last 10 years. The year 1976, from which we are measuring, was far below the potential activity levels of economic growth. The report of the Council of Economic Advisers (*4*) in 1977 estimated that output might have been about 8 percent higher in 1976 had high employment and activity levels prevailed. About 7.7 percent of the labor force was unemployed in 1976, and the labor force itself was smaller than it would have been under high employment conditions. Further, output per manhour was low since underutilization of employed workers occurs during periods of slow growth or recession.

We have assumed that the economy once again reaches its long-term potential rate of growth in 1980. To reach this goal, the annual growth in the GNP must be almost 5 percent per year between 1976 and 1980, a pace well above the long-term rate for a sustained noninflationary period but not excessively high for a recovery period. In the years following 1980, growth slows to a rate of about 3.5 percent annually.

Although the estimates for the year 2000 and the intervening decades were made with the assistance of a rather elaborate econometric model, certain governing assumptions based mainly on judgment were necessary before the model could be put into operation. So-called exogenous estimates were required for the rate of population growth, labor force participation rates, and the rate of rise in productivity or output per manhour. (The model may generate variations around this trend for cyclical reasons.)

It would have been possible to project the gross output at future dates from these variables without the use of an econometric model. However, the use of such a model (in this case, the MIT-Penn-SSRC model that was developed and used by the Federal Reserve Board) confers some important benefits. Since the model involves economic interrelations among a large number of variables, it enables us to develop a consistent set of estimates relating GNP to price levels, wage rates, and growth in employment. It can also be utilized to estimate demand categories, such as consumption and investment, which are consistent with Federal and State local receipts and expenditures.

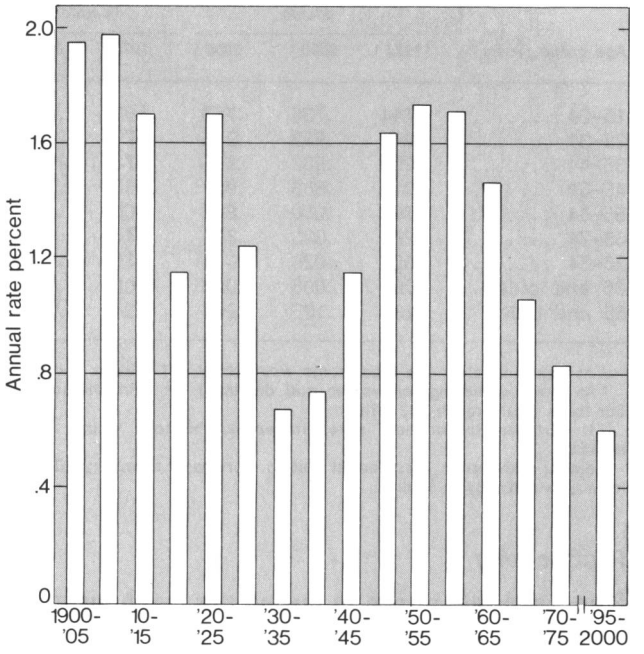
The path of development after 1980 lies close to the long-run potential of the economy if the basic assumptions the model incorporates are correct. Developments in prices and employment levels are based on the widely accepted theory that there is a "natural" relation between the rate of unemployment and rate of price rise (in the absence of shocks such as interruptions in the energy supply or other massive disturbances to the economy). Under present conditions and with the present composition of the labor force, a rate of unemployment of about 5 to 6 percent is assumed to be consistent with price stability. Pressures for higher wages will not be likely

Table 5. Growth rates: Past and projected for the year 2000 (dollar amounts in billions)

Economic component	1952	1976	2000			Percent change	
			MPS model	DRI model [1]	Chase econometrics model [1]	1952–76	1976–2000 MPS model
GNP ($ current)	$347	$1,706	$9,100	$10,018	$10,337		
GNP ($ 1972)	598.5	1,275	3,060	3,016	2,962	113	141
Potential GNP ($ 1972)	598.5	1,377	3,060	3,016	2,962	130	122
GNP deflator (1972=100)	58	134	300	331	347		
Consumption ($ 1972)	351	821	1,892	1,785	1,741		
Labor force (millions) [2]	66	97	132	138	138	47	36
Employment (millions) [3]	60	87.5	125	n.a.	n.a.	45	43
Population (millions) [4]	157.5	215	263	263	263	36.5	22
Labor force as a percent of population	42	45	50	n.a.	n.a.		

[1] Long-term forecasts from DRI and Chase only extend to 1990, so the MPS growth rates from 1990–2000 were applied to the DRI and Chase 1990 estimates. MPS projections are used throughout this report.
[2] Total including military.
[3] Assumes 5½ percent of labor force unemployed in 2000 compared to 7.7 percent in 1976.
[4] Population estimates from Census Bureau Series II.
Source: For 1952 data, *"Economic Report of the President,"* January 1977, and for 1976 data, Survey of Current Business, July 1977. Year 2000 figures estimated.

Figure 5. Population growth rate by 5-year periods, 1900-2000



Sources: Historical Chart Book. Board of Governors of the Federal Reserve System, 1977, Washington, D.C., and U.S. Bureau of the Census: Projections of the Population of the United States, by Age and Sex, 1975 to 2000, with Extensions of Total Population to 2025. Current Population Reports, Series P-25, No. 541, February 1975.

to accelerate an inflationary trend with this rate of joblessness.

The growth in the money supply is utilized in the model as a major policy instrument for gradually reducing the relatively high rate of price rise characteristic of recent years. (The inflation of the mid-1970s can be attributed only in part to wage pressure, monetary excesses, or monopolistic control of prices—the world boom, the quadrupling of energy prices, and the escalation in food prices were important factors.) Assuming the absence of new disturbances of this magnitude, prudent monetary policy and fiscal restraint moderate the rate of price rise even though the rate of unemployment also falls. By the year 2000, prices are assumed to increase at a rate of only 2–2.5 percent a year compared with 6 percent between 1975 and 1976 and a projected figure of about 5.5 percent between 1977 and 1980. Unemployment has been cut from 7.7 percent in 1976 to 5.5 percent in 2000, approximating the "natural" rate.

In a sense, the projection reflects an ideal solution to the dilemma of recent inflation combined with excessive unemployment. Rates of growth are relatively rapid between 1977 and 1980 as the economy recovers from recession levels, reducing unemployment appreciably. The rate of price rise over the next few years does not drop spectacularly, but falls further to acceptable levels in subsequent periods. The economy thus moves in a path close to its long-run growth potential with only mild deviations from high employment levels after 1980.

One of the big shifts anticipated in the next quarter century compared with the last 24 years is a pronounced slowing in the rate of population growth, as will be discussed later. Since the decline in growth rates will affect mainly the very young and the very old, particularly the young, the labor force rises significantly as a proportion of the total population—from 45 percent to 50 percent. It follows, as shown in table 6, that although total consumer expenditures are projected to rise at a somewhat slower rate than in the past 24 years, and to fall as a percent of GNP, they rise at a faster rate on a per capita basis. (With the increase in the retirement age under present statutes, the available labor force would comprise an even larger fraction of the population.)

Projections of Population and Labor Force

The Bureau of the Census has recently issued three sets, or series, of population projections running through the year 2050 (*5*). All three sets assume that mortality rates will fall gradually, but they differ in their assumptions as to fertility. Our population pro-

Table 6. Past and projected consumer expenditures for the year 2000

Factors	1952	1976	2000	Percent change 1952–76	Percent change 1976–2000
Consumer expenditures (billions of 1972 dollars)	351	821	1,892	134	130
Population (millions) [1]	157.5	215	263	36.5	22
Consumer expenditures per capita (1972 dollars)	2,228	3,820	7,194	71	88
Consumer expenditures as a percent of GNP	59	64	62	..	..

[1] Includes armed forces.

Sources: For 1952 data, *"Economic Report of the President,"* January 1977, and for 1976 data, Survey of Current Business, July 1977.

jections agree with Series II. The population is estimated to reach 263 million in the year 2000 (compared to 215 million in 1976), a figure that is about midway between the Series I high estimate of 287 million persons and the Series III low estimate of 245 million.

In estimating costs of illness, we made a separate prediction of total deaths for the year 2000 at 2.596 million. This number is 2 percent higher than the Census death projections. For purposes of economic projections in this study, however, we did not alter the Census Series II population projections.

Although the rate of increase in the U.S. population has been slowing as a long-term trend, it is believed that the population will continue to expand in year 2000 (fig. 5). The distribution by age will have altered considerably, however, as the following comparison of age groups, in percentages of the total, shows:

Age group (years)	*1976 estimated*	*2000, projected*
Under 24	43.4	36.1
25–34	14.9	18.2
35–54	21.7	29.7
55–64	9.3	8.9
65 and older	10.7	12.2
Total	100.0	100.0

SOURCE: Reference *3*.

Owing to the assumption that birth rates will continue to be low or declining, the proportion of the aged will rise while that of children and young persons will fall. The age groups from which the experienced labor force is drawn will increase substantially. The proportion of persons between 25 and 64 years will comprise 52 percent of the population in 2000 compared to 46 percent in 1976. Since most people who will be in the active work force are already alive, these estimates should be fairly accurate. However, labor force participation rates may change in ways that are difficult or impossible to foresee.

The trend toward higher rates of participation will probably continue, although the rate of increase will be slower. The participation rates for males in the prime age groups, which are at a historical low, may increase or decrease. Alternative assumptions as to participation rates are shown in table 7. The projection is based on the assumption that 132 million people will be in the labor force in the year 2000, an increase of more than one-third from 1976 levels.

Table 7. Estimated labor force participation rates for 1975 and projected rates for year 2000

Age group (years)	*Males*		*Females*	
	1975 [1]	*2000* [2]	*1975* [1]	*2000* [2 3]
15–24	.744	.735	.583	.727
25–34	.941	.932	.572	.701
35–44	.956	.932	.573	.679
45–54	.915	.883	.563	.636
55–64	.768	.650	.405	.424
65–74	.298	.093	.148	.126
75–84	.091	.029	.035	.030
85 and older	.020	.006	.005	.005
65 and older	.238	.136	.108	.068
	.753	.946	.727	.963
	.946	.963	.701	.927
	.963	.927	.679	.807
	.927	.807	.636	.375
	.807	.375	.424	.114
	.375	.114	.126	.026
	.114	.026	.030	.299
	.026	.299	.005	
	.299		.068	

[1] At constant rates, the labor force would total 127 million persons.
[2] At rates increasing for women and declining for men, the total labor force would reach 132 million.
[3] If participation for both sexes increases, the total would be 137 million.
Source: Manuscript prepared at Public Services Laboratory, Georgetown University, by A. Berk.

Productivity

The trend rate of rise in output per manhour in the private business economy is projected at about 2 percent per year after the economy nears its potential rate of high employment in 1980. This estimate of productivity growth is somewhat lower than some government economists would choose, but higher than many private forecasts.

It has been established, for the entire private economy, that the growth in output per manhour varies greatly from period to period, but that, over the long run from 1909 to 1975, the rate of growth averaged about 2.3 percent per year. During this period, great strides were made in agricultural efficiency which contributed to the rate of growth in the private sector. The capital to output ratio increased steadily, and the educational level of the population rose.

Period	*Percent per year*
1909–75	2.3
1909–47	1.9
1947–66	3.2
1966–75	1.7
1947–75	2.8

SOURCE: J. R. Norsworthy and L. J. Fulco: Productivity and Labor Costs in the Private Economy, 1975. Monthly Labor Review, 99: 3–11, May 1976.

Following World War II, progress in worker efficiency was much faster, raising expectations as to the pace of future economic growth. It was hoped that productivity might continue to average 3 percent per

annum or higher. The rate of productivity growth in the 18 years between 1948 and 1966 was 3.3 percent in the private economy compared with a longer-term trend of 2 to 2.5 percent. Unfortunately, this rate appears to have been exceptional. Performance has been poor since 1967 and, recently, the rise in output per manhour in the private business economy fell to levels far below the previous 20 years, averaging less than 2 percent a year.

There is disagreement over the causes of this unsatisfactory performance. A major factor undoubtedly was underutilization of employed manpower owing to slow growth rates in the economy punctuated by actual recessions. Long-term potential rates of growth in economic activity were realized only briefly in 1973. In the severe recession of 1974, productivity fell sharply, a rare occurrence even in periods of economic decline.

Demographic factors have also been unfavorable. A recent influx of young and inexperienced workers into the labor force reflects the baby boom of the 1950s. The proportion of the population in the age group from 14 to 24 years rose from 16 percent in 1959 to 21 percent in 1976, contributing to a slow growth in per worker output.

An inadequate rate of investment in capital-saving and labor saving machinery during the last decade has received considerable attention as a reason for the slowdown in productivity growth. A substantial proportion of investment in some major industries has been for the purpose of reducing pollution or other environmental impact or for improving worker safety, rather than for increasing output as traditionally measured in the GNP. It also appears that demand and output may have shifted somewhat to less labor-intensive industries.

The poor record of the 1970s, coupled with the problems that appear to lie ahead in energy sources and uses and increasingly scarce materials, have caused forecasters to become more cautious in viewing the future. Yet, it is unlikely that the same reasons which slowed productivity growth in recent years will be effective over the 24 years ahead. One encouraging factor in the outlook is a more favorable composition of the labor force. The proportion of inexperienced persons in the labor force is now at its height and will gradually fall. In addition, the pace of investment could easily accelerate because of revised tax laws, the birth of new technologies, or even changes in consumer preferences. Spurts of investment may accompany or follow changes in energy sources or methods of utilization, and this investment could be accompanied by retirement of obsolete equipment and an upward surge in output per worker. Pollution control may also have, as an important byproduct, a favorable effect on productivity as processes are modernized.

The assumption that the rate of growth in output per man-hour will not be much higher than 2 percent per annum, after 1980, may prove conservative, especially in view of the fact that the projected growth path of GNP between 1976 and 1980 does not involve any deep recessions. However, the brisk rise in productivity during the 1950s and early 1960s now appears more exceptional than was formerly realized. It is believed to have averaged more than 3 percent in the private sector of the economy, or about 1 percent above the longer term trend rate.

Considering that the future is so fraught with uncertainties about energy sources, availability of materials, and environmental and societal problems, we have preferred a conservative estimate.

Chapter 3. The MIT-Penn-SSRC Model

The MIT-Penn-SSRC (MPS) model of the U.S. economy was used to make the forecast to the year 2000 and, accordingly, to quantify the parameters that subsequently could be applied in estimating cost of illness.

One of several other large-scale econometric models might have been used; however, these were developed mainly for short-term business forecasting. It is not claimed that the MPS model that was applied is superior in every respect to other, general purpose econometric models. However, it has been updated and the equations respecified by the technicians of the Federal Reserve System since revised statistics on national income were released in early 1976. The latest estimates for 1976 have also been incorporated. It is also well suited for longer term projections since it is rather stable—that is, it tends to move around a path of equilibrium growth rather than to cause activity levels to fluctuate widely when a shock (such as some variable being affected by an exogeneous force) is introduced.

Many characteristics of the MPS or Federal Reserve model are irrelevant for our purposes. For example, the sector which determines the equilibrium rate of investment need not concern us, since this rate must be consistent with the rate of productivity growth that we have assumed. On the other hand, we are concerned with the characteristics that determine consumer income, consumption, and determinants of medical and health care costs.

At any given time, the maximum sustainable level of economic output is determined by the size and composition of the population and the state of technology—this state reflecting the capital stock and its composition, the education and skill of workers, and advances in productive techniques.

In the MPS model, changes in the stock of money have important short-term effects but, in the long run which concerns us, the money supply affects only the price level and not real output. Government budgets tend toward a balancing of receipts and expenditures. The model generates a fairly steady growth pattern given appropriate assumptions for technological progress, labor force growth, and the additional assumption that appropriate fiscal and monetary policies are pursued to compensate for any temporary aberrations in the pattern of private demand.

The size of the labor force in any given population depends on its age distribution, various social patterns, legal requirements and, especially, fluctuations in the level of demand and output. Under our assumptions, output fluctuates but averages close to the maximum sustainable level (once that level is obtained) and affords adequate opportunities for labor force participation.

The Model

The MPS model was recently updated to incorporate approximately 150 exogenous variables and 300 equations; about half of which are identities. The exogenous variables are various population measures, Federal expenditures and tax rates, foreign prices and production, and farm output.

The model was constructed primarily as a tool for policy analysis. Unlike the commercial models, such as Chase Econometrics and Data Resources, Inc. (DRI), it is not designed to forecast results for detailed industries. Thus, the demand side of the model is extremely aggregate in structure; it uses, for example, only two basic consumption equations, compared to the 11 in the DRI model. On the other hand, more attention is paid to the financial flow and interest rates and to their interaction with the economy.

The model can be loosely divided into three sectors —a demand sector containing the basic demand equations for consumption, investment, foreign trade, and government spending; a labor force, income, and price sector containing the equations for employment, wages, prices, and income; and a financial sector containing equations for interest rates and deposit flows. We will discuss only a few of the more important equations.

The demand sector. The ratio of consumption to total output in the model is determined by the rather sophisticated "life-cycle" theory of consumption and

saving—according to this theory consumers attempt to maximize the satisfaction or utility of their income by considering their expected earnings pattern over their entire span of life. Thus, current consumption depends on current income, accumulated assets, and expectations.

Consumption in the model is defined as spending on nondurables and services, including health care and durable goods (such as automobiles and appliances) are considered as depreciable wealth. Among consumer assets, stock market shares are the most volatile in value so that a sharp drop in the stock market may cause consumers to forego current consumption in order to restore their wealth. A rise in the market has the opposite effect.

Changes that are presumably short-term, such as market fluctuations, need not concern us in a long-run projection. Although they are not reflected in the model, social attitudes and changes in laws protecting income or health benefits for the aged, and so forth, also affect consumer spending. Income and health maintenance programs could easily affect the longer-term relation between income and consumption. Fortunately, discontinuities such as this can be introduced into the model for purposes of experimentation or testing.

As stated previously, the overall investment rate must be consistent with the assumed rate of productivity growth. The equations for the different forms of fixed investment are specified to incorporate various assumptions about factor substitutability. The producers' durable equipment equations are based on a putty-clay model of the economy. This model implies that once a machine is ordered, the ouput of that machine, and the labor required to operate it, are fixed for the life of the machine. The approach also assumes Harrod-neutral ("labor-augmenting") technological progress. This assumption constrains the capital to output ratio to remain constant because technological progress is reflected through improvement in efficiency units of labor. The assumption is virtually required if a smooth steady state is to be possible in the model. The only unusual feature in the current version of the producers' durable equipment equation is the inclusion of an explicit uncertainty term. It is implied that producers demand a higher expected return in periods when the economy is highly variable than when the economy is growing smoothly.

The equation for investment in producers' structures is similar to the equation for producers' durables, except that structures are assumed to be "putty-putty" instead of "putty-clay." This means that the capital to output (and capital to labor) ratio can be changed after the structure is completed.

Inventories of goods in the model are tied to the appropriate sales so that inventory to sales ratios are fixed in the long run. The current equations show that inventories adjust rapidly to desired levels, with nonretail durables being the slowest to adjust.

The two most important foreign trade equations are for nonagricultural exports and nonfuel imports. Both equations are based on foreign and domestic output and prices. The demand elasticity with respect to foreign GNP in the export equation is constrained to equal the elasticity of imports with respect to domestic output. (Both are 1.2) The service equations are similar in structure, except that goods exports and imports enter directly into the two service equations to capture trade-related services such as transportation and insurance.

Prices and wages. The wage equation is a standard Phillips curve formulation. The primary determinants of wage rate increases are the level and change in the unemployment rate and lagged prices. The equation implies a natural rate of unemployment. In common with all natural rate equations, which do not contain an explicit productivity term, the natural rate of unemployment is a function of the trend rate of growth of productivity. With a 2.6 percent rate of growth of productivity, the natural rate is 4.4 percent. At the 1.7 percent rate prevailing since 1969, the natural rate of unemployment is 5.6 percent.

The main price equation, which explains an adjusted fixed-weight deflator for domestic nonfarm

business, is based on a markup on unit labor costs. The size of the markup varies with exchange rate adjusted foreign prices (based on an "import-competing goods" argument) and the unemployment rate (as an index of capacity). The detailed deflators are spun off this main price equation through a series of relative price equations with the relative prices based on farm, import, and foreign prices; productivity; capacity measures; and a time term for relative productivity movements. Changes in farm and import prices are, in the long run, passed on to the appropriate final demand category.

Financial sector. The primary equation in the financial sector of the model is the equation for money demand. In most instances, the model is used with this equation reversed, so that the money supply is exogenous to the system and the U.S. Treasury bill rate is endogenous.

The equation is a fairly standard velocity equation, with demand deposit velocity explained by lagged demand deposits, current and lagged bill rates, passbook rates, and real per capita GNP. The elasticities with respect to prices and population are 1.0, with respect to real per capita output, 0.7. There is a velocity trend of less than 1 percent a year.

The remaining interest rates are derived from the Treasury bill rate through a set of term structure equations. The commercial paper rate is central to the longer maturity rates. It is derived simply from current and lagged bill rates. The longer rates are based on a distributed lag on commerical paper rates and price changes.

Considerations in Long-Term Forecasting

Several adjustments had to be made in the model to make a forecast for the long period to the year 2000. Variables normally exogenous to the model, such as population and Federal fiscal policy, had to be projected. Several variables, normally exogenous to the model, had to be made endogenous, such as Federal personal tax rates and foreign exchange rates. Trend terms in several equations, particularly the money demand and productivity equations, had to be examined with regard to their long-run behavior.

Many important properties of this forecast are based on the specific assumptions and adjustments made. The rate of growth of productivity, for example, is only an educated guess and could well be wrong. In general, we have tried to make the guesses in such a way as to raise the effective benefits from a reduction in illness.

Forecasting over a long time horizon is a difficult and, in many respects, an arbitrary process. The accuracy of the forecast depends on the continued stability of relationships that have held in the past, but could dissolve in the future. Many of these relationships must be restructured repeatedly as situations change. The housing market equations, for example, tend to change every time a new subsidy program is announced by the Federal Government. The savings deposits equations have a very important break with the legalization of new deposit instruments in 1969. Although we have no knowledge of when such breaks will occur in the future or what form they will take, they will happen.

In addition, rather sweeping assumptions must be made about the future courses of variables exogenous to the model. These variables include government tax and spending policies, birth rates, crop failures, and a great many other unpredictable matters. As indicated earlier, in making the forecast to the year 2000, we have assumed there will be no major shocks from these sources. There probably will be, but when and in what direction, we do not know.

Policy variables. We hope that the broad outlines of our projection are correct. No one should expect the cyclical detail to be accurate. Much of the forecast is highly dependent on the assumptions fed into the forecast. The most obvious example is the future course of monetary and fiscal policy. These assumptions are largely arbitrary, especially after the first few years of the forecast. We can make reasonable assumptions about the future real costs of existing programs, but guesses as to which programs will be added or reduced are just that—guesses.

For the long-range simulation, we assume that each principal category of Federal expenditures will retain its current relationship to the nominal GNP and that Federal employment will continue to decline relative to the working-age population. These assumptions are not the result of any detailed analysis but they seem reasonable. (Fortunately, the forecast is not very sensitive to this assumption.)

All tax rates remain at currently legislated levels except for the personal income tax rates. These rates are adjusted to maintain a balanced full-employment budget with a 1-year leg. These assumptions are obviously unrealistic and imply a much smoother movement of fiscal variables than has occurred in the past.

Tax laws simply do not remain constant over a long period, nor do they change evenly every year, as has been assumed for the personal tax rates in the simulation. Instead, large changes occur every few years. The assumption that the full-employment budget is in approximate balance of receipts and expenditures is also not true of the recent past. These assumptions, however, are no more arbitrary than others that could be made. Moreover, the outcome of long-term simulation is not significantly sensitive to reasonable changes in these assumptions.

A monetary policy was chosen that would create a smooth growth path, keeping the economy near the full-employment level. This choice is unrealistic on several counts. For exeample, the monetary policy chosen implies that the growth rate of money and the level of interest rates are less variable than in normal historical periods. This choice does affect the outcome of the forecast, since a smoother path gives a generally better picture of the economy.

Nonpolicy exogenous variables. We have assumed no large external shocks to the system. Over a 25-year period, some shocks are certain to occur. Although we cannot predict when they will occur or what form they will take (crop failures, oil cartels, foreign recessions), we know that some are certain to occur and that on balance they will worsen the economic outlook. Even if the number of good shocks (such as unusually good crops) balances the number of bad shocks (such as crop failures), the nonlinearities in the economic system will cause the bad shocks to damage the economy more than the good shocks help it.

The most important nonpolicy exogenous variable in the model is population. As indicated earlier, for the long-run forecast, we have used the Census Series II population projection which gives the following rates of growth of population, by 5-year periods:

Period	*Percent, annual rate*
1975–80	0.9
1980–85	1.0
1985–1990	0.9
1990–95	0.8
1995–2000	0.6

SOURCE: Reference *5*.

Foreign prices and output are assumed to grow at the same rates as U.S. prices and output. The assumption seemed the most neutral possible. The measures used are restricted to western industrialized nations (the Organization of Economic Cooperative Development countries) because of the lack of current, accurate data from outside the OECD. The exchange rate is adjusted in the forecast to keep the current account of the United States in approximate balance, a step that implies a slight surplus in our balance of trade. This assumption was made for the sake of neutrality, but it seems reasonable in a world of floating exchange rates. There is some question as to whether, in a world where large surpluses are being accumulated by the oil-producing nations, the United States will be able to maintain a trade surplus. A deficit would not seriously affect the pattern of the forecast so long as it was not growing rapidly over the period.

The forecast assumes that farm output will rise in proportion to total output. Farm prices rise in proportion to the fixed weight deflator.

The demand of monetary aggregates. As is well known, M1 (currency and demand deposits) velocity in the postwar period has risen at about a 3 percent annual rate on average. For the past two decades M2 (currency and demand deposits plus time deposits) velocity has shown no trend. The average annual rates of change of money velocity between 1956 and 1976 were as follows:

Definitions of money	*Rate*
Currency	+1.70
Demand deposits	+3.15
M1 velocity	+2.82
Time and savings	−3.61
M2 velocity	+.002

SOURCE: Federal Reserve Board, Division of Research and Statistics.

Our equations attempt to account for these trends. Currency appears to be approximately proportional to consumption expenditures, apart from a relatively small elasticity with respect to interest rates. The demand for demand deposits is more complicated. Economic agents appear to be able to economize on demand balances as transactions increase. The demand for demand deposits equation has an elasticity of about 0.6 with respect to real, per capita GNP. If this elasticity were unity, money balances would grow (in the absence of interest rate changes) at the same rate as the nominal GNP. If real, per capita GNP trends upward at 2.5 percent per year balances would grow 1 percent more slowly than the nominal GNP on this account [(1 − .6) × 2.5 = 1]. There also

appears to be about a 0.5 percent downward trend in deposits relative to GNP due to technical improvements in the payments mechanism. The remainder of the increase in the historical demand deposit velocity has been accounted for in our equation by generally rising interest rates. It should be noted that since mid-1974 this demand deposit relationship has not worked well. Demand deposits have grown much more slowly than predicted. A continuation of this phenomenon would have been very important for the forecast, and we will return to this problem later.

Time and savings deposits have generally risen relative to GNP. We believe the demand for these deposits normally is more closely related to wealth than to income but, in the long run, the wealth elasticity of time and savings deposits is unity. What then accounts for the increase in these deposits relative to GNP? Part of the answer is that the demand deposits eliminated by economies of scale and rising interest rates have gone into time and savings deposits. This by itself should not have been enough to hold M2 velocity constant, since part of the lost M1 should have gone to other interest-bearing assets. The extra time and savings deposits appear to have arisen from periodic expansions in the types of time and savings deposits which banks have been allowed to offer.

The most questionable part of our calculations, so far, is the part concerning M1 velocity. For the past 3 years, M1 has grown more slowly than expected by an average of about 3 percent per year. We may need to introduce henceforth a stronger negative time trend in the demand for money. In the forecast, we have assumed a 2 percent trend in M1 velocity. This assumption lowers the M1 growth needed, but has no other significant effect on the forecast.

Productivity. From World War II through the late 1960's output per hour in the nonfarm private economy grew at a rate of about 2.6 percent a year, corrected for cyclical effects. This rate came to be taken as a natural law. During the 1970s, as indicated previously, the rate of growth of output per hour has slowed dramatically to under 2 percent a year (again corrected for cyclical effects). The factors underlying productivity changes were summarized earlier.

Due largely to changes in tax incentives, the capital to output ratio implicit in the model's investment equation rose steadily during the 1950s and early 1960s. Since then, the ratio has actually fallen slightly. Moreover, in the absence of future increases in investment incentives, the ratio is not likely to rise above its mid-1960s peak. Even with increased incentives, it must eventually reach a constant value. If the early results of entering this variable into our productivity equation are correct, the true long-term productivity trend may be below 2 percent.

The rapid rise in oil and other energy prices has also been blamed for the recent productivity slowdown. Our results indicate this situation has had only a small influence on the rate of growth of pro-

Table 8. Projected growth rates and levels of economic variables, 1976 to year 2000 (dollars amounts in billions)

Economic component	*1976*	*Annual growth rates*					*2000*
		1977–80	*1980–85*	*1985–90*	*1990–95*	*1995–2000*	
GNP (current dollars)	$1,706	10.5	7.7	6.6	6.3	5.6	$9,100
GNP (1972 dollars)	1,275	4.9	3.4	3.3	3.6	3.6	3,060
GNP deflator [1]	134	5.4	4.2	3.2	2.6	2.0	300
Consumption (1972 dollars)	821	4.5	3.2	3.5	3.3	3.4	1,892
Population (millions)	215	0.9	1.0	0.9	0.8	0.6	263
Output per hour [2]	7.58	2.7	1.8	2.2	2.1	2.1	12.65
Labor force [3]	97	2.4	1.5	1.2	1.4	1.3	132
		Average over the period					
Levels							
Treasury bill rate	5.0	6.9	6.8	5.9	5.1	4.1	4.0
(Real) [4]	–0.3	2.0	2.6	2.7	2.5	2.1	1.8
Unemployment rate	7.7	6.4	6.5	6.3	5.3	5.5	5.5

[1] Prices excluding net exports.
[2] Private nonfarm business economy.
[3] Total in millions.
[4] Treasury bill rate less rate of growth of GNP deflator.
Source: Projections from the MPS model.

ductivity, lowering the level of output per hour by about 1 percent.

The changing composition of output has also been blamed for much of the fall in productivity growth. Since the series used in the model is for private nonfarm productivity, shifts into government and out of agriculture are irrelevant. Housing services are also excluded from the series, eliminating that possible cause of change. When we look at what remains in our series, we find some evidence of a shift in real output out of durable manufacturing and into services. However, the evidence for an acceleration in this shift (except for the expected cyclical movement) since the 1960s is weak.

Taking all the arguments into account, we feel a 2 percent growth rate of productivity is a reasonable, conservative estimate. We admit that this estimate could be wrong; if it is wrong, it would significantly affect the results of the forecast.

In general, the world would look better if productivity growth were higher. The natural rate of unemployment is a function of the rate of productivity growth. Our equations indicate that with a productivity growth trend of 2.6 percent, the natural rate of unemployment is 4.5 percent, while at 2 percent, it rises to 5.5 percent. Although in the short run, lower productivity reduces the unemployment rate, in the long-run, it increases it.

The most direct impact of a lower productivity rate is a lower rate of growth of real output and income. Although the difference between 2 percent and 2.6 percent is small for 1 year, by the end of 25 years it means a growth of only 64 percent in real per capita output, rather than a growth of 90 percent.

The Long-Term Forecast

The shape of the long-term forecast is heavily influenced by our assumptions and especially by the assumed rates of growth of productivity and the money supply (table 8). The expansion path projected is, deliberately, much smoother than the real world is likely to be, partly because smooth fiscal and monetary policies have been assumed. In fact, the monetary policy was chosen deliberately to smooth out any irregularities in the forecast and to produce stable growth rates.

Chapter 4. Major Economic Components of the Cost of Illness

The economic model defines the parameters for the estimates of the cost of illness presented in this report. As indicated previously, cost of illness is a composite of direct costs measured in expenditures for health services and goods, both public and private, and indirect costs measured in loss of working time and loss in earnings as a result of premature death and disability. In estimating direct expenditures for illness, the economic factors especially relevant are income and GNP, general price levels, and earnings of those in the labor force. Indirect cost calculations draw on calculated wage rates and productivity, interest rates, and rates of participation in the labor force. These components are endogenous factors in the economic growth model; they are the ingredients of estimates of illness costs.

Wage Rates and Productivity

Projections of wages and earnings are essential building blocks in estimating indirect illness costs. Average gross earnings of health practitioners are related to the earnings of others in the population. Earnings by age and sex are used to cost production losses attributed to premature death and disability. In estimating the present value of future earnings, year 2000 earnings were projected on the basis of year 1975 earnings that were increased by the projected rise in productivity and wage rates.

Table 9 illustrates projected increases in earnings between 1975 and year 2000. Earnings are calculated on two bases. One includes the value of work done in the home, the other excludes this work. Adjusting these projections solely by productivity

Table 9. Average market place earnings, by age group, for 1975 and year 2000

Age group (years)	Males			Females in labor force		
	[1] 1975	Year 2000 (In 1975$) [2]	Year 2000 (In year 2000$) [3]	[1] 1975	Year 2000 (In 1975$) [2]	Year 2000 (In year 2000$) [3]
Including household values [4]:						
15–24	$ 5,135	$ 9,028	$21,281	$ 4,105	$ 7,171	$16,903
25–34	14,004	24,330	57,342	10,587	18,373	43,312
35–44	16,747	29,062	68,446	10,957	19,011	44,814
45–54	17,746	30,791	72,532	10,962	18,165	42,821
55–64	15,551	26,825	63,183	9,918	17,075	40,251
65–74	8,525	14,873	35,059	5,591	9,710	22,891
75–84	7,206	12,471	29,398	4,519	7,841	18,484
85+	6,042	10,486	24,714	3,867	6,650	15,676
Excluding household values [5]:						
15–24	4,789	8,415	19,838	3,286	5,737	13,525
25–34	12,792	22,227	52,396	6,453	11,199	26,401
35–44	15,489	26,882	63,309	6,322	10,975	25,871
45–54	16,517	28,658	67,494	6,878	11,938	28,141
55–64	14,460	24,939	58,794	6,595	11,440	26,968
65–74	7,559	13,172	31,051	3,553	6,167	14,538
75–84	6,425	11,117	26,207	3,469	6,022	14,197
85+	5,561	9,656	22,762	3,398	5,897	13,900

[1] Earnings for males and females in the labor force are average earnings for all full-time and part-time employed in 1975, disregarding duration of empoyment.

[2] Earnings adjusted for productivity.

[3] Earnings adjusted for both productivity and inflation.

[4] Average market place earnings plus household values.

[5] Average market place earnings only.

Sources: Average market place earnings derived from BLS unpublished data, adjusted by wage supplements (12.6002 percent), derived from U.S. Department of Commerce, *Survey of Current Business*, February 1976; household values derived from Walker and Gauger, *Dollar Value of Household Work*; U.S. Census 1970, *Employment Status and Work Experience*, Table 13; U.S. Census 1970, *Detailed Characteristics*, Table 203. Method is adaptation of W. Brody, *Economic Value of a Housewife*. Social Security Administration Office of Research and Statistics, Research and Statistic Note 9, Washington, D.C., 1975.

increases results in figures expressed in the 1975 real earnings level; adjusting for both productivity and inflation results in figures expressed in the year 2000 price level. The GNP deflator was employed for the inflation in this chapter and in later chapters. A different deflator was used in Chapter 1.

It should be noted that, in projecting 2000 earnings, the annual rates of productivity growth and price increases came from the first cut of the economic projections and may differ slightly from the subsequent estimates. The first cut productivity estimates, in terms of annual rates of growth, follow:

Period	*Percent of growth*	
	1st estimate	*Revised estimate*
1977–80	2.6	2.7
1980–85	1.7	1.8
1985–90	2.2	2.2
1990–95	2.1	2.1
1995–2000	2.0	2.1

As indicated in Chapter 2, the projected rise in productivity is below the rate experienced during the period from World War II to the late 1960s. Some of the factors affecting future productivity growth have been mentioned earlier; these factors are elaborated further in this chapter.

Historically, the rise in productivity has been closely associated with demographic changes and with the shift of workers out of the agricultural sector as efficiency in that sector rose dramatically. In the future, neither demographic developments nor a further shift out of agriculture are expected to effect progress in worker efficiency. Technological progress and improvements in social and industrial organization will play major roles.

Since the early years of this century, the educational attainments of the labor force have risen dramatically, but it is not clear that productivity would be stimulated by a further rise in the general level of education.

In the post-World War II period, the percentage of women in the labor force has increased sharply. Characteristically, women have had somewhat less education and less experience, and have worked shorter hours than men. Women also tended to take jobs in distribution and services, low-productivity industries that were expanding rapidly. Thus, the participation of women in the labor force appeared to lower average productivity in the economy. In the future, however, the ratio of women to men will rise more slowly, and the differentiation in salary scales between the two sexes may lessen.

As discussed, the proportion of young and inexperienced workers also rose sharply in the 1960's and early 1970's. No similar increase is expected in the 25 years ahead.

BLS projections of productivity. Private economists have been more pessimistic than Government economists about the rate of productivity growth in the years to 1985. The most recent and thorough projection made by Government economists, "Revised Projections of the U.S. Economy to 1980 and 1985," appeared in the Monthly Labor Review in March 1976 (*6*). In these projections, the rate of productivity growth was lowered from an earlier estimate to allow for recent developments. According to the Bureau of Labor Statistics (BLS) (*6*):

> Partly the revision reflects the actual experience of the most recent period and particularly the impact of the cyclical downturn on productivity growth in the short run. Also, there is the expected cost of meeting pollution control and industrial safety requirements, a long period of less than full utilization of resources, and high energy prices . . . Investment in energy-saving equipment could also dampen the growth of productivity. Thus, although it is difficult to quantify their impact, many of the factors that may influence productivity growth in the next decade tend to be restrictive rather than expansive.

On the longer term outlook, the BLS comments: "After 1980, the economy may have adjusted to most of these changes and thus may return to productivity growth rates more characteristic of the 1950's and 1960's" (*6*). Private forecasters, on the other hand, emphasize the possibility of a capital investment shortage. Our estimates fall between the higher and lower ranges suggested by other projections.

Among the influences likely to result in relatively modest growth of productivity are (*a*) slower produc-

tivity growth in agriculture than in the past and a necessarily smaller contribution to total increases in output per manhour, (*b*) possible further decline in new investment over the next decade, (*c*) probable higher costs of energy and perhaps energy shortages, (*d*) a less favorable distribution of industry output (greater relative importance of labor-intensive industries which typically exhibit lower productivity), (*e*) the end of the era of the over-valued dollar and of cheap crude material imports, which could mean (*f*) shortages of raw materials, especially if energy becomes more expensive, (*g*) greater costs to control pollution, conserve resources, and protect the environment, and (*h*) greater costs associated with protecting workers and consumers from health hazards.

In estimating technological and productivity gains from now until the year 2000, we have tried to strike a compromise between undue pessimism and simply projecting what appears to be an unusually favorable post World War II trend. There seems ample reason, in view of the experience of the last 10 years and the problems which seem likely to be important in the future, to anticipate a considerably lower rate of growth in output per worker than characterized the 30 years following the last world war. On the other hand, the low output levels of the last 10 years were undoubtedly an important factor depressing the rate of progress, and it would be unwise to accept these levels as a benchmark.

Interest Rates for Discounting Future Earnings

In order to have a common base for comparison and to assess the value of a present cost that yields benefits in the future, the future returns must be reduced to their present value, or be discounted. Outlays for health or biomedical research can then be assessed by gauging whether the income flows in years to come, when put in the form of present values, yield a potential return that is comparable or competitive with other potential uses.

Discounting, besides allowing for comparison in present values, also allows for a more efficient allocation of resources. The theory is that benefits realized in the near future are more valuable than those in the distant future due to uncertainty of returns, and costs in the present or near future are more of burden than those of the distant future.

While the necessity for discounting is seldom questioned, a dilemma arises as to what discount rate to choose. There is lack of consensus on a specific rate yet the selection must be done with care, for the implications are extremely important. Costs of premature death are markedly affected by the discount rate selected.

Also it should be noted that there is a conceptual distinction between setting a rate when choosing among alternative government projects and setting a rate to use in expressing the current (or base-year) present value of future earnings lost. The latter rate should be a real rate, devoid of price inflation.

Conceptual positions on the choice of the discount rate. A social discount rate must be used to determine the opportunity cost of government funds invested in physical or human capital. Some researchers have concluded that the social discount rate is indeterminate, leading to a search in the realm of "second best." There are, however, several possible avenues of approach. One could choose the rate at which the government borrows funds with proper consideration of the length of time for which money is borrowed. Another possibility is the corporate earnings rate, using the notion that governments compete with the private sector for funds, and money that governments borrow could, alternatively, be utilized by the private sector. Or it is possible to look at the opportunity cost of tax dollars collected by the government since a major portion of social investment is financed this way; the point of this approach is that the uses to which those tax dollars are put reflect the social cost of government investment.

In arriving at a proper social discount rate, a number of considerations arise. In this section, we will survey only a few; the literature on the social discount rate is voluminous and has been surveyed in various contexts. See, for example, the discussions by Fisher and Krutilla (*7*) and the Joint Economic Committee's analysis (*8*).

Opportunity cost concept. The central notion behind the discussion of the discount rate is that government investment, whether for medical research or for irrigation, should enjoy a rate of return comparable to what could be earned in alternative pursuits. Any deviation from this precept implies an inefficiency in resource allocation between the public sector and the private sector. Alternatively, the capital funds could be used by private corporations, unincorporated enterprises, or by individuals.

Baumol (*9*) provided the clearest statement and use of the opportunity cost concept and employed it to grapple with several other issues discussed in this

section. In Baumol's view, the opportunity cost is best captured by the rate of return offered by business since, if funds were not invested for social purposes, they would be released for investment in private capital markets. Harberger (*10*) also favored the return which could be earned in private, incorporated businesses. However, he broadened it to cover returns on unincorporated enterprises and funds used by individuals.

In brief, the opportunity cost concept is well accepted, but there is dispute about whose opportunity cost is at issue, especially when the investment extends to future generations, as does investment in health care.

Tax distortions. If one adopts the idea that the rate corporations earn on equity capital reflects the opportunity cost of government investment, then the corporate profits tax complicates the exact choice of rates. If the return for corporations is 5 percent, then the government discount rate should be 2 times 5 percent or 10 percent. Because the corporate income tax is levied at a rate of 50 percent, the actual rate of earnings is 10 percent. Since according to the opportunity cost concept, misallocation of resources occurs if funds are diverted from high yield to low yield projects, the government should employ the higher rate representing the true rate of return.

Baumol adopted this line of reasoning as did Harberger and, indirectly, Eckstein, in his testimony before the Joint Economic Committee (*8*). Harberger extended it to include the additional uses of funds mentioned previously. The actual social discount rate may be less than twice the private corporate rate even after adjustment for corporate taxes, because of the varying ratios of debt to equity financing.

Source of funds. Eckstein distinguished between government borrowing and tax revenues as sources of funding for public capital formation. The notion of opportunity cost arises in this context in the form of the cost of borrowing funds in the first instance and, second, as the alternative uses of tax revenues. Using both approaches, Eckstein distinguished two acceptable social rates of discount. The lower rate is based on Federal Government long-term borrowing, and the higher rate essentially is based on the corporate rate. The choice of a discount rate then is indeterminant, but a reasonable range is set forth. The actual calculation of the second rate is documented by Eckstein and will not be elaborated here.

Risk. There has been intensive discussion of the role risk can play in the choice of a social rate of discount. Risk accounts for at least part of the level of return on private capital; riskier investments should produce higher compensation for persons parting with their funds. The question is whether a risk premium should be incorporated into the government discount rate. At one end of the spectrum, economists such as Arrow and Lind (*11*) and Samuelson (*12*) argue that government investment is riskfree due to the large and diversified investment portfolio held by the public; or to put it another way, because the total risk is spread over so many, for a single person, it becomes negligible. Thus government should not include a risk premium in its discount rate.

The other point of view, shared by Baumol, Hirschleifer (*13*), and Sandmo (*14*) is that return on public investment should be comparable to the return on private investment for projects of comparable riskiness. The basis for this view is that society receives the benefits from all investment projects, whether they be public or private; and all projects, public or private, should be evaluated on the basis of earnings.

Subjective time preference. The rate of discount on government expenditures ideally would be the same as the average rate of social time preference. This theory reflects society's preference between current and future consumption. Unfortunately, the preference can only be observed by reference to rates of interest. The return on government securities may approximate the rate of time preference better than private obligations because government obligations are relatively riskless. This method of evaluating the subjective rate of time preference differs from, and is lower than, the opportunity cost of public investment funds.

The juxtaposition of these two concepts led Baumol, among others, to conclude that there is a basic indeterminacy in the choice of the proper discount rate.

Documentation of current practices. Since medical research is essentially government funded, it is appropriate to consider the discount rate used by Federal Government agencies for other investments. More or less standard practice calls for discounting based on the average "coupon rate" on interest-bearing marketable securities of the United States which, when originally issued, had terms of maturity of 15 years or more. In the summer of 1968, the

Water Resources Council proposed a more reasonable procedure for determining the discount rate. The Council called for the use of the yield rate rather than the coupon rate. The difference in methods would result in a 4⅝ percent discount rate for 1969 compared with a 3¼ percent coupon rate.

Eckstein in 1968 suggested formulation of the discount rate by looking at the two sources of Federal money (*8*). One source, borrowing, costs Goverment about 5.5 percent. Taxation is the other source, and its price is the opportunity cost of the tax money for the taxpayers. Eckstein estimated this cost at about 8 percent in 1968. These two costs would be combined to set the discount rate. The cost of taxation would be weighted more heavily, since it is the source for almost all Government funds. This step would mean a discount rate of over 7 percent for 1968.

In 1968, the Association of American Railroads suggested that the relevant discount rate for use in evaluating public investments should be in the 8 to 10 percent range. This proposal is based on the fact that riskless Government bonds can bring 5.5 percent and the return to private investors can be estimated conservatively at 12 percent.

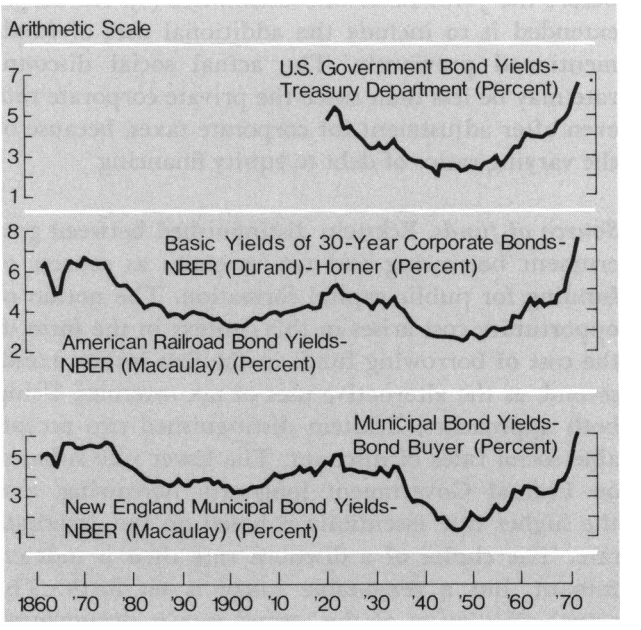
In her 1966 study estimating the cost of disease, Rice used two discount rates—6 percent and 8 percent—to estimate the present value of lifetime earnings (*15*). She felt these rates were in the intermediate range of rates used. To illuminate the subject, she presented historical evidence on the use of the discount rate in assessing the value of future earnings. In the "Money Value of a Man," published in 1946, Dublin and Lotka measured the present value of a person's net future earnings (gross earnings less personal consumption) using a 2.5 percent discount rate (*16*). In a 1958 study developing the cost of mental illness, Fein estimated the present value of future expected earnings for specific 10-year age groups; he employed various discount rates from 2 to 5 percent (*17*). In 1961 Weisbrod used 4 percent and 10 percent as discount rates to analyze future earnings in "Economics of Public Health" (*18*). In studies published in 1964 and 1965 Klarman calculated the present value of future earnings for persons with syphilis and for those who died of cardiovascular disease (*19, 20*). In the syphilis study, he used a discount rate of 4 percent, while in the cardiovascular deaths study, he used a rate of 6 percent.

It should be noted that the studies were completed before the onset of serious and prolonged inflation. Presently, all monetary interest rates must be adjusted to reflect anticipated depreciation in the value of the dollar in order to arrive at the "pure" or "natural" interest rate rather than the monetary rate. The GNP price deflator is used in adjusting the discount rate used in developing the estimates in table 9.

In this report, we have chosen to employ two discount rates: a low rate, 2.5 percent, which would be near the yield on short-term government securities (90-day bills) after allowance for expected inflation, and a rate of 10 percent representing the high end of a range of estimates reflecting opportunity costs. Since our study presumes that inflation will be brought under control only gradually, the real yield on investment, whether public or private, will be lower than the monetary rate of interest, but by declining percentages.

Historical data sources. In studying the cost of disease spanning the 20th century, discount rates may be desirable for certain specific years, and past interest rates will be of considerable help in guiding one's final decision. Sources for two typical market rates—the yield rates of U.S. Government long-term bonds and common stock yields—are of particular value. Rates exist for U.S. Government bonds since 1919, the Cowles Commission lists stock yields from

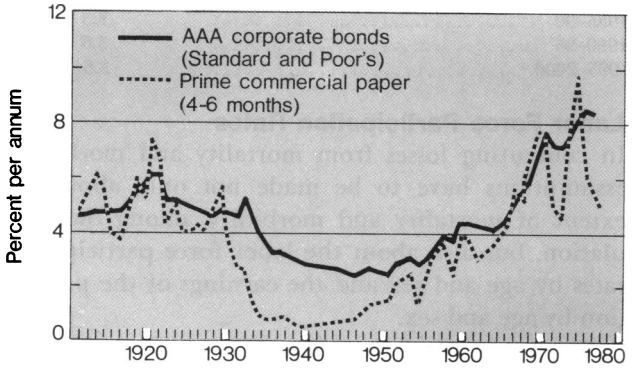
Figure 6. Various long-term interest rates



Source: U.S. Bureau of Economic Analysis: Long-Term Economic Growth 1850-1970. U.S. Government Printing Office, Washington, D.C., 1973.

1895 to 1937, while Moody's covers stocks from 1929 on. These rates were published in "The Statistical History of the U.S. from Colonial Times to the Present" (*21*). Market yields from 1900–20 can be found in "The Financial Review, 1921" (*22*). Homer's "A History of Interest Rates" also is an excellent source for both interest rates on U.S. Government bonds and prime corporate bonds since the turn of the century (*23*). Figures 6 and 7 illustrate the movements of a few relevant interest rates over long periods. These charts were drawn from a variety of sources, such as Macaulay's work for the National Bureau of Economic Research, which is extremely helpful about interest rates in the early 20th century (*24*).

Figure 7. Comparison of movement between long- and short-term interest rates



Source: Historical Chart Book. Board of Governors of the Federal Reserve System, 1977, Washington, D.C.

Price Movements

Price changes in the period ahead affect several important variables: (*a*) nominal wage levels and dollar earnings loss due to disease, (*b*) prices of medical care and expenditures for personal health services, (*c*) earnings of providers of care, and (*d*) interest rate changes.

Table 10 reports historical rates of change in two price indices that are based on the National Income Accounts compiled by the Commerce Department, the GNP deflator and the consumption price index, and in five price indices that are derived from the monthly survey of consumer prices conducted by the Bureau of Labor Statistics. The consumer price index (CPI) attempts to measure the changing prices of an unchanging group of goods of constant quality, while the implicit GNP price deflators reflect the changing composition of economic activity for the entire economy.

The table 10 data show that price movements are similar for the GNP deflator and the all-item CPI.

Table 10. Trends in prices, GNP deflator and consumer price indices, 1933–75

Year	GNP deflator (1972 base)		Consumer Price Indices (1967 base)				
	All items	Consumption	All items	Medical care	Drugs	Physician fees	Hospital room charges
1975	127.18	126.5	161.2	168.6	118.8	169.4	226.6
1974	116.02	116.9	147.7	150.5	109.6	150.9	194.2
1973	105.80	105.5	133.1	137.7	105.9	138.2	176.0
1972	100.00	100.0	125.3	132.5	105.6	133.8	168.3
1971	96.02	96.6	121.3	128.4	105.4	129.8	157.5
1970	91.36	92.5	116.3	120.6	103.6	121.4	141.7
1965	74.32	77.1	94.5	89.5	100.2	88.3	77.7
1960	68.67	71.7	88.7	79.1	104.5	77.0	57.8
1955	60.98	64.2	80.2	64.8	94.7	65.4	44.1
1950	53.64	56.8	72.1	53.7	88.5	55.2	31.3
1945	37.99	44.0	53.9	42.1	74.8	46.0	18.9
1940	29.10	30.8	42.0	36.8	70.8	39.6	15.1
1935	..	..	..	36.1	70.7	39.2	14.2
1933	25.13	26.8	38.8	..	..	..	..
Average [1] annual change, entire period (percent)	3.9	3.7	3.4	3.9	1.3	3.7	6.9
Average annual change 1965–75 (percent)	5.4	5.0	5.3	6.3	1.7	6.5	10.7

[1] The computational formula is $\ln\left[\left(\frac{\text{Ending year}}{\text{Beginning year}}\right)\right] \div$ (Number of years).

Source: GNP deflator data obtained from the Economic Report of the President, 1976. CPI data are from *"Historical Statistics of the United States,"* and various issues of "Statistical Abstract of the United States."

The absolute levels are different because they are calculated on different base years, but the rates of change are remarkably similar over time. The overall GNP deflator has increased at a slightly faster rate than the deflator for the consumption component of GNP or the CPI. This is because of structural changes over the 1933–75 period and productivity improvement in the consumer goods sector. Over the 1965–75 period, the GNP deflator and all-item CPI index changed at almost identical rates.

A more difficult issue is the relationship between medical prices and the aggregate price indices. It is apparent from table 10 that, over the longer period, medical care sector prices have grown at rates somewhat larger than the aggregate price level. There is some variation from the overall trend; drug prices as measured have risen at a lower rate and hospital charges have climbed at faster rates. However, from 1965 to 1975, medical sector prices have risen at rates substantially higher than general prices. The important and difficult question is whether this differential rate of growth in prices will continue.

The question is very important because of the power of compounding rates of growth. For example, if two items have equal prices in 1975 but their prices increase at annual compound rates of growth of 3 and 6 percent annually, after 25 years the slower growth prices will more than double, and the faster growth prices will more than quadruple.

In arriving at medical care prices for the year 2000, we assumed that the long-run relationship between the GNP deflator and medical care prices will be restored. It is not expected that the rise in medical care prices that accompanied the introduction of the Medicare and Medicaid programs represents a long-term trend. There are two justifications for this assumption. Public concerns about controlling the rising cost of medical care can be viewed as one justification. The rapid rise of medical care prices is leading to public and private efforts to contain medical costs. Recent proposals introduced in Congress to limit the rise in hospital costs to one and one-half times the rise in overall prices illustrate the policy direction. The second justification is that, historically, differentials in sectoral price growth which are unrelated to productivity changes do not long persist. As Baumol has indicated, there is reason to expect moderately larger rates of inflation in service sector industries than in manufacturing industries because productivity per worker tends not to increase as rapidly in the service sector (*25*).

The assumption that the long-run relationship between the GNP deflator and medical sector prices will be restored is germane to (*a*) the assumed prices of medical care and the resulting expenditure estimates and (*b*) assumed earnings of providers of care used in estimating the costs of care.

Nominal earnings used in pricing the indirect costs of disease in the year 2000 are based on estimates of the future path of the GNP price deflator as well as productivity increases. The assumed time path of the GNP price deflator follows:

Period	*Percent per annum*
1977–80	4.9
1980–85	3.4
1985–90	3.3
1990–95	3.6
1995–2000	3.6

Labor Force Participation Rates

In computing losses from mortality and morbidity, assumptions have to be made not only about the extent of mortality and morbidity among the population, but also about the labor force participation rates by age and sex and the earnings of the population by age and sex.

Three sets of assumptions were used to compute labor force participation rates (LFPR). First, it was assumed that the rates observed in 1975, adjusted for full employment (defined at 5 percent unemployment) would prevail in the year 2000, as expressed in the "Employment and Training Report of the President, 1976" (*26*). We adjusted the data to include the institutional population using Johnson's Special Labor Force Report, "The U.S. Labor Force: Projections to 1990" (*27*).

Another adjustment of the 1975 rates was made to include those who had dropped out of the labor force, discouraged by the high unemployment rates. Using coefficients computed by Rosenblum, updating a model of Tella's (*28*), we included in the labor force some workers who would have been employed had the unemployment rate remained at 5 percent.

The 1976 Employment and Training Report (*26*) does not provide labor force participation rates for the age categories we needed for this report. For the age-group 15-24 years, this report showed a breakdown by ages 16–17, 17–18, and 20–24. These groups were weighted by the number in the labor force to give us the age group needed. Similiarly, for the groups over 65 years, the numbers in the labor force were used as a weighting factor.

In the second instance, the projections developed

by Fullerton of the U.S. Department of Labor for 1990 were used as a basis for our year 2000 projections (*29*). Fullerton assumed that the trend in observed LFPR in the 1955-75 period would continue until 1995 and that the rates would then remain constant. Using his projections of LFPR for 1980 and 1990, the assumption was made that the change between 1990 and 2000 would equal the change between 1980 and 1990. The rates used were Fullerton's unpublished projections of the total population (including both the military and the institutional population). Again, as with the constant LFPR, adjustments for age group categories had to be made.

In the third instance, a new set of projections for the year 2000 was made. Fullerton showed that if the declining trend observed in the past 20 years in most male age groups were to continue, adult males would show substantially lower LFPR in 2000 than in 1950. This decline would be particularly true for men over 45. This lowering of labor participation would impose strain on the economy and may, therefore, be reversed. Thus, for our third set of labor force participation rates, it was assumed that by the year 2000, the rates prevalent in 1947 would be observed for adult male workers. The source for the 1947 LFPR was, again, the "Employment and Training Report of the President, 1976." This third set of rates is projected only for males. Fullerton projected female labor force participation rates to be increased by the year 2000. Therefore, for both our decreasing and increasing rates of labor force participation for males, the rates for females are increasing (table 11).

Table 11. Labor force participation rates (LFPR) and rates for housewives in year 2000, under three sets of assumptions

Age group	Males	Females	Housewives	Total of females and housewives
Constant LFPR				
15–24	.744002	.583274	.241701	.824975
25–34	.941245	.572331	.410562	.982893
35–44	.955653	.573427	.409510	.982937
45–54	.915245	.562842	.415300	.978142
55–64	.767772	.404773	.562490	.967263
65–74	.297621	.148003	.749757	.89776
75–84	.090864	.034907	.810678	.845585
85 + ...	.0204	.0058	.835128	.840928
Increasing LFPR				
15–24	.75331	.72718	.158236	.885416
25–34	.94594	.7014	.286656	.988056
35–44	.96283	.67877	.308381	.987151
45–54	.92665	.6358	.34599	.98179
55–64	.80708	.42397	.544348	.968318
65–74	.37506	.125961	.7691543	.895115
75–84	.11451	.0297083	.815045	.844753
85 + ...	.025711	.0049368	.835853	.8407898
Fullerton's LFPR (decreasing)				
15–24	.73501	.72718	.158236	.885416
24–34	.93186	.7014	.286656	.988056
35–44	.93204	.67877	.308381	.987151
45–54	.88314	.6358	.34599	.98179
55–64	.64955	.42397	.544348	.968318
65–74	.092719	.125961	.7691543	.895115
75–84	.0286518	.0297083	.815045	.844753
85+	.0064326	.0049368	.835853	.8407898

PART II. DIRECT COST OF ILLNESS

Chapter 5. Estimated Direct Costs of Illness

Major contributors to Part II were Charles L. Vehorn, Douglas P. Wagner, J. Steven Landefeld and Robert S. Rycroft

The estimates of direct costs of illness for the fiscal year 2000 are linked to the economic model described in Chapter 3. Two sets of estimates are made. The first estimate approaches expenditures in the year 2000 from the perspective of the aggregate demand for care; the second set is based on disaggregated estimates. In making the first set of projections, a behavioral model of demand for health services is employed intially, and to those projections are added an estimate of expenditures, mainly governmental, not encompassed by personal health care. The second set, or the disaggregated projections, is based on estimates primarily of the supply of providers of care and the amounts expected to be paid per provider, or per unit of care, in the case of hospital services.

In using these estimates, it is important to note that they are a small part of a forthcoming, far larger study covering illness costs over the 20th century. For the larger study, resources were certainly not sufficient for an in-depth forecast of fiscal year 2000 expenditures for health services. Fiscal year 2000 is used to maintain consistency with previous reports that considered fiscal years 1900, 1930, and 1975. It was necessary, however, to employ some calendar year data in the estimating models, but this has very little impact on the projections. These projections are intended at best to illustrate the magnitude of direct costs, given the overall economic model within which they are estimated.

An Aggregate Behavioral Model

The postulated behavioral model we applied was developed earlier for purposes of assessing the historic contribution of biomedical research to health expenditures. It can be written formally as:

$H = f(D, P, F, T)$

where

H = real per capita personal health care expenditures
D = characteristics of demanders
P = provider characteristics
F = financial characteristics of the health care system
T = characteristics of technical advances (biomedical research and development).

Health expenditures per capita are expected to rise with increases in demand and changing numbers of providers. As less direct financing takes place and more third-party payments are made, incentives for efficiency in use of services diminish. Also, as cost-increasing technologies expand relative to cost-reducing scientific progress, expenditures for some illnesses will tend to increase.

The values of the independent variables applied in the year 2000 estimates of real per capita personal health expenditures, H, were derived as follows:

Real per capita income, a proxy for characteristics of demanders, D, was calculated from the real GNP estimate of $2.4 trillion derived from the economic model but at 1967 prices. In deriving real per capita income from the estimated per capita GNP, a recent year ratio of per capita income to per capita GNP was used. The per capita personal income for the year 2000 was $7,345 at 1967 prices.

The optimistic projection for the number of providers, P (an average of physicians and nurses per capita normalized by the respective standard deviations) was estimated as is described subsequently in this chapter. A projection of slow growth in the number of providers is based on changes in the demographic composition of the population only. Utilization data on physician visits per capita in 1975 for 12 age-sex groups are available from the Health Interview Survey of the National Center for Health Statistics. On the assumption that these utilization rates will remain constant, population estimates for year 2000 were applied to produce estimated physician visits for each group. Summing over age groups produces a projected total of 1.6 billion visits.

In 1975, there were 1.1 billion physician visits and an estimated total of 393,000 physicians in the United States, or 2,687 patient visits per physician. If visits per physician remain constant over time, the number of physicians required to serve patients would total 599,000 in the year 2000.

Any model attempting to capture shifts in medical market behavior must not neglect consumer and provider characteristics. The medical marketplace is unique both in the providers' role in determining demand and in the method of payment. In most markets, the demanders pay the supplier directly, but in this market the prevalance of third-party payments, as measured by private insurance, Medicare, and Medicaid (excluding other government third-party payments), has grown from 7.2 percent of personal health care expenditures in 1948 to 52.7 percent in 1975. Given the long political debate on health insurance, a further rise in the third-party payment share may be expected.

Third-party payments, F, were computed on three bases. In one, the percentage of personal health expenditures financed by third-party payments in 1975 (52.7 percent) was used; in a second, the coverage was assumed to rise to 75 percent of personal health care expenditures; and in a third, to 85 percent. These percentages were arbitrarily selected, but it is assumed that even with universal insurance coverage, some health costs, such as over-the-counter drugs, cosmetic surgery, certain prosthetic dentistry, and so forth, would be excluded as third-party payments.

It might also be noted that the adoption of national health insurance would have repercussions on employment and productivity. These impacts were not explicitly considered, but Mitchell and Phelps (*30*) estimated that various plans currently under consideration would increase employers' present premiums $5 to $21 billion and increase unemployment 0.4–1.4 percentage points.

Particularly important to health are advances in biomedical science. If research and development creates a product that almost wipes out a disease, such as the Salk poliomyelitis vaccine, then the cost of caring for those with the disease will gradually diminish, leaving only the cost of preventive immunization. Medical technology, however, is not always cost reducing. Some technical advances minimize pain or prolong life rather than curing a disease or condition. Some technological advances such as kidney dialysis, that provide a better quality of health care, tend to be cost-increasing. As providers furnish better services and as consumers grow to expect an ever higher quality of treatment, the demand for medical services tends to rise. Further increases in expenditures are likely unless the cost-reducing technical advances are large enough to outweigh cost-increasing factors.

As one of several possible proxies for biomedical advances, T, we used the number of Ph.D.s in biomedical sciences. In making the estimates, the number of new Ph.D.s in biomedical sciences, T, was assumed to grow proportionately to the number of physicians. For the year 2000, the estimate was 8,510. In view of demographic trends and expected reduced enrollments in higher education, this number may be too high, although application of the average annual growth rate for biomedical Ph.D.s between 1976 and a 1980 National Science Foundation projection produces a year 2000 projection slightly above 8,510. However, a substantial change in the number (for example, to two-thirds its level) would make only a small change in personal health expenditures for the year 2000 because the elasticity coefficient is relatively low and not a significant determinant of expenditures.

Costs of illness will certainly be influenced by a number of factors, including the general trends in prices and wages, the perceptions of the population about the efficacy of medical care, the structure for organization of care, and methods of paying for that care. It was not possible to control explicitly for all the factors affecting the cost of illness 25 years ahead, but the complex array of factors should be kept in mind when considering the estimates presented subsequently.

The projections for year 2000 were derived from the behavioral model estimated in log form and adjusted for first order autocorrelation (*31*):

$$\ln H = -1.91 + 0.58 \ln D + 0.79 \ln P + 0.17 \ln F + 0.05 \ln T$$
$$(-3.2) \quad (6.7) \quad (2.8) \quad (2.8) \quad (1.5)$$
$$R^2 = .901$$

where

H = real per capita personal health care expenditures in 1967 dollars

D = real per capita personal income (1967 dollars)

P = a weighted average (equal weights) of the stock of doctors and nurses (per 100,000 population) normalized by the respective standard deviations

F = financing method—the share of third-party payments (private health insurance, Medicare, and Medicaid) in total personal health care expenditures

T = number of new Ph.D.s in the biomedical sciences lagged 10 years to reflect the assumed time lag before the average new Ph.D. contributes to a new product or new techniques affecting changes in expenditures.

Personal health expenditures are estimated at $695–$960 per capita at 1967 prices, depending on various assumptions about providers and the financing system for the year 2000. This represents a 137 to 230 percent rise over real per capita personal health care expenditures of $293 in 1975 at 1967 prices. At 1972 prices, the price base of the general economic model, the total would be $880–$1,216 per capita; at 1975 prices, $1,120–$1,547; and at year 2000 prices, $2,639–3,648 per capita.

Personal health care expenditures under various assumptions and their percent of the real GNP are summarized in table 12.

Of the elasticity coefficients that are statistically significant, income and number of providers have the highest magnitudes. The income coefficient indicates that a 1 percent rise in real per capita income will be reflected by a 0.58 percent rise in real per capita personal health care expenditures, and a 1 percent rise in the provider variable, by a 0.79 percent rise in real per capita health expenditures. A 1 percent increase in the share of third-party payments, controlling for the larger income rise, is estimated to increase expenditures only 0.17 percent in the year ahead.

The category of personal health care expenditures has maintained a relatively stable share of total national health care expenditures in the recent past. Over the last decade, the range was 85.9–86.9 percent of the total. Estimates of personal health care expenditures for year 2000 were adjusted upwards under the assumption that these estimates account for 86.4 percent of national health care expenditures. The projections for total national health expenditures are presented in table 13.

The proportion of total national health expenditures by class of service (physicians' services, dentists' services, and so forth) has remained comparatively stable over the past decade except for hospital care, drug expenditures, and nursing home care.

In fiscal year 1976 hospital care accounted for 46 percent of total personal health expenditures, and physicians' services, for 21.9 percent, making an aggregated share of 67.9 percent for hospital and physicians' services combined. In 1965, hospital care was 39.3 percent and physicians' services were 25.1 percent of personal health care expenditures (table 14).

Other categories subject to change, namely, nursing homes and drugs, shifted in opposite directions. The portion of expenditures for drugs decreased from 13.9 percent in 1965 to 9.3 percent in 1976; the portion of nursing home expenditures increased from

Table 12. Personal health care expenditures in billions of dollars

Assumptions	Expenditures [1]			
	1972 prices	1975 prices	2000 prices	Percent of GNP
Expenditures, 1970	$ 65.8	$ 83.7	$197.4	6.3
Expenditures, 1975	83.1	105.7	249.3	7.3
Projected expenditures, 2000, continued rapid growth in supply of providers:				
Insurance coverage at 52.7 percent	294.5	374.8	883.4	9.6
Insurance coverage at 75 percent	313.0	398.3	938.9	10.2
Insurance coverage at 85 percent	319.8	406.9	959.4	10.5
Projected expenditures, year 2000, assuming slow growth in supply of providers:				
Insurance coverage at 52.7 percent	231.3	294.3	694.0	7.6
Insurance coverage at 75 percent	245.9	312.9	737.7	8.0
Insurance coverage at 85 percent	251.2	319.7	753.6	8.2

[1] Personal health care expenditures were computed at 1967 prices, then price adjusted using the GNP deflator, because the 1967 price base was used in an earlier analytical work.

3.8 percent in 1965 to 8.8 percent in 1976. Using the 1976 percent distributions of personal health care expenditures and assuming health insurance would cover 75 percent of these expenditures, projections for the various categories were made for year 2000 (table 15). Projections for expenditures not in the personal health care category were made based on shares of total national health expenditures.

Table 13. National health care expenditures for year 2000 in billions of dollars

Assumptions of growth rate	Projected with insurance coverage of: 52.7 percent	75 percent	85 percent
Year 2000 prices			
Rapid growth of physicians	$1,022.4	$1,086.7	$1,110.4
Slower growth of physicians	803.2	853.8	872.2
1975 prices [1]			
Rapid growth of physicians	433.6	460.9	470.9
Slower growth of physicians	340.7	362.1	369.9
Percent of GNP			
Rapid growth of physicians	11.1	11.8	12.1
Slower growth of physicians	8.7	9.3	9.5

[1] Price adjusted by GNP deflator.

A Disaggregated Set of Estimates

In addition to the aggregate model approach, estimates of illness costs for the year 2000 were approximated generally by deriving supplies of health providers along with the income receipts for each class of provider group as indicated in subsequent sections.

Table 14. Percent distribution of personal health care expenditures, by type of service

Type of service	1965	1970	1975	1976
Hospital care	39.3	43.1	45.6	46.0
Physicians' services	25.1	22.4	21.7	21.9
Dentists' services	8.1	7.4	7.4	7.1
Other professional services	3.0	2.3	2.1	2.0
Drugs and drug sundries	13.9	11.8	9.7	9.3
Eyeglasses and appliances	3.4	3.0	1.7	1.6
Nursing home care	3.8	6.3	8.6	8.8
Other health services	3.4	3.7	3.2	3.3
Personal health care expenditures as a percent of total national health care expenditures	86.1	86.9	86.5	86.4

Source: Robert M. Gibson and Majorie Smith Mueller, "National Health Expenditures, Fiscal Year 1976," Social Security Bulletin, 40: 3–22. April 1977.

Table 15. National health expenditures, by type of expenditure, for 1976 and projections for year 2000, in billions of dollars

Type of expenditure	1976	1976 percent distribution	Year 2000 assuming insurance coverage of 75 percent: 1975 price level [1]	2000 price level
Total	$139.3	..	[2] $362.1–460.9	[2] $853.8–1,086.7
Personal health care	120.4	100	312.9–398.3	737.7– 938.9
Hospital care	55.4	46	143.9–183.2	339.3– 431.9
Physicians' services	26.4	22	68.8– 87.6	162.3– 206.6
Dentists' services	8.6	7	21.9– 27.9	51.6– 65.7
Other professional services	2.4	2	6.3– 7.5	14.8– 17.8
Drugs and drug sundries	11.2	9	28.2– 35.8	66.4– 84.5
Eyeglasses and appliances	2.0	2	6.3– 7.5	14.8– 17.8
Nursing home care	10.6	9	28.2– 35.8	66.4– 84.5
Other health services	3.9	3	9.4– 12.0	22.1– 28.2
Prepayment and administration	7.3	[3] 5	18.1– 23.0	42.7– 54.3
Government public health activities	3.3	[3] 2	7.3– 9.2	17.1– 21.7
Research	3.3	[3] 2	8.3– 9.2	17.1– 21.7
Construction	5.0	[3] 4	14.5– 18.4	34.2– 43.5

[1] Price adjusted by GNP deflator.
[2] The range is due to various assumptions about the growth in health care providers.
[3] Percent of total, rather than percent of personal health care expenditures category. Numbers may not add up to totals due to rounding.

Source for 1976 expenditures: Robert M. Gibson and Marjorie Smith Mueller, "National Health Expenditures, Fiscal Year 1976," Social Security Bulletin, 40: 3–22, April 1977.

The classification is that used in estimates of major components of national health expenditures.

- Hospital beds are estimated separately for each major class of hospitals but with particular emphasis on short-term non-Federal hospitals and psychiatric hospitals
- The numbers of physicians are estimated with separate analysis of the components for MDs and DOs
- The number of dentists are projected
- Gross receipts as an aggregate are estimated for "other professional services"
- The expenditures for drugs and drug sundries are derived based on former levels of expenditures
- Eyeglasses and appliance expenditures are projected based on consumer outlays
- Estimates of nursing home care allow for the aging of the population
- Prepayment and administration estimates were made based on various assumptions about third-party payments.

Hospital care. Hospital expenditures are divided by type of facility (Federal, short-term general and special, long-term general and special, psychiatric and tuberculosis), and quantity and price trends are forecast for each type.

Short-term general and special hospitals. Care in short-term general and special hospitals constitutes a large and increasing portion of total hospital inpatient care. Estimates for the year 2000 are made using a two-step procedure. In the first step, we assume that past variations in hospital use by different age-sex groups will continue to exist in the future. Information on the use of short stay hospitals in 1975, collected in the Hospital Discharge Survey of the National Center for Health Statistics, showed the following variations in days of care per 1,000 population:

Age group	*Males*	*Females*
Under 15 years	364.8	289.7
15–44 years	633.9	1,122.1
45–64 years	1,699.9	1,793.6
65 years and older	4,379.0	4,016.4

SOURCE: Abraham L. Ranofsky: Utilization of Short-Stay Hospitals. Data from the National Health Survey, Series 13, No. 31. DHEW Publication No. (HRA) 77–1782, April, 1977, p. 2.

These utilization rates are multiplied by corresponding Census Series II population projections to arrive at a preliminary estimate of total non-Federal short-term hospital days of care in 2000—349,846,000. The preliminary estimate is 33 percent larger than the 1975 total, when an adjustment is made for a change in the age and sex distribution of the population (*32*).

The second step in forecasting use of short-term hospitals is to adjust this preliminary total for factors such as increasing real income. To obtain estimates of the partial impact of changes in income, the following model is postulated to explain the annual use of short-term hospital beds per 1,000 population in the United States: $DAYS = f(Y\ THIRD,\ OLD)$

where

$DAYS$ = days of care in short-term general and other special, non-Federal hospital beds per 1,000 population

Y = real per capita personal income (1967 $)

$THIRD$ = percent of personal health expenditures accounted for by private insurance, Medicare, and Medicaid

OLD = percent of the population over the age of 65

The variables included in this equation were selected because they capture the major factors believed to have caused changes in use of hospital beds in the past, and reasonable forecasts of the level of these variables are available for the year 2000. To obtain unbiased estimates of the partial impact of income on hospital bed use, it is important to include such factors as the aging of the population.

The independent variables are all demand factors. An underlying assumption is that the supply of hospital beds will adjust in the long run to meet the demand.

National time series data for the years 1946–75 are used to estimate the specified equation in the double-logarithmic form. The estimated coefficients and t-statistics corrected for autocorrelation are:

$$DAYS = 2.202 + .521Y + -.040\ THIRD + \underset{(5.63)}{} \underset{(0.610)}{}$$
$$.331\ OLD$$
$$(.819)$$
$$R^2 = .92$$
$$F = 100.6$$

While the coefficient of third-party payments does not have the expected sign and the t-statistics suggest lack of significance of two of the variables, the model, given the high R^2 and F statistic, may be useful in

estimating the number of year 2000 beds. Clearly, even after correction for autocorrelation, there is a high correlation among the independent variables that impacts on the signs and significance of particular variables. Moreover, these coefficients also capture the impact of other factors on the use of hospitals, such as changes in technology.

To forecast use of short-term beds, exogenous projections of the change in the independent variables, other than the demographic variable *OLD,* must be made. Real per capita personal income is projected to grow at a rate equal to the rate of growth of real GNP per capita in the MPS model. In 1967 prices, this implies a growth of real per capita personal income from $3,630 to $7,345. Multiplying the difference in the natural logarithms of the 1975 and 2000 per capita incomes by the estimated coefficient yields the appropriate adjustment in the dependent variable due to this factor. Adding this adjustment to the number of days of short-term hospital care per 1,000 implied by the demographic adjustments taken in step 1 and multiplying by Census Series II forecasts of 263 million people in 2000 yields a final estimate of 505,041,000 days of care, or 1,920 days per 1,000 population in non-Federal short-term general and other special hospitals in 2000. This forecast is almost twice the number of days of care in the United States in 1975 (*32*).

The total days of bed use has not been adjusted to reflect the possible impact of increasing insurance coverage. The current share of hospital expenditures covered by third-party payments is now so large (91 percent in 1976) that increased utilization in response to increases in coverage will be greatly limited (*33*).

Calculating total hospital expenditures in the year 2000 requires not only estimates of the supply of beds, but also putting a price on a day of hospital care. Forecasting the trend in hospital prices relative to overall prices is difficult. One reasonable approach would be to assume that hospital prices will inflate at the same rate as the general price level, but the increases in hospital prices from 1946 to 1975 were more than twice the increase in the overall consumer price index, or GNP deflator. National concern over the extent of medical care price inflation has become so intense that it seems unreasonable to assume a continuation of historic trends. Some attenuation of this differential rate of inflation will almost certainly occur, through Federal Government price restrictions or controls, if not through market forces. For theoretical reasons first elaborated in detail by Baumol, the attenuation of the rate of hospital cost inflation seems unlikely to reduce it to the general rate of inflation in the economy as a whole (*25*).

Several economic facts seem to indicate that the rate of inflation in the hospital sector is likely to be somewhat larger than the overall inflation rate for the foreseeable future. First, for industries in which the output is largely a labor service, such as hospital care, productivity increases tend to be slower than for manufacturing industries. Second, over the long term, the income of most groups of workers in society increases at approximately the same rates. Divergences cannot last long unless the particular occupation or industry is disappearing or rapidly and radically expanding. Recent research by Freeman has indicated that even the supply of skilled manpower adjusts fairly rapidly to market incentives (*34*). Moreover, in the manufacturing sector, workers tend to receive raises equal to the increase in their productivity. Service sector workers receive raises that are competitive with earnings in manufacturing.

The theoretical considerations mentioned are used to forecast hospital price trends in the following way. We assume that real earnings in the hospital sector will increase at the same rate as in the rest of the economy. The MPS model assumes average annual increases in productivity for the economy at 2 percent per year. American Hospital Association data on short-term general hospitals indicate that approximately 60 percent of total expenditures in the 1960–75 time period were for labor services (*32*). Finally, we assume that productivity in the hospital sector, at least patient days per labor hour, remains constant. These assumptions imply that hospital prices must rise by 1.2 percentage points more than the general rate of inflation (.60 × 2.0) per year.

The price assumption has such a large impact relative to the predicted change in use of hospital beds that alternative assumptions merit investigation. The simplest approach is to present alternative estimates of expenditures for short-term hospitals in the year 2000 based on alternative assumptions about the difference in the rate of increase in hospital prices and the economy-wide price level. The MPS model predicts that the GNP deflator (1972 = 100) in 2000 will be 300. This figure represents a continuous compound rate of growth of 3.2 per cent per annum from the 1976 level of 134. Estimates of total hospital expenditures in 2000 in current and 1975 dollars were made under the assumptions that the rate of increase in hospital prices is (*a*) equal to overall inflation, (*b*)

1.2 percentage points faster, and (*c*) 3 percent faster. We have chosen the 3 percent figure because it approximates the differential between the consumer price index for hospital room charges and the GNP deflator for the 1940–65 and the 1970–75 periods. The alternate estimates of real and nominal expenditures (in billions of dollars) for short term hospital care in the year 2000 follow:

Price assumptions	*2000 dollars*	*1975 dollars*
Same as the GNP deflator	$180.3	76.5
Faster than the GNP deflator by 1.2 percent	242.9	103.0
Faster than the GNP deflator by 3 percent	381.3	161.7

Other hospital beds. With the exception of tuberculosis hospitals, the number of days of care in 2000 in the other hospital categories—Federal, long-term general and special, and psychiatric—are forecast by estimation equations similar to that for short-term hospitals. For the nongovernment categories, data on the days of care per 1,000 population were gathered for 1946–75 and regressed on measures of income, age of the population, third-party payments, and two additional variables—the ratio of hospital prices to overall consumer prices, *P*, and a time trend, *T*. *P* and *T* are included in the regression to capture the trend toward deinstitutionalization in these types of hospitals. Finally, the third-party payment variable is excluded from the estimating equation for care in Federal Government hospitals, because care in them has been completely financed by the Government throughout the period. (Again, the estimates of the double-logarithmic form are adjusted for first order autocorrelation.)

The estimated coefficients are multiplied by independent estimates of year 2000 values of the independent variables to obtain forecasts of days of care per 1,000 population and total days of care in that year. We use the same forecasts of independent variables that are used for forecasting short-term hospital beds. Specifically, hospital prices and the portion paid by health insurance are assumed to remain constant, the 2000 income level is that forecast by the MPS model, the trend variable increases by 25 years, and following census projections, the percent of the population which is more than 65 years of age increases to 11.6 percent.

The estimated equations and implied forecasts are reported in table 16. The definitions of variables are the same as for short-term hospital beds. A projection of short-term hospital utilization based entirely on the one-step approach of forecasting based on the regression equation yields a projection of 1,794 days of care per 1,000 population, which is reasonably close to the 1,920.3 days of care per 1,000 population obtained from the two-step procedure.

The three equations appear to be reasonably good predictive tools because of their relatively high R^2 and strongly significant $F-$ values. The equations explain from 82 to 90 percent of the total variations in the respective dependent variables between 1946 and 1975. The individual coefficients in each equation will not be discussed here. Unexpected signs can be explained by the sample size and multicollinearity among the independent variables. Moreover, unexpected signs are of little concern when all variables in the equation are to be used to predict future values of the dependent variable, the independent variables together capture the major causal factors, and it is reasonable to assume that the causal factors will change in the future in the same relative patterns as they have in the past.

Despite the comparatively high R^2 of the forecasting equation and the implied precision thereof, the

Table 16. Equation estimates and forecasts of days of care in Federal hospitals, long-term general and special hospitals, and psychiatric hospitals per 1,000 population, year 2000

Independent variable	*Dependent variables*		
	Days of care in Federal hospitals per 1,000	*Days of care in long-term hospitals per 1,000*	*Days of care in psychiatric hospitals per 1,000*
T	−.968	2.022	+4.16
(*t*)	(.681)	(.861)	(1.761)
Y	.0881	−.8096	−1.819
(*t*)	(.293)	(1.436)	(3.176)
THIRD	..	.178	1.055
(*t*)	..	(.692)	(4.084)
OLD	.6434	−3.696	−7.334
(*t*)	(.426)	(1.341)	(2.636)
P	−.3986	−.3912	−1.351
(*t*)	(1.424)	(.896)	(3.083)
Intercept	7.404	10.3347	16.757
R^2	.84	.82	.90
F	33.3	21.8	43.5
Derived estimates			
Predicted days of care per 1,000, year 2000	176	52	236
Total days of care, year 2000	46,273,000	13,773,000	62,081,000
Days of care per 1,000, 1975	182	72	454

forecast of Federal Government hospital care should be viewed as subject to greater uncertainty than the other categories of hospitals. This is primarily because policy decisions about Federal Government hospitals are derived in complex Federal budget negotiations and are not based exclusively upon medical considerations. The totals could be changed radically by the decisions of a few people, or by an external event, such as a war. In contrast, the number of patients in the other categories of hospitals are the result of the behavior of thousands of individuals, physicians, and hospital administrators, and it is subject to the law of large numbers and its averaging characteristics. In this context, the Federal Government care forecast represents essentially an extrapolation of past trends since 1946.

The estimates of long-term care and psychiatric care also seem reasonable in light of the trend toward deinstitutionalizing patients since 1963. In that year, President Kennedy set a goal of reducing the number of patients under custodial care by 50 percent. The change in the number of non-Federal psychiatric patients suggests that that goal has been surpassed. In 1963, there were approximately 657,000 patients in these institutions; by 1975, there were 265,000 (*32*). Further decreases can be foreseen as more community-based alternative services become available in half-way houses and community mental health centers. However, there remains a hard core of severely disabled psychiatric and long-term patients who are unlikely to be discharged. The forecasts in table 16 should be viewed as point estimates of the likely number of days of care per 1,000 population necessary for the severely mentally disabled in the year 2000. These projections imply approximately 170,000 psychiatric inpatients per day in 2000 and are reasonably consistent with Pollack and Taube's estimate of less than 150,000 patients in need of long-term psychiatric care in State mental institutions today (*35*). The difference is largely accounted for by patients in non-State, non-Federal psychiatric hospitals, and the growth in the population by year 2000.

There remains the problem that projections of costs based on this type of supply-side disaggregation may underestimate future costs if structural changes in the delivery of care are imperfectly captured in the computations. For example, a large part of the decrease in psychiatric hospital beds has been accompanied by increases in other, less comprehensive mental health facilities. If the projections fail to predict these increases, and their consequent cost impact, the final total costs of disease for 2000 would be underestimated.

The final category of hospitals for which data are collected by the American Hospital Association is tuberculosis hospitals. In light of the rapid decline in tuberculous patients, it seems most reasonable to forecast that there will be no special purpose tuberculosis hospitals by 2000. In 1950, there were 72,000 tuberculosis hospital beds and only 63,000 hospitalized patients (*32*). The occupancy rate started declining shortly thereafter, and the number of beds has declined steadily since. By 1975, there were only 5,848 beds in non-Federal hospitals devoted to tuberculosis and other respiratory diseases and 3,276 hospitalized patients on an average day (*32*).

Total expenditures of other long-term hospitals were priced by computing the average cost per patient day in each category in 1975 and assuming that these costs will inflate at the same rate as do short-term hospital prices (*32*). The details are reported in table 17.

Table 17. Costs of Federal, long-term, and psychiatric hospitals in year 2000

Costs	Federal	Long-term	Psychiatric
1975 data:			
Patient days per 1,000 population	182.3	71.8	453.8
Cost per patient day	$116.74	$ 62.29	$ 41.36
Year 2000 data:			
Predicted patient days per 1,000 population	175.94	52.37	236.05
Total patient days (in thousands)	46,273	13,773	62,081
Assuming hospital prices inflate 1.2 percent faster than the GNP deflator:			
Cost per patient day, year 2000 prices	$370.84	$197.88	$134.57
Cost per day, in year 2000 at 1975 prices	$157.30	$ 83.93	$ 57.08
Total cost, year 2000 prices (in billions)	$ 17.16	$ 2.73	$ 8.35
Total cost, 1975 prices (in billions)	$ 7.28	$ 1.16	$ 3.54
Assuming hospital prices inflate 3 percent faster than the GNP deflator:			
Cost per patient day, year 2000 prices	$567.81	$302.98	$206.05
Cost per day, in year 2000 at 1975 prices	$240.85	$128.51	$ 87.40
Total cost, year 2000 prices (in billions)	$ 26.27	$ 4.17	$ 12.79
Total cost, 1975 prices (in billions)	$ 11.14	$ 1.77	$ 5.43

The total hospital expenditures in the year 2000 for 627.2 million aggregate days of hospital care are forecast to range from $271.1 to $425.6 billion in year 2000 prices, or from $115.0 to $180.5 billion when deflated to the aggregate 1975 price level. These totals are the summation of estimates for both short- and long-term hospitals. Almost 90 percent of these costs are accounted for by the short-term general and special hospitals. Total expenditures reflect increased short-term utilization attributable to demographic and economic changes and substantially decreased use of long-term and psychiatric hospitals. The low end of the range represents the assumption that hospital prices increase at a rate of 1.2 percent faster than the overall price level, while the upper end of the range assumes hospital prices rise 3 percent faster than the overall price level. The magnitude of the difference between the upper and lower expenditure projections reflects the importance of compounded rates of inflation over 25 years.

However, the hospital expenditure estimates do not take full account of various hospital cost containment approaches being urged, including hospital utilization review, restrictions on additions of new hospital beds, the enforcement policies of the new health systems agencies, and possible new regulations attached to one form or another of extensions of prepayment coverage. Also the estimates do not consider change in the organizational structure of hospital care that would emphasize group practice controls over the use of hospitals, delivery of health care in the home, or care in hospices.

Physicians' services. Both supply and demand approaches are used in estimating physicians' services.

Pure supply approach. A pure supply analysis is used in forecasting expenditures for physicians' services. The number of physicians is derived from a manpower model developed by the Bureau of Health Resources Development (BHRD) for Phase I of Project SOAR (*36*). (BHRD, however, is not responsible for all the specific assumptions we used to derive the estimates.)

The methodology used to forecast manpower supplies is admittedly unsophisticated. Essentially, supply is projected independently of any considerations of demand. The formula that is the basis of the projection methodology is:

$$S_n = S_{to} - \sum_{t=0}^{n} G_t + \sum_{t=0}^{n} F_t - \sum_{t=0}^{n} D_t$$

where S_n is the active supply of physicians at time n, S_{to} is the active supply of physicians in the base year, G_t is the number of domestically trained graduates in period t. F_t is the number of foreign-trained graduates in period t, and D_t is the number of deaths and retirements in period t.

The physician supply at any point in time is the sum of active doctors of medicine (MDs) and osteopathy (DOs). The numbers in 1974 by 10-year age groups are shown in table 18.

For purposes of the estimates, future values of G, F, and D must be forecast. The assumptions underlying these forecasts will be reviewed briefly.

A significant portion of the active physicians in the country received their training not in the United States but in Canada and other foreign countries. The estimated number of physicians is based on the existing number of practitioners by age group augmented by estimated new supplies from U.S. medical schools and abroad and decreased by separations due to deaths and retirements (table 19).

The vital factor influencing the projection of future graduates from U.S. medicals schools is clearly the projected path of future enrollments. The fol-

Table 18. Active doctors of medicine and osteopathy, 1974, by source of education

Age group (years)	U.S. medical schools	Canadian medical schools	Other foreign schools	Schools of osteopathy
Under 30	35,338	733	8,205	1,479
30–40	71.321	1,478	28,720	3,425
40–50	62,668	1,298	18,713	3,142
50–60	55,690	1,153	8,463	2,648
60–70	34,427	712	5,109	1,971
70 and older	12,931	264	1,731	886
Total	272,375	5,638	70,941	13,551

Sources: American Medical Association and American Osteopathic Association

lowing analysis is based partly on unpublished data and work in progress prepared by BHRD (now the Bureau of Health Manpower), Health Resources Administration.

Academic year	*Actual and projected 1st year enrollment*
1972–73	13,726
1973–74	14,185
1974–75	14,963
1975–76	15,351
1976–77	15,055
1977–78	15,348
1978–79	15,777
1979–80	15,955
1980–81	16,063

Actual enrollment data were available through 1975–76, and projections through 1980–81 (*37*). The projections take account of planned expansion of places in existing medical schools. These estimates are based on information from administrative officials at each of the schools.

To the projected total must be added the estimated enrollment of five new medical schools, as follows:

- Medical School of the University of Health Sciences of the Uniformed Services (1976)—150 first-year students.
- Wright State University School of Medicine, a Veterans Administration-supported school (1976)—96 first-year students.
- Northeastern Ohio Universities College of Medicine (1977)—100 first-year students.
- Texas A & M University, a Veterans Administration-supported school (1977)—95 first-year students.
- University of South Carolina Medical School, Columbia, a Veterans Administration-supported school (1977)—112 first-year students.

Each school is projected to reach full capacity by 1981–82. BHRD has estimated first-year enrollments in these schools through 1987–88.

Construction of medical schools and expansion of their capacity are heavily dependent on Federal support. Given the current discussion of physician surpluses (*38*), it is assumed that Federal support will drop beyond 1980–81 to a level just sufficient to maintain existing capacity. Capacity will continue to grow, because of support by State and local governments and private sources. A growth rate of 0.81 percent per annum was selected; this rate prevailed during the 10 years before massive Federal intervention in medical school education began in 1965. The 0.81 percent rate reflects both new construction and expansion of the existing capacity of the schools.

The bulk of U.S. MDs have graduated from 4-year schools. However, a not insignificant (although declining) portion of MDs have come from 3-year programs. Data on the enrollment in 3- and 4-year schools are available through 1974–75 (*37*). Preliminary estimates of BHRD indicate that 3-year enrollments will decline to approximately 9.0 percent of 4-year enrollments in 1987–88. We assumed that this proportion will remain stable through year 2000 (table 20).

Graduates who transfer from foreign schools into American schools must also be considered. For simplicity, it was assumed that all such students transfer after 2 years and take 2 years to complete their studies. Actual data through 1975–76 (*37*) and projections of enrollments through 1980–81 were made available to the Bureau of Health Manpower from school records. It was assumed that the 1980–81 projections of 490 transfers per year would continue to 1998.

Not all enrollees complete medical school. AMA data indicate an attrition rate of 1.53 percent for 4-year schools (*37*). A zero attrition rate for the less

Table 19. Projected number of physicians through year 2000

	Active base plus graduates				
			Total deaths and retirements		
Year	*Active as of January*	*Gross additions*	*as of December*	*Net gain*	*Active as of December*
1974	..	..	..	..	356,096
1975	356,752	16,677	2,660	14,017	370,769
1976	370,759	18,208	3,062	15,146	385,905
1977	385,895	18,261	3,375	14,886	400,781
1978	400,771	19,143	3,694	15,449	416,220
1979	416,210	19,543	3,991	15,552	431,762
1980	431,750	22,095	4,247	17,848	449,598
1981	449,586	22,428	4,509	17,919	467,505
1982	467,493	22,667	4,759	17,908	485,401
1983	485,389	22,810	5,006	17,804	503,193
1984	503,179	23,099	5,255	17,844	521,023
1985	521,009	23,365	5,444	17,921	538,930
1986	538,916	23,603	5,645	17,958	556,874
1987	556,860	23,837	5,825	18,012	574,872
1988	574,858	24,079	6,033	18,046	592,904
1989	592,890	24,308	6,231	18,077	610,967
1990	610,953	23,625	6,450	18,175	629,128
1991	629,114	24,854	6,643	18,211	647,325
1992	647,311	25,082	6,821	18,261	665,572
1993	665,556	25,314	7,002	18,312	683,868
1994	683,852	25,545	7,200	18,345	702,197
1995	702,181	25,780	7,380	18,400	720,581
1996	720,565	26,013	7,626	18,387	738,952
1997	738,936	26,249	7,903	18,346	757,282
1998	757,266	26,487	8,129	18,358	775,624
1999	775,608	26,724	8,343	18,381	793,989
2000	793,973	26,965	8,588	18,377	812,350

than 4-year programs was assumed because of the lack of data on which to base a correction for attrition and because the 3-year school students can fall back on 4-year programs if their progress is too slow and the number of transfers is too small to be significant. In any case, the total supply would not be greatly affected.

The AMA recorded an average yearly net gain of 165 Canadian medical graduates for the 1970–73 period (*37*). Because there are very little data on which to base projections, we assumed that this rate would continue throughout the projection period.

Similar problems crop up for foreign medical graduates (FMGs), but they are considerably more significant because the number of FMGs is about 20 times greater than the graduates of Canadian medical schools. Unpublished data from BHRD indicate that the net inflow of FMGs over the 1970–74 period was 3,100. This number is heavily conditional on Federal legislation. Under the assumption that the current legislation will not be modified and that informal restrictions do not influence the situation, the future influx of FMGs was projected to be 3,100 a year through year 2000.

To compute losses, physician mortality and retirement rates were applied to the base of active physicians in each year. Mortality rates were obtained from a study by Goodman (*39*). Retirement rates were computed from 1967 data collected by the AMA on active physicians (*40*).

Table 20. Enrollment in three- and four-year medical schools to 1997–98

Year	3-year schools	4-year schools	Total
1976–77	1,988	13,151	15,139
1977–78	2,054	13,556	15,610
1978–79	1,751	14,379	16,130
1979–80	1,648	14,762	16,410
1980–81	1,458	15,089	16,547
1981–82	1,493	15,223	16,716
1982–83	1,517	15,335	16,852
1983–84	1,544	15,445	16,989
1984–85	1,569	15,563	17,132
1985–86	1,594	15,672	17,266
1986–87	1,617	15,789	17,406
1987–88	1,720	15,828	17,548
1988–89	1,734	15,956	17,690
1889–90	1,748	16,086	17,834
1990–91	1,762	16,217	17,979
1991–92	1,776	16,349	18,125
1992–93	1,791	16,481	18,272
1993–94	1,805	16,615	18,420
1994–95	1,820	16,749	18,569
1995–96	1,835	16,885	18,720
1996–97	1,849	17,023	18,872
1997–98	1,865	17,165	19,030

Table 21. First-year enrollments in schools of osteopathy to 1997–98

Year	3-year schools	4-year schools
1973–74	245	644
1974–75	298	667
1975–76	333	701
1976–77	363	735
1977–78	373	860
1978–79	427	966
1979–80	467	984
1980–81	507	1,068
1981–82	547	1,108
1982–83	586	1,148
1983–84	625	1,187
1984–85	664	1,226
1985–86	703	1,265
1986–87	742	1,304
1987–88	781	1,343
1988–89	820	1,382
1989–90	859	1,421
1990–91	898	1,460
1991–92	937	1,499
1992–93	976	1,538
1993–94	1,015	1,577
1994–95	1,054	1,616
1995–96	1,093	1,655
1996–97	1,132	1,694
1997–98	1,171	1,733

Enrollments in both 3- and 4-year schools of osteopathy are projected in table 21. BHRD estimated first-year enrollments in 3-year schools through 1978 and in 4-year schools through 1984 from school capitation grant applications. It was assumed that increases in enrollments would equal the same absolute amount for both types of schools past those dates. The 1971–74 observed attrition rate of 3.6 percent for both types of programs was assumed to hold through the year 2000. Death and retirement rates for doctors of osteopathy are assumed to be the same as that for MDs.

Expenditures for physician services. Projections of physician expenditures to year 2000 require some assumptions about the future gross income of physicians. We assume physicians will maintain their relative position in the distribution of income. Constancy of income for physicians, relative to other groups, would agree with either a target income hypothesis (*41*) or the unbalanced growth hypothesis of Baumol (*25*). The target income hypothesis sug-

gests that physicians have a target income in mind and adjust prices or work to achieve that income goal. Baumol, in his work on the increasing real costs of service sector activities, has pointed out that wages in the service sector tend to keep pace with wages in the rest of the economy. Both concepts tend to support a constant relative income hypothesis so long as there is no long-run excess demand or an excess supply of physicians in the market.

It was assumed that gross income per physician would rise over the period 1975–2000 at the same rate as the increase in personal income per capita predicted by the MPS model, or at 6.2 percent per annum. In 1975, physicians' gross income averaged $56,234. An annual growth of 6.2 percent would raise year 2000 gross income per physician to $268,242. Multiplying by our year 2000 projection of total physician manpower, we project an expenditure for physician services at $217.9 billion in year 2000 prices and $92.4 billion in 1975 dollars.

Pure demand projection. The analysis presented previously implicitly assumes that the demand for physician services will adjust itself to changes in the supply; otherwise gross real income per physician could not rise to the predicted level. An alternative to this approach is to predict changes in demand and assume that supply will respond to changes in demand.

Perhaps the simplest means of projecting changes in the demand for physician services is to alter the demographic composition of the population, presented previously, in the aggregate model. This "constant utilization rates for a changed population" projection is essentially that used by Fein in "The Doctor Shortage: An Economic Diagnosis" (*42*).

Costing out the expenditures for the 599,000 physicians projected by changes in the age-sex distribution of the population requires that average gross income for physicians in year 2000 be estimated. Using the same average income per physician derived previously in the pure supply analysis yields an estimated total expenditure on physician services of $160.7 billion in year 2000 dollars, or $68.2 billion in 1975 dollars. As compared to the pure supply projections of the cost of physician services, the alternative pure demand analysis produces a more conservative estimate, some $57.2 billion lower than the supply estimate of $217.9 billion.

Demand, supply, and national health insurance. Although this simple demand projection implicitly includes a third-party payment and income effect in the changes of the age-sex structure of the population, evaluation of the effects of national health insurance requires explicit consideration of third-party payments. Newhouse and co-workers have estimated that the coverage of physician visits under a system with 25 percent coinsurance would raise the demand for ambulatory physician services by 30 percent and a full coverage system by 75 percent (*33*). These projections assume that the real price of medical care remains constant. Constant prices in the face of increasing demand imply a supply response matching the increase in demand.

Determination of the actual impact on prices requires at least a simple analysis of probable supply response. It is assumed that increases in productivity, waiting times, and the supply of physicians will offset the expected increase in demand so that the price of physician services in the long run will continue along its historical path. The likelihood of this result is increased to the extent price controls of some sort accompany the introduction of national health insurance.

The literature which is currently available suggests that the use of physician extenders may provide significant productivity gains in the future (*43*). As the number of ancillary personnel and the length of the queue increases, so will the output per physician as measured by office visits per physician.

Newhouse and co-workers have suggested that the short-run supply response of the system to the insurance coverage of physician visits would be an increase in waiting times and a decrease in the amount of time the physician spends with each patient (*33*). Many of these changes will be perceived as decreases in the quality of care, but visits per physician will rise in response to the pressure of demand. If this decline in quality (and increase in waiting time) does not decrease greatly the quantity of demand, physicians will be able to enjoy increased real incomes at relatively constant prices.

If physician incomes do rise, they may work fewer hours. If they are able to earn a targeted income in less time, work effort may decline. A study by Feldstein supporting this hypothesis found that fewer services were provided as price increases led to increase in physicians' income (*44*). To the extent improvements in productivity do lead to decreases in work, there will be some upward pressure on prices.

If the total supply of physicians increases along with a substantial increase in the productivity of physicians, then the real price of physician services might fall.

Faced with expected increases in productivity and the disincentive impact of salaried employment, it is difficult to predict with any assurance what will occur in the future. If, however, we employ the manpower projections of the pure supply analysis, then it is possible to assume with some legitimacy that increases in demand will be met by increases in supply, and prices may stabilize. The supply projection for the year 2000 is 812,000 physicians. If we inflate our estimated physician visits by 30 percent to 2 billion and divide this number by the 1975 ratio of visits to physicians, we obtain a projected total of 778,000 physicians in year 2000. This would infer an excess of physicians in year 2000 and thus perhaps a downward, rather than upward, pressure on prices. Realistically, however, the negative impacts on physician supply must be taken into account if decreases in long run supply and work effort per physician more than offset the expected productivity increases assumed for group practice and other changes in the organization of care.

In the short run, the introduction of national health insurance, even with price controls, will exert pressure on physicians' prices, but in the longer run, by year 2000 the available evidence, given the expected physician supply, does not suggest large added increases.

Employing the projected 6.2 percent per annum increase in physician incomes to 1975 average gross income produces year 2000 expenditures (in billions) for physicians' services.

Projection assumption	*Year 2000 prices*	*1975 prices*
Pure supply projection	$217.9	$92.4
Pure demand projection	160.8	68.2
National health insurance, with 75 percent of physician visits covered	208.8	88.6

The pure demand projections ($161 billion in year 2000 dollars) are the lowest, while the pure supply and national health insurance projections are close to one another, since the projected impact of national health insurance will stimulate demand enough to nearly match the projected increase in the supply of physicians.

Dental services. A supply approach, similar to that used for physicians, was adopted for dentists. The forecast of the number of dentists again uses the Bureau of Health Manpower methodology, but the assumptions cannot be attributed to that organization. The active base of dentists in 1970 follows:

Age (years)	*Number*
Under 30	14,080
30–39	29,160
40–49	26,799
50–59	15,272
60 and older	16,908
Total	102,219

Note: Percentage active factors were applied to the total number of living dentists at each year of age from the 1970 Census.

Additions to this number are determined almost entirely by future enrollments, since there is no significant input from foreign schools.

Graduates enter the profession from 3- or 4-year schools. An emerging trend is a shift in enrollment toward 3-year programs. BHRD collected enrollment data though 1974–75, and projected enrollments through 1978–79, based on reports obtained from individual schools (table 22).

Enrollments are heavily dependent on expanding Federal support. In the absence of concern about dentist shortages, it appears acceptable to assume that

Table 22. First-year enrollments in U.S. dental schools to 1997–98

Year	*3-year schools*	*4-year schools*	*Total*
1974–75	1,056	4,561	5,617
1975–76	1,083	4,680	5,763
1976–77	1,086	4,677	5,763
1977–78	1,089	4,674	5,763
1978–79	1,092	4,671	5,763
1979–80	1,095	4,668	5,763
1980–81	1,098	4,665	5,763
1981–82	1,101	4,662	5,763
1982–83	1,104	4,659	5,763
1983–84	1,107	4,656	5,763
1984–85	1,110	4,653	5,763
1985–86	1,113	4,650	5,763
1986–87	1,116	4,647	5,763
1987–88	1,119	4,644	5,763
1988–89	1,122	4,641	5,763
1989–90	1,125	4,638	5,763
1990–91	1,128	4,635	5,763
1991–92	1,131	4,632	5,763
1992–93	1,134	4,629	5,763
1993–94	1,137	4,626	5,763
1994–95	1,140	4,623	5,763
1995–96	1,143	4,620	5,763
1996–97	1,146	4,617	5,763
1997–98	1,149	4,614	5,763

after 1978–79, Federal support will be sufficient only to maintain the first year enrollment levels existing then. This enrollment level will be maintained until the end of the projection period. The trend toward shorter schooling is assumed to continue also.

The attrition rate for dental students in the 3-year programs is higher than in the 4-year programs. The 8.8 percent rate observed in 1970 was assumed to persist to 2000. Attrition rates in a BHRD study of 4-year programs were assumed to rise from 5.2 percent in 1972 to 6.6 percent in 1976 and then remain constant.

To calculate retirements, the Bureau of Health Resources Development developed an occupation-specific series of retirement rates for dentists. For losses to the profession resulting from death, survival rates for white males were used (*36*). Table 23 shows the projected active base of dentists through the end of the projection period.

The assumption that dentists maintain their relative position on the income scale yields a projection of $58.9 billion in year 2000 prices, or $25.0 billion in 1975 prices for dental expenditures. This cost figure is computed by using the same method that was used for physicians. Continuous compounding of the 6.2 percent average annual growth rate in income per capita yields a number to be multipled by the estimated number of dentists in year 2000 to obtain total dental care expenditures in year 2000.

Table 23. Projected number of dentists through year 2000

Year	Active as of January	Gross additions	Total deaths and retirements as of December	Net gain	Active as of December
1970	..	..	..	..	102,219
1971	102,219	3,793	2,219	1,574	103,793
1972	103,793	3,971	2,247	1,724	105,517
1973	105,517	4,104	2,272	1,832	107,349
1974	107,349	4,632	2,300	2,332	109,681
1975	109,681	4,859	2,315	2,544	112,225
1976	112,225	5,190	2,324	2,866	115,091
1977	115,091	5,208	2,366	2,842	117,933
1978	117,933	5,362	2,399	2,963	120,896
1979	120,896	5,477	2,416	3,061	123,957
1980	123,957	5,416	2,433	2,983	126,940
1981	126,940	5,360	2,447	2,913	129,853
1982	129,853	5,362	2,482	2,880	132,733
1983	132,733	5,361	2,511	2,850	135,583
1984	135,583	5,362	2,537	2,825	138,408
1985	138,408	5,362	2,559	2,803	141,211
1986	141,211	5,362	2,589	2,773	143,984
1987	143,984	5,364	2,618	2,746	146,730
1988	146,730	5,361	2,640	2,721	149,451
1989	149,451	5,362	2,663	2,699	152,150
1990	152,150	5,364	2,697	2,667	154,817
1991	154,817	5,362	2,747	2,615	157,432
1992	157,432	5,362	2,809	2,553	159,985
1993	159,985	5,363	2,855	2,508	162,493
1994	162,493	5,363	2,897	2,466	164,959
1995	164,959	5,362	2,965	2,397	167,356
1996	167,356	5,362	3,065	2,297	169,653
1997	169,653	5,362	3,206	2,156	171,809
1998	171,809	5,363	3,292	2,071	173,880
1999	173,880	5,362	3,379	1,983	175,863
2000	175,863	5,362	3,460	1,902	177,765

Other professional services. This category of direct health services includes a wide variety of self-employed health professionals and independent services.

Private duty registered and practical nurses
Chiropracters
Birth control clinics
Blood banks
Blood donor stations
Chiropodists
Christian Science practitioners
Dieticians
Dispensaries not operated by hospitals or by groups of physicians
Medical photography
Midwives
Naturopaths
Nutritionists
Occupational therapeutics
Outpatient treatment clinics for alcoholism
Oxygen tent services
Physiotherapy
Podiatrists
Psychiatric clinics

Their diversity makes estimation of future health expenditures for these services extremely difficult. The major unifying thread seems to be that most of their services will be used because of a physician referral. Historically, expenditures for other health professionals have averaged approximately 10 percent of the expenditures for physician services. We therefore assumed that this relationship would continue and took 10 percent of the year 2000 physician expenditures to make the following (in billions) estimates:

Projection	Year 2000 prices	1975 prices
Pure supply projection	$21.8	$9.2
Pure demand projection	16.1	6.8
National health insurance, with 75 percent of physician visits covered ..	20.9	8.9

Future drug expenditures. In the future, a number of factors will impact on the use rates and prices of drugs. Most important are changes in the age-sex composition of the population, changes in the method of payment, governmental utilization review, and price controls.

The elderly represent only 10 percent of the population, yet they account for 25 percent of total drug expenditures (*45*). Persons over age 65 have nearly three times as many prescriptions and refills as the rest of the population (*46*). Although the aged have better health insurance coverage than the rest of the population for out-of-hospital drugs, they pay 80 percent of drug expenses out of their own pockets (*45*). As the proportion of the elderly in the population rises, it is likely that drug use rates and expenditures will also rise.

Women, who have drug expenditures one-third greater than males (*46*), will also comprise an increasing proportion of the population.

Since 78 percent of drug expenditures are for prescription drugs, the physician plays a major role in determining total drug expenditures (*47*). There are approximately 1.6 prescriptions issued per outpatient physician visit (*45*); over time, if physician visits per capita rise, so should total drug expenditures.

Perhaps the most important factor that may influence future drug expenditures is drug coverage in national health insurance. In general, prescription drug use is perceived as an inelastic involuntary demand, but the demand for hospital care was so perceived before the advent of Medicare. The basic issue is whether there are significant numbers of persons with an unmet need for prescription drugs. Accompanying issues are whether the number of unnecessary prescriptions written each year will increase and the degree to which higher priced prescription drugs will be substituted for over-the-counter drugs not covered by insurance.

Undue use will be moderated if increased drug coverage under national health insurance is accompanied by utilization review and the prescribing of generic drugs listed on compulsory formularies. The authors of one study have suggested that utilization review might reduce irrational prescribing below current levels. It has been estimated that almost 25 percent of prescriptions are unnecessary or have no proven efficacy (*45*). Compulsory formularies of generic drug equivalents that must be substituted for higher cost brand name drugs combined with price controls on drugs without unpatented generic substitues would certainly slow increases in average drug prices. DHEW's Task Force on Prescription Drugs has even projected a decrease in average prescription prices under these conditions. Although the projection is perhaps a bit optimistic, if drug price increases can be held to their present rate, it will be a large offset to increases in utilization. Over 1965–75, the price index for drug and drug sundries has risen at the rate of 1.7 percent a year while the entire medical care price index has gone up 6.3 percent a year.

Estimated drug expenditures, year 2000. One of the simplest ways to estimate drug expenditures is to take expenditures in 1975 for various age groups and multiply by the projected population in each group for year 2000. This procedure will account for increases in expenditures due to the larger proportion of aged in the population and will also make partial allowance for the increasing ratio of females to males. As the percentage of the population over 65 rises, so will the percentage of the population which is female under existing mortality conditions. Also, since the elderly have approximately 20 percent of their drug expenditures covered by third-party payments as compared with 14 percent for the rest of the population, this procedure implicitly adjusts for some increase in total third-party payments.

This procedure was applied to recent Social Security Administration estimates of expenditures on drugs and drug sundries for those under 19 years, 19 to 64 years, and 65 and over. Simulation of future drug expenditures to reflect the year 2000 age distribution produces a total drug expenditures of $16.6 billion ($13.4 billion in 1975 dollars, or $11.9 billion in 1972 dollars).

A means of validating this estimate is to project physician visits by a similar procedure and estimate drug expenditures from that number. Health Interview Survey data on physician visits per capita in 1975 for 12 age-sex groups were multipled by year 2000 population estimates for each group. The total physician visits were then multiplied by the average number of prescriptions per physician visit in 1975. This estimate of year 2000 prescriptions was in turn multiplied by the average 1975 prescription price. Finally, this sum was adjusted by approximately 20 percent to account for nonprescription drug expenditures. The result, when rounded, is an estimate of $11.9 billion in 1972 dollars, a figure that matches the estimate of $11.9 billion described previously. Although the methods are different in concept and basic data sources, they tend to validate one another with respect to the factors each takes into account.

To obtain a more comprehensive estimate of drug expenditures, a simple expenditure model was developed. The statistical estimation over 1950–76 was

based on a multiple regression equation. The intermediate variable, physician visits per capita, was eliminated in favor of the basic variables percent of the population over 50 and the percent of the population that is female.

$$DREXPC = 122.019 + 0.119\ THIRD + 30.947FEM - (1.51) \quad (3.24)$$
$$0.480\ FIFTY + 0.636\ RYPC$$
$$(0.50) \quad (2.37)$$
$$R^2 = .99$$

where

DREXPC	=	drug expenditures per capita
THIRD	=	third-party payments
FEM	=	percent of females in the population
FIFTY	=	percent of population over 50
RYPC	=	real income per capita.

In prediction, as opposed to hypothesis testing, the objective is to maximize the squared correlation coefficient. Thus, as suggested earlier, we should not be concerned with the inappropriate sign attached to *FIFTY*. The odd result is due to high multicollinearity in the regression, especially between *FEM* and *FIFTY* for the reasons described previously. Nevertheless, a variable should not be excluded from the regression if there are theoretical grounds for inclusion. The high R^2 attached to the theoretically correct equation indicates that its value in prediction is relatively high.

Forecasting the year 2000 involves plugging in the projected values for the independent variables and multiplying the resulting drug expenditures per capita by the projected population. The values for the two variables *FEM* and *FIFTY*, 51.38 and 34.93, respectively, were derived from population projections. The estimated per capita personal income is that used in the hospital bed projections. The projected third-party payment variable is based on a series of different assumptions. The first assumes that third-party coverage for drugs will remain constant in the 1976 proportion of 15.6 percent. Under these conditions, per capita drug expenditures in constant dollars would rise 33 percent to $57.86 by 2000. Multiplying by the projected population in that year produces total year 2000 drug expenditures of $15.1 billion in 1972 dollars. Note that this total is 25 percent larger than the estimates by the age/physician methods; presumably this represents the effect of increases in real per capita income not explicitly considered in the other prediction methods.

A second and third set of assumptions about third-party payments are based on the extension of Medicare part A to cover out-of-hospital drugs and, alternatively, mandatory coverage of the entire population for prescription drugs. It was assumed that, under either alternative, there would be a consumer co-payment of 20 percent, an assumption consistent with the 18 percent rate implied by a $1 deductible per prescription when the average price of a prescription is $5.60.

If utilization review keeps the proportion of prescription drugs as a percent of total drug sales relatively constant at 78 percent, then compulsory coverage of the entire population for prescription drugs at a copayment rate of 20 percent would imply third-party payments for about 62.4 percent of total drug expenditures. Such coverage would increase per capita expenditures to $68.25 in 1972 dollars, almost 18 percent higher than the estimate of $57.86 produced when third-party payments are assumed to remain constant. Total drug expenditures will rise to $17.8 billion in 1972 prices. The relative magnitude of this increase is consistent with estimates by the DHEW Task Force on Prescription Drugs on the impact of extended third-party coverage. The Task Force's basic estimate of the increased use by beneficiaries was 15 percent, although the variability of such estimates can be seen by noting that, in a set of alternative cost estimates, the same group estimated that a 25 to 40 percent increase in utilization was attributable to extended third-party coverage (*46*).

The second set of assumptions about health insurance assumes extension to a more limited group—the aged currently covered under Medicare, part A. If 80 percent of prescription drugs are covered for this population group and a relatively constant share of total drug expenditures are accounted for by the aged, the aggregate third-party coverage will rise to 26.2 percent. Under this more limited coverage, total drug expenditures in 1972 dollars would rise to $16.0 billion. This sum is 6.4 percent larger than the estimated total if third-party coverage is held constant at 15.6 percent.

The final set of estimates, which yields the largest projected drug expenditures, makes an adjustment for the impact of national health insurance on physician visits. Newhouse and co-workers have estimated, as indicated earlier, that 25 percent co-insurance of physician visits would raise the total number of visits by 30 percent.

Based on our estimate of physician visits for year 2000, a 30 percent increase would add 482,775,300

physician visits to the estimated total of 1,609,251,000 visits in year 2000. If all other factors are held constant, the impact of this change would yield an additional 772 million prescriptions at a cost of $3.6 billion in 1972 prices. This would boost total drug expenditures under national health insurance covering the entire population to $21.3 billion in 1972 dollars (table 24).

Price adjustment. Historically, the drug industry has been characterized by high, but relatively stable, prices. From 1950 to 1975, the implicit price deflator for drugs rose 36 percent from 82.8 to 112.5 while the GNP price deflator rose 137 percent from 53.6 to 127.2. As discussed previously there is reason to believe that this relative stability will continue if utilization review and the use of recommended or compulsory formularies is incorporated in the legislation for national insurance. On this assumption, we have used a simple log linear regression, over the period 1950–76, to estimate drug prices in year 2000.

$$LDRUGPD = 3.37716 + 0.27327 LGNPPD$$
$$R^2 = .792$$

where

LDRUGPD = natural log of the implicit price deflator for drugs and drug sundries

LGNPPD = natural log of the implicit price deflator for GNP.

Using this estimating equation and the predicted GNP price deflator from the MPS model produces an estimated price deflator for drugs in year 2000 of 130.19. Inflating the 1972 estimates by this index increases year 2000 drug expenditures with full coverage to $29.7 billion.

Table 24. Drug expenditures using various estimation models, in billions of dollars, year 2000

Estimation model	1975 dollars	2000 dollars (drug price deflator)	2000 dollars (overall price deflator)
Projected age distribution ...	$13.4	$16.6	$31.6
Projected physician visits without national health insurance	13.4	16.6	31.6
Regression model:			
Constant third-party coverage	16.9	21.0	39.9
Extension to Medicare population	18.0	22.3	42.4
Total population coverage (drugs only)	20.0	24.7	47.2
Total population coverage (drugs and physician visits)	24.0	29.7	56.6

Since rapid technological change in drugs may cause drug price indices to underestimate the true rate of drug price increase, alternative projections were made. It was assumed that drug prices would increase at the same rate as the overall GNP price deflator. Under this assumption, year 2000 drug expenditures would range from $31.6 to $56.6 billion in year 2000 dollars.

Eyeglasses and appliances. Statistically, the only factor which is consistently a good predictor of eyeglass and appliance expenditures is personal income per capita. Fluctuations in real expenditures on eyeglasses and appliances are correlated with the business cycle. During periods of depression in personal income, replacements of durable goods, such as eyeglasses, are probably postponed until the household economic outlook improves.

One would expect eyeglass expenditures to be statistically related to age of the population and the extent of third-party payments. As it turns out, however, regressions, including these variables and per capita income, perform poorly. The probable explanation for the poor performance of these other variables is multicollinearity and in the case of third-party payments for eyeglasses and appliances, a very poor data base.

The estimating equation for eyeglasses and appliances was the following double log regression equation estimated over the period 1950 to 1976.

$$LEYEPC = -6.36 + 1.056\, LRYPC$$
$$R^2 = .88$$

where

LEYEPC = natural log of real expenditures per capita on eyeglasses and appliances

LRYPC = natural log of real personal income per capita

Applying our projected value for real per capita per-personal income in year 2000 yields an estimated year 2000 expenditure on eyeglasses and appliances of $4.5 billion in 1972 prices, or $5.4 billion in 1975 dollars.

To convert this sum to year 2000 dollars, we again used a double log regression of the GNP price deflator for eyeglasses and appliances on the total GNP price deflator—1950 to 1975.

$$LEYED = 0.47 + 0.892\, LGNPP$$
$$R^2 = .99$$

where

LEYED = natural log of the implicit price deflator for ophthalmological products and orthopedic devices

LGNPP = natural log of the total GNP implicit price deflators.

Using this equation produces a year 2000 price index of 260.10 and a projected eyeglass and appliance expenditure of $11.7 billion in year 2000 dollars.

Alternatively, if instead of lagging behind the general price level, it is assumed that eyeglasses and appliance prices rise at the rate of the overall price deflator, eyeglass and appliance expenditures in year 2000 dollars would be $12.7 billion.

Nursing home expenditures. Expenditures for nursing home care are projected to the year 2000 by applying use rates by age and sex to forecast a preliminary figure. The preliminary projection is then adjusted by the partial impacts attributed to nondemographic factors, such as the change in average income level, the transfer of mental health patients to nursing homes, and decreasing availability of unemployed housewives for the home care of relatives.

Table 25. Age distribution of the residents of nursing homes in 1974 and year 2000 forecast

Sex and age group	Nursing home residents, 1974	Percent of 1974 population in nursing homes	Population forecast, year 2000 (in thousands)	Nursing home residents, 2000
Males:				
Under 45 years	12,600	.017	87,119	14,810
45–54	12,600	.110	17,448	19,193
55–64	27,200	.295	10,912	32,190
65–69	28,700	.826	4,021	33,213
70–74	36,500	1.514	3,368	50,992
75–79	47,200	3.043	2,375	72,271
80–84	55,100	5.776	1,383	79,882
85 years and over	98,300	17.036	894	152,302
Total males	318,100	...	...	454,854
Females:				
Under 45 years	10,900	.015	86,095	12,914
45–54	15,700	.128	18,294	23,416
55–64	35,300	.266	12,025	31,986
65–69	36,100	.828	5,002	41,417
70–74	61,900	1.881	4,688	88,181
75–79	115,500	4.857	3,849	186,946
80–84	167,000	10.109	2,697	272,640
85 years and over	315,300	27.041	2,323	628,162
Total Females	757,700	...	...	1,285,663
Total population	1,075,800	...	...	1,740,517

Data sources: Nursing home population from "Utilization of Nursing Homes, United States: National Nursing Home Survey August 1973–April 1974." National Center for Health Statistics, 13 Number 28, DHEW Publication No. (HRA) 77-1779, July 1977. Population is Census estimate of the popuation as of July 1, 1974, and the 2000 projection is from Census Series II projections.

The first step in forecasting nursing home expenditures to the year 2000 is to estimate the impact of the changing population on their use. Data from the National Nursing Home Survey conducted in 1973–74 indicate, as expected, that the probability of residing in a nursing home is strongly dependent on the person's age (*48*). The percent of population resident in nursing homes by age and sex is indicated in table 25. The impact of increasing age on the probability of residing in a nursing home is apparent. Notably, the probability of residing in a nursing home is about equal for men and women until age 70, after which age the probability for women increases much faster than for men.

Table 25 also contains the Census Series II population forecasts for 2000 along with a set of corresponding forecasts of the number of nursing home residents. The forecasts of residents are based on the assumption that the same percentage of each age group would be in nursing homes in 1974 and 2000. In 1974, $7,450 million was spent on nursing home care. If real expenditures per nursing home resident remain constant until the year 2000, this would imply a total expenditure in 2000 of $13.2 billion in 1975 prices. In year 2000 prices, this amount corresponds to $31.2 billion.

The second step in this process of forecasting nursing home expenditures is to adjust these preliminary totals for other anticipated changes in society by 2000. However, the Social Security Administration has calculated annual data on nursing home expenditures since 1948, based on the periodic surveys of nursing home populations conducted by the National Center for Health Statistics (NCHS) and trends in economic and other data in the intervening years (*49*). We postulate the following model to explain changes in these expenditures over the 1948–75 period.

NUEX = *f*(*Y, POP, PCOLD, FLFPR, PSYCH, MEDICA*)

where

NUEX = nursing home expenditures

Y = real per capita personal income
POP = total population
$PCOLD$ = percent of population over 65 years of age
$FLFPR$ = female labor force participation rate
$PSYCH$ = number of psychiatric hospital beds in the United States per 1,000
$MEDICA$ = a dummy variable = 1 for 1968 and later years to capture the impact of Medicare and Medicaid on nursing home expenditures.

The variables in this equation were selected because they capture the major factors believed to have impacted on trends in nursing home expenditures in the past, and reasonable estimates of the level of these variables are available for the year 2000. Two variables merit further explanation. *FLFPR* was selected because as women leave the home for paid employment, it seems likely that they will be less able to care for ailing older relatives in their homes. *PSYCH* is thought to be important because of the rapid deinstitutionalization of psychiatric hospital inmates over the last decade and the transfer of large numbers of these patients to nursing home care. To obtain unbiased estimates of the partial impact of these variables as well as of income, it is necessary to control for such important factors as the size and aging of the population.

All independent variables in the equation are demand factors. An underlying assumption is that the supply of beds will adjust in the long run to meet the demand. The validity of this assumption may be questioned in light of the fact that 72 percent of all nursing homes maintained waiting lists in 1973–74. However, there were also about 100,000 vacant beds, the people on waiting lists totalled less than 15 percent of all those in nursing homes, and the number on waiting lists may include considerable double-counting. In light of the rapid increases in demand factors, such as Federal Government financing of Medicaid and Medicare and the transfer of large numbers of former mental patients to nursing homes, it seems reasonable to assume that current waiting lists are a short-term phenomena.

The equation previously specified was estimated on national time series data for the years 1948–75 in the double logarithmic form. The estimated coefficients and t-statistics corrected for autocorrelation are:

$$NUEX = \underset{}{-79.086} + \underset{(0.162)}{.286\,FLFPR} + \underset{(1.959)}{1.5033\,Y} + \underset{(3.712)}{6.8172\,POP} - \underset{(1.685)}{3.624\,PCOLD} - \underset{(6.077)}{1.3537\,PSYCH} + \underset{(3.132)}{.294\,MEDICA}$$

$R^2 = .993$
$F = 518$

The equation performs very well. Ninety-nine percent of the variation in the dependent variable is accounted for by the explanatory variables, all but one of which have the expected sign and three of which are significantly different from zero.

The next step is to use the coefficients as estimates of the partial impact of each independent variable on nursing home expenditures to adjust our preliminary total expenditure figure. Multiplying the difference in the natural logarithms of the 1975 and 2000 values of the independent variables by their corresponding coefficients yields the appropriate correction. This process is illustrated in table 26 for three variables. We do not adjust for the number of old people because that was previously incorporated in the first step. The final step in the adjustment process is to sum the figures in the bottom row of table 26, add the sum to the natural logarithm of the preliminary forecast of nursing home expenditures in the year 2000 illustrated previously and take the antilog of the total.

These calculations result in a projected nursing home expenditure of $56.9 billion in the year 2000

Table 26. Computation of nursing home expenditures, using as the preliminary estimate of expenditure $13.2 billion in 1975 prices and $31.2 billion in year 2000 prices

Item	Additional factors affecting nursing home expenditures		
	Income per capita (dollars)	Female labor force participation (percent)	Psychiatric beds per 1,000
1975 values	$3,630	45.8	1.5
Estimated 2000 values	7,345	55.0	1.0
Computations			
Regression coefficient	1.50	.286	−1.4
Ln (natural log) 1975 values	8.2	3.8	.44
Ln (natural log) 2000 values	8.9	4.0	.0034
Difference 2000–1975 *Ln* values times regression coefficient	+1.06	+.05	+.59

in year 2000 prices, or $24.1 billion in 1975 prices, a sum about 2.6 times the corresponding expenditures in 1975.

The difference between the $24.1 billion and the preliminary projection of $13.2 billion can, in theory, be decomposed into an income component, a component due to changing female work patterns, and a component due to the transfer of psychiatric inpatients to nursing homes. However, a component not explicitly controlled in the equation, namely, changes in nursing home prices, is correlated with trends in all three of these independent variables. Because of our inability to separate out price and quantity trends in historical data, the price impact is necessarily confounded with other effects. Thus, we interpret the increments to the preliminary forecast as also capturing the impact of past trends in nursing home prices. On balance, it does seem reasonable for future increases in income and social changes, such as increased participation in the labor market by adult women and transfer of psychiatric patients to nursing homes, along with relative price increases in the nursing home sector, to result in greater nursing home expenditures than would be expected as a result of increases in numbers of aged in the population. However, other factors, such as enlarged home care programs, hospices, and enlarged housing facilities for the aged, may reduce nursing home care.

Prepayment and administration. In 1975, the administrative cost of the prepayment and private health insurance coverage of health expenditures was $5.95 billion, or approximately 5 percent of total health expenditures. This sum is a small portion of the total expenditures, the projection of which must be subject to considerable uncertainty because of the divergent impact of alternative national health expenditure plans on the private insurance industry. Somewhat arbitrarily, we project that the percentage of total health expenditures accounted for by this category will decline to from 3.6 to 4.8 percent of the total because of economies of scale. This calculation implies that prepayment and administration costs for the year 2000 would lie between $36.8 and $48.3 billion in year 2000 dollars, or $15.6 to $20.5 billion in 1975 dollars.

Comparison of Projections Used in the Aggregate and Disaggregate Approaches

As mentioned at the beginning of this chapter, these projections are intended to illustrate the magnitudes involved under various assumptions about the future course of economic events. The advent of national health insurance, or a policy change to control the medical care cost inflation, will have a significant impact on the projections.

Tables 27 and 28 illustrate projections from the aggregate model assuming insurance coverage of 75 percent and projections from the disaggregated approach. The disaggregated approach generally yields lower estimates. The major reason for this difference rests in the nature of the assumptions employed in constructing the two projections. The tables help to underscore how the projections can vary under different reasonable assumptions about the future direction of health care.

The range for the total cost of health expenditures in year 2000 prices is from $709.8 billion to $1,086.7 billion (table 28), but these sums should not be con-

Table 27. Projections of national health expenditures, by class of service, for year 2000, using the aggregate and disaggregated models, 1975 prices in billions of dollars (using GNP deflator)

Type of health service	*Aggregate model, assuming insurance coverage of 75 percent*	*Estimates obtained from the disaggregated model*
Percent of GNP.	9.3–11.8	7.8–11.1
Total	[1] $362.1–460.9	$301.1–429.9
Personal health care expenses	312.9–398.3	256.4–372.6
Hospital care	143.9–183.2	[2] 115.0–180.5
Physicians' services	68.8–87.6	68.2–92.4
Dentists' services .	21.9–27.9	25.0
Other professional services	6.3–7.5	6.8–9.2
Drug and drug sundries	28.2–35.8	13.4–24.0
Eyeglasses and appliances	6.3–7.5	5.4
Nursing-home care	28.2–35.8	13.2–24.1
Other health services	9.4–12.0	[3] 9.4–12.0
Prepayment and administration .	18.1–23.0	15.6–20.5
Government public health activities ..	7.3–9.2	[3] 7.3–9.2
Research	7.3–9.2	[3] 7.3–9.2
Construction	14.5–18.4	[3] 14.5–18.4

[1] The range is due to various assumptions about the growth in health care providers. Numbers may not add up to totals due to rounding.

[2] Low number assumes that hospital prices rise 1.2 percent more per year than the general rate of inflation, high number assumes 3 percent more.

[3] Disaggregated estimates were not made for this class of expenditure.

sidered excessive. In 1970, Rice and McGee (*50*), using a methodolgy suggested by Klarman and coworkers (*51*) projected national health expenditures for 1980. If their estimated growth rate in expenditures over the 1975-80 period is used for a year 2000 projection, expenditures range from a low of $529 billion to a high of $1,015 billion, a variation of almost 2 to 1. Anderson projected health expenditures to be 9 percent of the GNP through 2020 (*52*). Correspondence with Professor Anderson revealed that he now believes health expenditures will rise above 9 percent, perhaps even higher than 12 percent.

Turning solely to the disaggregated estimates, figure 8 illustrates the growth in hospital expenditures relative to physicians' services over the century. In 1930, physicians' fees exceeded hospital costs, but by 1975 hospital expenditures were more than twice those for physicians. Depending on which assumption regarding hospital price inflation is used, the difference between hospital and physician expenditures will stabilize or fall, and other types of health service expenditures will fall relative to physicians' services.

The estimates of national health expenditures, as indicated previously in this chapter, are based on a number of assumptions about demography including population growth, health care, the use of health services, and methods of providing care. Less than complete coverage of health services is built into the estimates as is the assumption of no great advances in the prevention of major diseases.

Table 28. Projections of national health expenditures, by class of service, for year 2000 using the aggregate and disaggregated models, year 2000 prices, in billions of dollars

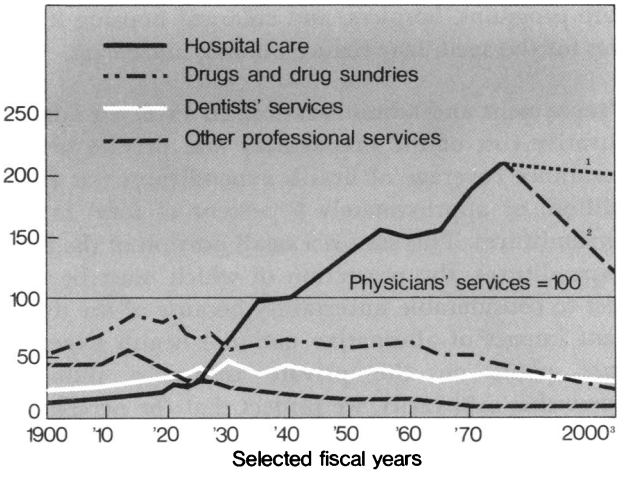
Type of health service	Aggregate model, assuming insurance coverage of 75 percent	Estimates obtained from the disaggregated model
Percent of GNP.	9.3–11.8	7.8–11.1
Total	[1] $853.8–1,086.7	$709.8–1,013.6
Personal health care expenses	737.8–939.1	604.4–878.5
Hospital care	339.3–432.0	[2] 271.1–425.6
Physicians' services	162.2–206.5	160.8–217.9
Dentists' services .	51.6–65.8	58.9
Other professional services	14.9–17.7	16.0–21.7
Drug and drug sundries	66.5–84.4	31.6–56.6
Eyeglasses and appliances	14.9–17.7	12.7
Nursing-home care	66.5–84.4	31.1–56.8
Other health services	22.2–28.3	[3] 22.2–28.3
Prepayment and administration	42.7–54.2	36.8–48.3
Government public health activities ..	17.2–21.7	[3] 17.2–21.7
Research	17.2–21.7	[3] 17.2–21.7
Construction	34.2–43.4	[3] 34.2–43.4

[1] The range is due to various assumptions about the growth in health care providers. Numbers may not add up to totals due to rounding.

[2] Low number assumes that hospital prices rise 1.2 percent more per year than the general rate of inflation, high number assumes 3 percent more.

[3] Disaggregated estimates were not made for this class of expenditure.

Figure 8. Expenditures for health care 1900-2000, relative to the cost of physicians' services



[1] Dotted line assumes hospital prices rise 3 percent more per year than general prices.

[2] Dashed line assumes 1.2 percent faster.

[3] Year 2000 estimates are made assuming enactment of national health insurance.

PART III. INDIRECT COST OF ILLNESS
Chapter 6. Indirect Costs: Mortality Losses in the Year 2000

Major contributors to Part III were Selma J. Mushkin, Aviva Berk, and Cynthia Resnick.

Indirect costs to the economy attributable to premature death represent the years of productive time lost valued in terms of the earnings lost. Premature death for these purposes is defined as death that reduces years of attachment to the labor force for male workers. For women, the years that are counted include years of unpaid work in the household.

Dollar costs of premature death are presented both in terms of the work time and in earnings that are lost by death during the single year 2000, and in terms of the asset value of those earnings, taking into account the continuing loss of work time based on life expectancies and the economic product from that work in the years following the year 2000. In addition, the costs are shown in nondollar terms as years of life that are lost and also as years of productive life lost. The estimates of years of life that are lost help to define the magnitude of mortality losses without regard to the immediate role of the individual as a producer in the economy. In many ways these figures come closer to reflecting the value of the individual in society than do other counts of mortality losses.

The methods of preparing the estimates of the cost of premature death for year 2000 and the assumptions on which these estimates are based are outlined in the sections that follow.

Projected Deaths

The 2.6 million deaths projected in the year 2000 occur in a population expected by the Bureau of the Census to reach 263 million (*3*). More than half of those dying will be males. Interestingly, circulatory diseases are expected to cause less than half of all deaths of men but more than 60 percent of all deaths of women. This difference reflects the predictions of heart disease experts that the death rates for women will not decline as rapidly as for men (*53*).

The second most prevalent cause of death is expected to be cancer. It is projected to cause about 18 percent of all deaths. Accidents, poisonings, and violence rank third as the cause of all deaths, but cause disproportionately more deaths among males (133,000) than among females (56,000). Diseases of the respiratory system rank fourth, causing 6 percent of all deaths (table 29).

If we assume that these deaths occur evenly throughout the year, the person-years lost will average half the number of deaths, or 1.3 million. However, not all these years would have been productive years. The number of productive years lost we estimate at 800,000. This number is derived by applying age and sex specific labor force participation rates to one-half the numbers of deaths. (The number of deaths is divided by 2 since deaths are assumed to occur evenly throughout the year and the loss in a single year is only one-half the months of the year.)

Two sources were used to project the number of deaths by age, sex, and diagnosis in the year 2000. The first source comprised a set of projections made by experts using a Delphi approach and described more fully elsewhere (*54*). Seven diseases, which are major killers today, were selected and experts in each disease were asked to estimate specific disease death rates by age and sex in 2000. These rates were applied to the census projections of year 2000 population. The source of the projected number of deaths due to diseases of the respiratory system was the Delphi study. Projected deaths due to diseases of the digestive system include the Delphi projections for both digestive system diseases and cirrhosis of the liver. Malignant neoplasm deaths were also derived from the Delphi study as were the deaths caused by circulatory diseases. (The Delphi category includes vascular diseases as well as diseases of the heart.) The category of endocrine, nutritional, and metabolic diseases includes diabetes mellitus for which Delphi projections were available. It was assumed that the changes projected for diabetes would also apply to the other diseases in the category.

A second source, estimates developed by the Office of the Actuary of the Social Security Administration (*2*), was used to project deaths in all other disease categories. To the extent that the disease categories used by the Office of the Actuary corresponded to ours, the death rates estimated by the actuaries (multiplied

Table 29. Number and percentage distribution of deaths in year 2000, by age, sex, and cause

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Number of deaths										
Infective and parasitic diseases	20,856	10,829	2,145	1,145	2,744	4,795	10,027	1,709	1,073	1,918	5,327
Neoplasms	467,040	255,769	2,365	11,150	86,281	155,973	211,271	1,753	11,963	67,750	129,805
Endocrine, nutritional and metabolic diseases	57,672	23,343	584	1,313	5,523	15,923	34,329	405	1,143	5,538	27,243
Diseases of the blood and blood-forming organs	7,271	3,155	424	342	672	1,717	4,116	335	371	728	2,682
Mental disorders	13,268	8,506	774	2,479	3,283	1,970	4,762	205	962	1,277	2,318
Diseases of the nervous system and sense organs	22,736	11,696	2,659	1,658	2,961	4,418	11,040	1,612	1,442	2,877	5,109
Diseases of the circulatory system	1,438,349	659,713	2,049	20,185	151,311	486,168	778,636	1,616	9,341	70,602	697,077
Diseases of the respiratory system	166,062	98,471	3,095	2,710	17,940	74,726	67,591	2,302	1,996	9,306	53,987
Diseases of the digestive system, oral cavity, salivary glands, and jaws	95,054	54,176	937	7,967	23,562	21,710	40,878	717	4,440	12,596	23,125
Diseases of the genitourinary system	38,558	17,285	367	989	3,097	12,832	21,273	279	1,276	3,375	16,343
Complications of pregnancy, childbirth, and puerperium	566	..	..	..	..	..	566	164	397	5	..
Diseases of the skin and subcutaneous tissue	3,014	1,053	51	76	244	682	1,961	40	129	252	1,540
Diseases of the musculoskeletal system and connective tissue	6,975	2,035	77	205	648	1,105	4,940	141	587	1,272	2,940
Congenital anomalies and certain causes of perinatal mortality	38,519	21,717	20,151	581	583	402	16,802	15,249	500	558	495
Symptoms and ill-defined conditions	41,805	22,968	5,357	3,351	5,937	8,323	18,837	3,121	2,253	3,345	10,118
Accidents, poisonings, and violence	189,345	133,142	37,378	46,040	30,439	19,285	56,203	11,960	14,018	12,259	17,966
Total	2,607,090	1,323,858	78,413	100,191	335,225	810,029	1,283,232	41,608	51,891	193,658	996,075

Table 29. (continued) Number and percentage distribution of deaths in year 2000, by age, sex, and cause

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Percentage distribution										
Infective and parasitic diseases	0.8	0.8	2.7	1.1	0.8	0.5	0.7	4.1	2.0	0.9	0.5
Neoplasms	17.9	19.3	3.0	11.1	25.7	19.2	16.4	4.2	23.0	34.9	13.0
Endocrine, nutritional and metabolic diseases	2.2	1.7	0.7	1.3	1.6	1.9	2.6	0.9	2.2	2.8	2.7
Diseases of the blood and blood-forming organs	0.2	0.2	0.5	0.3	0.2	0.2	0.3	0.8	0.7	0.3	0.2
Mental disorders	0.5	0.6	0.9	2.4	0.9	0.2	0.3	0.4	1.8	0.6	0.2
Diseases of the nervous system and sense organs	0.8	0.8	3.3	1.6	0.8	0.5	0.8	3.8	2.7	1.4	0.5
Diseases of the circulatory system	55.1	49.8	2.6	20.1	45.1	60.0	60.6	3.8	18.0	36.4	69.9
Diseases of the respiratory system	6.3	7.4	3.9	2.7	5.3	9.2	5.2	5.5	3.8	4.8	5.4
Diseases of the digestive system, oral cavity, salivary glands, and jaws	3.6	4.0	1.1	7.9	7.0	2.6	3.1	1.7	8.5	6.5	2.3
Diseases of the genitourinary system	1.4	1.3	0.4	0.9	0.9	1.5	1.6	0.6	2.4	1.7	1.6
Complications of pregnancy, childbirth, and puerperium	[1]	—	—	—	—	—	[1]	0.3	0.7	[1]	—
Diseases of the skin and subcutaneous tissue	0.1	[1]	[1]	[1]	[1]	[1]	0.1	[1]	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.2	0.1	[1]	0.2	0.1	0.1	0.3	0.3	1.1	0.6	0.2
Congenital anomalies and certain causes of perinatal mortality	1.4	1.6	25.6	0.5	0.1	0.0	1.3	36.6	0.9	0.2	[1]
Symptoms and ill-defined conditions	1.6	1.7	6.8	3.3	1.7	1.0	1.4	7.5	4.3	1.7	1.0
Accidents, poisonings, and violence	7.2	10.0	47.6	45.9	9.0	2.3	4.3	28.7	27.0	6.3	1.8
Total [2]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Less than 0.1 percent.

[2] Totals may not add up due to truncation of numbers.

by the projected year 2000 population) were employed. Accidents, poisonings, and violence-caused deaths were derived from the Office of the Actuary estimates, as was the category comprising certain causes of perinatal morbidity and mortality and congenital anomalies. The remaining disease categories were included as a miscellaneous group in the Office of Actuary estimates. These remaining disease categories were:

Infective and parasitic diseases
Blood diseases
Mental disorders
Nervous system diseases
Genitourinary diseases
Complications of pregnancy
Skin diseases
Musculoskeletal diseases
Symptoms and ill-defined conditions

To arrive at an estimate of death rates for these nine remaining disease categories, the following procedure was used:

1. The total number of 1975 deaths in these disease categories was obtained.
2. The percentage distribution of this total by age, sex, and diagnosis was calculated.
3. The death rates for the whole miscellaneous group as one category were multiplied by year 2000 population projections to compute the number of deaths for this "umbrella category."
4. The percentage distribution by age, sex, and diagnosis as calculated in step 2 was applied to the total deaths as described in step 3 in order to obtain the number of deaths by age and sex in the nine categories. This procedure assumes a constant relationship among these nine categories between 1975 and 2000.

Labor Force Participation

In one illustration, the "constant rate" projection, it was assumed that the year 2000 rates would be the same as those observed in 1975. This rate was adjusted to full employment (defined at 5 percent unemployment). Using coefficients computed by Rosenblum, an economist with the National Commission on Employment and Unemployment, that updated a model of Tella's (*28*), we raised the labor force participation rates of some segments of the population who would have entered the labor force if unemployment had been kept at 5 percent. (Alternative projections of labor force participation were also computed.)

It should also be noted that our source for the 1975 rates, "The Employment and Training Report of the President, 1976" (*26*), excluded the institutional population. Our 1975 rates were adjusted to include this population. This adjustment was made using Johnson's Special Labor Force Report, "The U.S. Labor Force: Projections to 1990" (*27*).

As indicated in Chapter 2, different estimates of labor force participation rates are entirely within the prospects of the years ahead. Especially uncertain are the work patterns of men 45 years of age and older and the response of women to paid employment.

The last 25 years have witnessed a marked change in labor force participation of women and of men 45 and older. The percentages of men follow:

Year	*45–54 years*	*55–64 years*	*65 and older*
1950	95.8	86.9	45.8
1975	92.1	75.8	21.7
2000 low	88.3	65.0	[1] 9.3
2000 high	92.7	80.7	[1] 37.5

[1] Age group 65–74 years.

In 1950, men were in the labor force in larger proportions than they are today. Social Security protections and new lifestyles have contributed to the changes. But the costs of large numbers of persons in the older age groups who fail to work and thus fail to produce goods and services, coupled with the large transfer costs for retirement benefits, point to economic and financial difficulties ahead that could jar the nation into reconsideration of attitudes toward work and retirement. At the same time the move toward equal rights for women has enlarged their labor force participation rates. Illustrative is the experience of women 35 to 44 years of age. The percentage of females in two age groups in the labor force follows:

Year	*16 years and older*	*35–44 years*
1950	33.9	39.1
1975	46.4	55.8
2000, low rate		57.3
2000, high rate		67.9

Will these trends continue or be reversed in the future? We show high and low participation rates for the male age groups of particular concern and for women at a selected age that is generally representative of the work experience. If labor force participation of both men and women increases, the labor force in year 2000 would be 10 million larger

than at constant labor force rates. The difference is about 8 percent in numbers in the labor force and in the potential cost of loss of earnings due to premature death.

One alternative to the constant rate is based on projections developed by Fullerton (*29*); it has been described in chapter 4. Another set of projections for the year 2000 was also made. Fullerton shows that if the trend observed in the past 20 years were to continue, most male age groups, and particularly those 45 and older, would show lower labor force participation rates at the end of the century than they did in 1950. This smaller labor force participaton is likely to strain the economy, as indicated earlier. Thus for our third set of labor force participation rates, it was assumed that by the year 2000, the rates prevalent in 1947 would be observed for adult male workers. The source for the 1947 labor force participation rates was, again, the "Employment and Training Report of the President, 1976" (*26*).

Note that this third set of rates is projected only for males. Fullerton projected female labor force participation rates to be increased by the year 2000. Therefore, for both our "decreasing" and "increasing" labor force participation rates for males, female labor force participation rates are shown to be on the increase.

With all three sets of labor force participation rates, the problem of the substantial number of females who "keep house" and are not in the labor force had to be considered. Losses due to premature mortality or morbidity among housewives are very real, but would equal zero in our calculations if only females in the labor force (as defined by the Bureau of Labor Statistics) were included. Therefore, still another series was constructed—the K or keeping house series. This series is based on data published by the Bureau of Labor Statistics since 1959 on the number of women by age not in the labor force because they are "keeping house." It was assumed that the proportion of women not in the labor force who "kept house" would remain constant on average. Thus, a ratio of women keeping house to women in the labor force was computed for the years between 1959 and 1975. This ratio was used to construct the alternative keeping house rate for the year 2000. For the rate we have defined as constant, the housekeeping rates observed in 1975 were used, derived from the Bureau of Labor Statistics' publication, "Employment and Earnings" (*55*).

Table 30 shows the productive years lost in the study year by disease categories. It should be noted that females lose many more years than men because their years of productivity include housekeeping years for which we have little data for men. We have computed and have available estimates showing loss of productive years in the study year due to premature mortality based on alternative assumptions about labor force participation rates and housekeeping rates.

Value of Productive Time Lost

When we ask how much these productive years lost would cost the economy in terms of foregone output, the problem of what earnings to attribute to household work is significant, particularly for women. Rice, in her 1966 report, "Estimating the Cost of Illness" (*15*), assumed that the value of household work was equal to the wages of a domestic worker. In updating Rice's study, Cooper (*56*), used a different approach based on the work of Brody, "Economic Value of a Housewife" (*57*). Essentially, Brody assumed that the time spent in various household tasks should be remunerated on the same basis as such time in the marketplace. For example, if child care costs $2.35 an hour, this rate should be applied to the hours spent by the housewife in child care, and so forth. The time use in households has been described by Walker and Gauger from a study they had conducted in New York State. Walker and Gauger (*58*) computed the dollar value of household work, and found that the most relevant variables were number of children and age of the youngest child.

Brody, using census data, divided the female population not in the labor force into groups by the age and number of their children. She then computed what she termed the market cost approach to the value of household work for all women in the United States who were not in the labor force in 1971.

We have extended the idea that the value of unpaid work done at home should be taken into account when computing the present value of future earnings. Thus, for women not in the labor force whose main work is keeping house, we computed "household earnings" data, following the Brody approach. We also computed "household earnings" for women in the labor force with household responsibilities and added the "household earnings" to the marketplace earnings provided by BLS.

Table 30. Productive years lost in the single year 2000, assuming constant labor force participation rates

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Number of years										
Infective and parasitic diseases	6,027	2,188	94	544	1,149	400	3,839	91	527	933	2,287
Neoplasms	150,740	55,481	440	5,313	35,300	14,427	95,260	316	5,879	32,925	56,140
Endocrine, nutritional, and metabolic diseases	19,252	4,248	40	626	2,281	1,302	15,004	35	562	2,689	11,718
Diseases of the blood and blood-forming organs	2,340	617	51	162	278	126	1,722	36	182	354	1,150
Mental disorders	5,163	3,014	250	1,178	1,404	182	2,149	63	473	622	992
Diseases of the nervous system and sense organs	7,233	2,790	348	788	1,242	413	4,443	125	709	1,399	2,209
Diseases of the circulatory system	444,044	107,432	389	9,626	62,525	34,892	336,612	323	4,591	34,268	297,430
Diseases of the respiratory system	43,139	14,435	220	1,290	7,284	5,641	28,703	158	981	4,519	23,046
Diseases of the digestive system, oral cavity, salivary glands, and jaws	34,159	15,806	95	3,798	9,946	1,968	18,353	99	2,182	6,127	9,945
Diseases of the genitourinary system	12,014	2,683	71	470	1,280	862	9,331	55	627	1,640	7,009
Complications of pregnancy, childbirth, and puerperium	264	—	—	—	—	—	264	67	195	2	—
Diseases of the skin and subcuaneous tissue	1,042	190	4	36	102	48	852	9	63	123	657
Diseases of the musculoskeletal system and connective tissue	2,694	482	18	98	270	96	2,213	39	288	618	1,267
Congenital anomalies and certain causes of perinatal mortality	1,538	688	125	276	248	39	851	118	246	271	215
Symptoms and ill-defined conditions	12,576	5,327	558	1,592	2,491	686	7,249	185	1,107	1,627	4,330
Accidents, poisonings, and violence	70,703	47,188	10,645	21,834	13,063	1,647	23,515	2,950	6,889	5,968	7,707
Total	812,928	262,570	13,348	47,630	138,862	62,730	550,358	4,669	25,502	94,084	426,102

Table 30. (continued) Productive years lost in the single year 2000, assuming constant labor force participation rates

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Percentage distribution										
Infective and parasitic diseases	0.7	0.8	0.7	1.1	0.8	0.6	0.6	1.9	2.0	0.9	0.5
Neoplasms	18.5	21.1	3.2	11.1	25.4	22.9	17.3	6.7	23.0	34.9	13.1
Endocrine, nutritional and metabolic diseases	2.3	1.6	0.2	1.3	1.6	2.0	2.7	0.7	2.2	2.8	2.7
Diseases of the blood and blood-forming organs	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.7	0.7	0.3	0.2
Mental disorders	0.6	1.1	1.8	2.4	1.0	0.2	0.3	1.3	1.8	0.6	0.2
Diseases of the nervous system and sense organs	0.8	1.0	2.6	1.6	0.8	0.6	0.8	2.6	2.7	1.4	0.5
Diseases of the circulatory system	54.6	40.9	2.9	20.2	45.0	55.6	61.1	6.9	18.0	36.4	69.8
Diseases of the respiratory system	5.3	5.4	1.6	2.7	5.2	8.9	5.2	3.3	3.8	4.8	5.4
Diseases of the digestive system, oral cavity, salivary glands, and jaws	4.2	6.0	0.7	7.9	7.1	3.1	3.3	2.1	8.5	6.5	2.3
Diseases of the genitourinary system	1.4	1.0	0.5	0.9	0.9	1.3	1.6	1.1	2.4	1.7	1.6
Complications of pregnancy, childbirth, and puerperium	[1]	—	—	—	—	—	[1]	1.4	0.7	[1]	—
Diseases of the skin and subcutaneous tissue	0.1	[1]	[1]	[1]	[1]	[1]	0.1	0.1	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.3	0.1	0.1	0.2	0.1	0.1	0.4	0.8	1.1	0.6	0.2
Congenital anomalies and certain causes of perinatal mortality	0.1	0.2	0.9	0.5	0.1	[1]	0.1	2.5	0.9	0.2	[1]
Symptoms and ill-defined conditions	1.5	2.0	4.1	3.3	1.7	1.0	1.3	3.9	4.3	1.7	1.0
Accidents, poisonings and violence	8.6	17.9	79.7	45.8	9.4	2.6	4.2	63.1	27.0	6.3	1.8
Total [2]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Less than 0.1 percent.

[2] Totals may not add up due to truncation of numbers.

Further, we computed "household earnings" for men, placing a value on the activities of married men in household chores, and added those to the BLS data.

For women not in the labor force, "household earnings" were computed in the following manner: from 1970 census data we computed ratios

$$\frac{W_{ijk}}{W_i}$$

where

W_i = number of women in age group i
j = number of children
k = the age of the youngest child

These ratios were then multiplied by the yearly dollar value of household work for women not in the labor force as computed by Walker and Gauger, taking account of the number of children and age of the youngest, adjusted for the change in the consumer price index between 1971 and 1975. A similar procedure was used for employed women.

Similarly, for men, ratios were computed for all husbands by age of husband and number of children under 18 to all household heads in that age group. These data were derived from the Census Bureau's Current Population Reports, "Household and Family Characteristics" (*59*). Walker and Gauger provided the dollar value of time contributed by husbands according to number of children in the household and the employment status of the wife. These values were adjusted for the change in CPI between 1971 and 1975. Using data on employment of wives by number of children, provided by Walker and Woods' "Time Use: A Measure of Household Production of Goods" (*60*), it was possible to obtain weighted averages of dollar value of time contributed by husbands in 1975, by number of children. These were then multiplied by the ratios of husbands in each age group by number of children to total husbands in each age group, derived from the Current Poulation Reports (*59*), to obtain weighted averages of the dollar value of household work for male heads of households by age group.

Brody did not impute household values to single women on the theory that "if a woman keeps house for herself alone, then her death or disability is not only a loss of her services, but a loss of the demand for her services as well. Therefore, the net economic effect on society is nil" (*57*). This argument, however, implies that an allowance for consumption is taken out of the earnings of single women but not from any other group in the population. The problem, however, is academic since Walker and Gauger did not study any "single" households and we, therefore, have no data on which to base household value for people living alone. We thus imputed zero household value to people living alone, rather than make arbitrary assumptions concerning their household production. Thus, for men, only married men with spouses present were imputed a household value; for women, all women ever married were imputed household value until age 65; beyond age 65, only women with spouses present and female heads of household were given earnings.

The sources for these figures were the Census Bureau's "U.S. Detailed Characteristics of the Population" (*61*) and the Current Population Reports, "Household and Family Characteristics" (*59*). The imputed household values were then added to the BLS earnings to give total earnings. These total earnings were a basis for computing the present value of lifetime earnings. It should be noted that there is only one component to the "earnings" of women out of the labor force, that is their imputed income for household work, while for both men and women in the labor force, their earnings include both marketplace earnings and imputed household earnings.

Determining earnings is important because earnings are assumed to be a good measure of the value of production. Or to put it differently, the assumption is made that workers are paid the value of their incremental or marginal product. The problems inherent in this assumption are manifold. For example, to the extent that certain subgroups of the population may be paid less than the value of their incremental or marginal product because of discrimination and other institutional barriers, we may be biasing economic costs. However, as yet this approach is the only one providing consistent and meaningful results in measuring production loss.

Adjustment for Year 2000 Values

The marketplace earnings attributed to the population in the year 2000 are based on the observed earnings of the population in 1975. Thus, the estimates in table 31 assume the same pattern of earnings

distribution over the life cycle as was observed in 1975 from cross-sectional data. The peak-earnings age in 1975 is assumed to be the peak in the year 2000. Further, men are assumed to earn more than women in the year 2000 as they did in 1975, and wage supplements are assumed to be of the same relative importance in year 2000 as in 1975.

The 1975 earnings are derived from unpublished data provided by the Bureau of Labor Statistics' Office of Current Employment Analysis. The data on average earnings by age group provided by the Bureau include more part-year workers than do the labor force projections to the year 2000. Since part-year workers earn less than full-year workers, the average earnings for all workers is somewhat reduced. The result is that the total market earnings lost due to mortality (and morbidity) are conservative estimates of the true values. The bias appears to be approximately 5 percent or less. This discrepancy occurs because the most detailed labor force projections project the labor force at an instant in time, while the most detailed data on earnings report earnings for all persons within an age-sex category who had any work experience during the calendar year. Where the age groups that we needed differed from those of the Bureau, the ratios of those who worked were used as a weighting factor. To all our 1975 earnings data, a constant factor of 12.6 percent was applied to adjust earnings for wage supplements. This constant was derived from the U.S. Commerce Department's "Survey of Current Business" published in January 1976 (*62*).

Keeping earnings in year 2000 in 1975 prices assumes that any productivity increases will show up in the earnings rise. The rise of output per manhour in the last quarter of this century is that projected by the MPS economic model, reproduced as follows:

	Annual growth rate	
Period	*Output per hour* [1]	*GNP deflator, base year 1972* [2]
1977–80	2.7	5.4
1980–85	1.8	4.2
1985–90	2.2	3.2
1990–95	2.1	2.6
1995–2000	2.1	2.0

[1] Private nonfarm business economy.
[2] Prices excluding net exports.

When these growth rates are applied to 1975 earnings, we obtain year 2000 earnings in 1975 dollars. It should be noted that we have no real information on which to base the rise in output per manhour for household services. Therefore, the rates for the economy as a whole were used for these services. Furthermore, distribution of household work between men and women may very well change in the last quarter of this century. However, we make no assumptions about this change and assume only that the distribution of household work among men and women observed in the Walker and Gauger study (*58*) will remain constant. Table 31 shows earnings including and excluding imputed household earnings for males and females.

To transform the real earnings into nominal earnings, that is, into year 2000 dollars, annual growth rates in prices based on the GNP deflator of the basic economic model were assumed. The results of our calculations of the imputed value of work time lost in the single year 2000 due to premature deaths in that year are $9,166,000 in 1975 dollars and $21,484,000 in year 2000 dollars.

Tables 32 and 33 show the distribution by age, sex, and diagnosis of single-year earnings loss due to mortality in the year 2000. Clearly, tables 32 and 33 are very similar, but in table 33 all numbers in 1975 dollars have been raised by the projected GNP price deflator to obtain year 2000 dollars.

Year 2000 Earnings Loss Due to Premature Death, Single Year Estimate

To estimate losses by age and sex attributable to premature death, single-year earnings for year 2000, in both current and 1975 prices, were multiplied by the estimated number of deaths of those who are expected to be in the labor force and those women who are assumed to be housewives only.

In tables 32 and 33, the earnings figures are computed on the basis of an assumed constant labor force participation rate. Increasing the labor force participation implies more time lost during the year because of premature death. Decreases in labor force participation among males, as past trends suggest, yield less time lost due to death and a lower cost of death.

Table 31. Average earnings by age group for 1975 and year 2000

Age group	Males			Females in labor force		
	1975 [1]	Year 2000 [2] (In 1975 dollars)	Year 2000 [3] (In year 2000 (dollars)	1975 [1]	Year 2000 [2] (In 1975 dollars)	Year 2000 [3] (In year 2000 dollars)
Including household values [4]						
15–24	$ 5,135	$ 9,028	$21,281	$ 4,105	$ 7,171	$16,903
25–34	14,004	24,330	57,342	10,587	18,373	43,312
35–44	16,747	29,062	68,446	10,957	19,011	44,814
45–54	17,746	30,791	72,532	10,962	18,165	42,821
55–64	15,551	26,825	63,183	9,918	17,075	40,251
65–74	8,525	14,873	35,059	5,591	9,710	22,891
75–84	7,206	12,471	29,398	4,519	7,841	18,484
85 and older	6,042	10,486	24,714	3,867	6,650	15,676
Excluding household values [5]						
15–24	4,789	8,415	19,838	3,286	5,737	13,525
25–34	12,792	22,227	52,396	6,453	11,199	26,401
35–44	15,489	26,882	63,309	6,322	10,975	25,871
45–54	16,517	28,658	67,494	6,878	11,938	28,141
55–64	14,460	24,939	58,794	6,595	11,440	26,968
65–74	7,559	13,172	31,051	3,553	6,167	14,538
75–84	6,425	11,117	26,207	3,469	6,022	14,197
85 and older	5,561	9,656	22,762	3,398	5,897	13,900

[1] Earnings for males and females in the labor force are average earnings for all full-time and part-time employed in 1975, disregarding duration of employment.

[2] Earnings adjusted for productivity.

[3] Earnings adjusted for both productivity and inflation.

[4] Average market place earnings plus household values.

[5] Average market place earnings only.

Sources: Average market place earnings derived from BLS unpublished data, adjusted by wage supplements (12.6002 percent), derived from U.S. Department of Commerce, *Survey of Current Business*, February 1976; household values derived from Walker and Gauger, *Dollar Value of Household Work;* U.S. Census 1970, *Employment Status and Work Experience*, Table 13; U.S. Census 1970, *Detailed Characteristics*, Table 203. Method is adaptation of W. Brody, *Economic Value of a Housewife.*

Table 32. Single year earnings loss for year 2000 mortality, assuming constant labor force participation rates and including household values, in millions of 1975 dollars

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Millions of 1975 dollars										
Infective and parasitic diseases	$ 83	$ 54	[2]	$ 14	$ 33	$ 5	$ 28	[2]	$ 8	$ 12	$ 6
Neoplasms	2,092	1,361	3	149	1,000	207	730	2	97	446	183
Endocrine, nutritional, and metabolic diseases	181	101	[2]	17	65	18	79	[2]	9	35	34
Diseases of the blood and blood-forming organs	25	14	[2]	4	7	1	11	[2]	3	4	3
Mental disorders	97	78	2	32	41	2	19	[2]	7	8	2
Diseases of the nervous system and sense organs	105	66	3	21	35	5	39	1	11	19	7
Diseases of the circulatory system	3,800	2,554	3	274	1,786	490	1,245	2	75	453	713
Diseases of the respiratory system	455	322	1	35	205	79	132	1	16	60	54
Diseases of the digestive system, oral cavity, salivary glands and jaws	575	425	[2]	109	288	28	150	[2]	36	84	28
Diseases of the genitourinary system	114	62	[2]	13	36	12	52	[2]	10	22	19
Complications of pregnancy, childbirth, and puerperium	3	—	—	—	—	—	3	[2]	3	[2]	—
Diseases of the skin and subcutaneous tissue	9	4	[2]	[2]	2	[2]	4	[2]	1	1	1

Table 32. (continued) Single year earnings loss for year 2000 mortality, assuming constant labor force participation rates and including household values, in millions of 1975 dollars

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Millions of 1975 dollars										
Diseases of tthe musculoskeletal system and connective tissue	29	11	[2]	2	7	1	17	[2]	4	8	3
Congenital anomalies and certain causes of perinatal mortality	26	16	1	7	7	[2]	9	1	4	3	[2]
Symptoms and ill-defined conditions	183	130	5	43	72	9	53	1	18	22	10
Accidents, poisonings and violence	1,332	1,087	96	583	384	23	244	25	114	83	20
Total [1]	9,116	6,293	120	1,308	3,975	888	2,823	40	422	1,269	1,091
	Percentage distribution										
Infective and parasitic diseases	0.9	0.8	0.7	1.1	0.8	0.6	1.0	1.9	2.0	1.0	0.5
Neoplasms	22.9	21.6	3.2	11.4	25.1	23.3	25.8	6.7	23.0	35.2	16.8
Endocrine, nutritional, and metabolic diseases	1.9	1.6	0.2	1.3	1.6	2.0	2.8	0.7	2.2	2.8	3.1
Diseases of the blood and blood-forming organs	0.2	0.2	0.3	0.3	0.1	0.1	0.3	0.7	0.7	0.3	0.2
Mental disorders	1.0	1.2	1.8	2.4	1.0	0.2	0.6	1.3	1.8	0.6	0.2
Diseases of the nervous system and sense organs	1.1	1.0	2.6	1.6	0.9	0.6	1.3	2.6	2.7	1.5	0.6
Diseases of the circulatory system	41.6	40.5	2.9	20.9	44.9	55.2	44.1	6.9	17.9	35.7	65.3
Diseases of the respiratory system	4.9	5.1	1.6	2.7	5.1	8.9	4.7	3.3	3.8	4.7	5.0
Diseases of the digestive system, oral cavity, salivary glands and jaws	6.3	6.7	0.7	8.2	7.2	3.1	5.3	2.1	8.5	6.6	2.6
Diseases of the genitourinary system	1.2	0.9	0.5	0.9	0.9	1.3	1.8	1.1	2.4	1.7	1.7
Complications of pregnancy, childbirth, and puerperium	[3]	—	—	—	—	—	0.1	1.4	0.7	[3]	—
Diseases of the skin and subcutaneous tissue	[3]	[3]	[3]	[3]	[3]	[3]	0.1	0.1	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.3	0.1	0.1	0.2	0.1	0.1	0.6	0.8	1.1	0.6	0.3
Congenital anomalies and certain causes of perinatal mortality	0.2	0.2	0.9	0.5	0.1	[3]	0.3	2.5	0.9	0.2	[3]
Symptoms and ill-defined conditions	2.0	2.0	4.1	3.3	1.8	1.1	1.8	3.9	4.3	1.7	0.9
Accidents, poisonings and violence	14.6	17.2	79.7	44.5	9.6	2.6	8.6	63.1	27.0	6.6	1.9
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.
[2] Less than $1.0 million.
[3] Less than 0.1 percent.

Total person years of time lost due to premature death, with alternate assumptions about constant rate of work force participation, follow:

Assumption	*Person years lost*
Decreasing labor force participation	755,000
Increasing labor force participation	835,000

The difference between high and low estimates is 10.6 percent, with constant rates yielding an intermediate number of person years lost.

In the calculation of single-year losses, females account for only 31 percent of the total loss because they earn less than males in the market place. Also, note that, although the disease categories of loss are ranked in the same order for both males and females, accidents, poisonings, and violence, which rank third greatest for both sexes, account for 17 percent of males' loss but only 9 percent of females' loss. Circulatory diseases, which rank first, contribute 44 percent of females' loss compared to 41 percent for males. Neoplasms contribute 26 per-

Table 33. Single year earnings loss for year 2000 mortality ssuming constant labor force participation rates and including household values, in millions of year 2000 dollars

		Males					*Females*				
Disease category	*Total males and females* [1]	*All ages*	*Under 25*	*25–44*	*45–64*	*65 and over*	*All ages*	*Under 25*	*25–44*	*45–64*	*65 and over*
Infective and parasitic diseases	$ 197	$ 129	$ 2	$ 35	$ 78	$ 13	$ 68	$ 2	$ 20	$ 30	$ 14
Neoplasms	4,930	3,207	9	353	2,357	488	1,723	6	229	1,054	433
Endocrine, nutritional, and metabolic diseases ...	427	239	1	41	153	43	188	1	22	84	81
Diseases of the blood and blood-forming organs .	61	34	1	10	19	4	26	1	7	11	7
Mental disorders	230	184	5	75	96	6	46	1	18	20	5
Diseases of the nervous system and sense organs	249	156	7	50	84	14	92	2	28	46	17
Diseases of the circulatory system	8,956	6,019	8	645	4,208	1,157	2,936	7	179	1,070	1,681
Diseases of the respiratory system	1,073	760	4	84	483	188	313	3	38	142	129
Diseases of the digestive system, oral cavity, salivary glands, and jaws	1,357	1,002	2	253	681	67	354	2	84	200	67
Diseases of the genitourinary system	269	146	1	31	86	28	122	1	24	52	45
Complications of pregnancy, childbirth and puerperium	9	—	—	—	—	—	9	1	7	[2]	—
Diseases of the skin and subcutaneous tissue ..	21	11	[2]	2	7	1	10	[2]	2	4	4
Diseases of the musculoskeleral system and connective tissue	69	28	[2]	6	18	3	41	1	11	20	8
Congenital anomalies and certain causes of perinatal mortality	61	38	2	17	17	1	22	2	10	8	2
Symptoms and ill-defined conditions	432	306	11	102	170	23	125	4	43	53	25
Accidents, poisonings, and violence	3,139	2,561	226	1,374	905	55	577	61	269	198	49
Total [1]	21,484	14,826	284	3,083	9,364	2,094	6,658	96	995	2,994	2,572

[1] Totals may not add up due to truncation of numbers.
[2] Less than $1 million.

cent of the loss for females compared to 22 percent for the males.

Asset Losses of Year 2000 Deaths

Our discussion of mortality losses in the year 2000 has so far concentrated on the person years of work lost and the imputed value of those losses incurred during the year 2000. In Chapter 7, these losses will be compared to morbidity losses. However, a person's death deprives the economy of his output not only in the year of his death but also in subsequent years in which he could have been expected to continue to produce. Thus, mortality losses should include a calculation of total years lost—the years lost when average remaining years of life are applied to death, by age and sex, of the prematurely deceased.

Two procedures have been followed in making such computations. In the first procedure, computation of the remaining years of life lost is based on current survival and life expectancy tables. The result of these calculations is shown in table 34. These calculations rely only on assumptions of life expectancy derived from unpublished projected life tables for the year 2000 sent to us by the Office of the Actuary, Social Security Administration.

The projections in the table vary neither by labor force participation rates nor by earnings. Again, circulatory diseases contribute the most years lost (39 percent); neoplasms rank second (18 percent); and accidents, poisonings, and violence rank third (16 percent). Though the rankings are the same, the relative size of the contribution of each disease category is somewhat different than in the previous calculations.

In the second procedure, account is taken of the losses of production in the economy. A calculation of total productive years lost shows that of the 41 million aggregate years of life lost by the deaths projected for year 2000, 27.6 million years would have been productive if labor force participation rates were constant. If the participation rate assumption is changed, the following estimates are derived.

Assumption	*Years of productive life lost*
Decreasing labor force participation rates	23,700,000
Increasing labor force participation rates	28,500,000

Table 35 gives the distribution by disease category of productive years lost. Disease rankings are changed somewhat. For males, circulatory diseases cause 25 percent of the years lost; accidents, poisonings, and violence cause 31 percent; and neoplasms 14 percent. For females, diseases of the circulatory system cause 43 percent of the loss, neoplasms cause 20 percent; and accidents, poisonings, and violence 10 percent.

The present value of future earnings is used to measure the dollar loss due to premature mortality. This human capital approach, used by the Public Services Laboratory in earlier reports, was used extensively by Rice and Cooper (*56*). It is based on an analogy with physical capital, suggesting that people, not unlike machines, provide a stream of services during the years of productive life. The value of these services is measured by discounting to the present the stream of marginal earnings that would have been generated if the person had not died prematurely.

Other approaches (*63–66*) to the valuation of life include Schelling's "willingness-to-pay" approach and Rosen and Thaler's examination of the extra compensation for job-entailed risks.

Table 36 shows the present value of future earnings, assuming constant labor force participation rates by age and sex, with 2.5 percent and 10 percent interest rates. (Both rates have been adjusted for a yearly growth in productivity of approximate 2 percent). We show computations in constant 1975 dollars and in current year 2000 dollars and include household values.

Assumptions of increasing or decreasing work force participation yield different estimates of the present value of future earnings. The differences (in thousands of dollars) are summarized for two age groups of males:

	Interest rate of 10 percent		*Interest rate of 2.5 percent*	
Age groups	*1975 dollars*	*Year 2000 dollars*	*1975 dollars*	*Year 2000 dollars*
Decreasing participation:				
25–34 years	$304	$717	$721	$1,700
55–64 years	90	212	96	226
Increasing participation:				
25–34 years	317	747	795	1,874
55–64 years	126	297	150	354

Table 34. Total years lost because of premature mortality, in thousands of years

Disease category	Total males and females[1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Thousands of years										
Infective and parasitic diseases	556	283	142	42	58	40	273	126	46	51	49
Neoplasms	7,455	3,679	136	395	1,747	1,400	3,775	115	500	1,786	1,372
Endocrine, nutritional and metabolic diseases	816	331	36	46	114	134	484	28	48	141	265
Diseases of the blood and blood-forming organs	150	66	26	12	13	13	83	23	16	19	24
Mental disorders	332	223	41	92	72	17	108	12	40	35	19
Diseases of the nervous system and sense organs	636	327	163	61	63	39	308	115	61	77	53
Diseases of the circulatory system	15,883	7,774	120	705	3,128	3,819	8,109	108	391	1,794	5,815
Diseases of the respiratory system	2,200	1,262	201	97	357	604	938	169	85	239	444
Diseases of the digestive system, oral cavity, salivary glands and jaws	1,837	1,040	59	280	508	191	796	50	186	340	219
Diseases of the genitourinary system	529	219	21	36	64	97	310	18	53	88	149
Complications of pregnancy, childbirth and puerperium	28	—	—	—	—	—	28	9	18	[2]	—
Diseases of the skin and subcutaneous tissue	44	16	3	2	5	5	27	2	5	6	12
Diseases of the musculoskeletal system and connective tissue	131	35	4	7	13	9	96	8	25	33	28
Congenital anomalies and certain causes of perinatal mortality	2,644	1,430	1,392	21	12	3	1,214	1,171	22	15	5
Symptoms and ill-defined conditions	1,170	665	344	125	126	69	504	232	96	90	85
Accidents, poisonings and violence	6,553	4,657	2,048	1,764	678	164	1,896	773	620	339	162
Total[1]	40,971	22,014	4,743	3,692	6,965	6,612	18,956	2,967	2,218	5,059	8,710
	Percentage distribution										
Infective and parasitic diseases	1.3	1.2	3.0	1.1	0.8	0.6	1.4	4.2	2.0	1.0	0.5
Neoplasms	18.1	16.7	2.8	10.7	25.0	21.1	19.9	3.9	22.5	35.3	15.7
Endocrine, nutritional and metabolic diseases	1.9	1.5	0.7	1.2	1.6	2.0	2.5	0.9	2.1	2.8	3.0
Diseases of the blood and blood-forming organs	0.3	0.3	0.5	0.3	0.1	0.2	0.4	0.7	0.7	0.3	0.2
Mental disorders	0.8	1.0	0.8	2.4	1.0	0.2	0.5	0.4	1.8	0.6	0.2
Diseases of the nervous system and sense organs	1.5	1.4	3.4	1.6	0.9	0.6	1.6	3.8	2.7	1.5	0.6
Diseases of the circulatory system	38.7	35.3	2.5	19.0	44.9	57.7	42.7	3.6	17.6	35.4	66.7
Diseases of the respiratory system	5.3	5.7	4.2	2.6	5.1	9.1	4.9	5.7	3.8	4.7	5.1
Diseases of the digestive system, oral cavity, salivary glands and jaws	4.4	4.7	1.2	7.6	7.3	2.8	4.2	1.7	8.4	6.7	2.5
Diseases of the genitourinary system	1.2	0.9	0.4	0.9	0.9	1.4	1.6	0.6	2.4	1.7	1.7
Complications of pregnancy, childbirth and puerperium	[3]	—	—	—	—	—	0.1	0.3	0.8	[3]	—

Table 34. (continued) Total years lost because of premature mortality, in thousands of years

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Percentage distribution										
Diseases of the skin and subcutaneous tissue	0.1	[3]	[3]	[3]	[3]	[3]	0.1	[3]	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.3	0.1	[3]	0.2	0.1	0.1	0.5	0.2	1.1	0.6	0.3
Congenital anomalies and certain causes of perinatal mortality	6.4	6.4	29.3	0.5	0.1	[3]	6.4	39.4	1.0	0.2	[3]
Symptoms and ill-defined conditions	2.8	3.0	7.2	3.3	1.8	1.0	2.6	7.8	4.3	1.7	0.9
Accidents, poisonings and violence	15.9	21.1	43.1	47.7	9.7	2.4	10.0	26.0	27.9	6.7	1.8
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.
[2] Less than 1,000 years.
[3] Less than 0.1 percent.

Table 35. Total productive years lost because of premature mortality, assuming constant labor force participation rates

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Thousands of years										
Infective and parasitic diseases	402	163	95	31	30	5	238	102	44	48	43
Neoplasms	4,930	1,454	103	292	856	202	3,476	103	481	1,680	1,210
Endocrine, nutritional and metabolic diseases	574	135	26	34	57	18	438	24	46	133	234
Diseases of the blood and blood-forming organs	112	37	18	9	6	1	75	20	15	18	21
Mental disorders	245	143	32	69	39	2	101	11	39	33	17
Diseases of the nervous system and sense organs	478	201	117	46	32	5	276	96	59	73	47
Diseases of the circulatory system	9,919	2,662	89	518	1,569	485	7,256	95	377	1,683	5,100
Diseases of the respiratory system	1,292	460	137	72	171	78	831	137	81	224	387
Diseases of the digestive system, oral cavity, salivary glands, and jaws	1,278	543	41	207	267	27	735	42	179	320	192
Diseases of the genitourinary system	369	86	15	26	32	11	282	16	51	82	131
Complications of pregnancy, childbirth, and puerperium	27	—	—	—	—	—	27	9	17	[2]	—
Diseases of the skin and subcutaneous tissue	33	7	2	2	2	[2]	25	2	5	6	11
Diseases of the musculoskeletal system and connective tissue	106	17	3	5	6	1	89	8	24	31	25

Table 35. (continued) Total productive years lost because of premature mortality, assuming constant labor force participation rates

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Thousands of years										
Congenital anomalies and certain causes of perinatal mortality	1,891	930	906	16	6	[2]	960	919	21	14	4
Symptoms and ill-defined conditions	845	406	236	94	65	9	439	187	92	85	74
Accidents, poisonings, and violence	5,090	3,328	1,595	1,340	368	23	1,762	700	598	320	141
Total [1]	27,598	10,581	3,422	2,768	3,514	875	17,017	2,479	2,136	4,756	7,644
	Percentage distribution										
Infective and parasitic diseases	1.4	1.5	2.8	1.1	0.8	0.6	1.4	4.1	2.0	1.0	0.5
Neoplasms	17.8	13.7	3.0	10.5	24.3	23.1	20.4	4.1	22.5	35.3	15.8
Endocrine, nutritional and metabolic diseases	2.0	1.2	0.7	1.2	1.6	2.0	2.5	0.9	2.1	2.7	3.0
Diseases of the blood and blood-forming organs	0.4	0.3	0.5	0.3	0.1	0.1	0.4	0.8	0.7	0.3	0.2
Mental disorders	0.8	1.3	0.9	2.5	1.1	0.2	0.5	0.4	1.8	0.7	0.2
Diseases of the nervous system and sense organs	1.7	1.9	3.4	1.6	0.9	0.6	1.6	3.8	2.7	1.5	0.6
Diseases of the circulatory system	35.9	25.1	2.6	18.7	44.6	55.4	42.6	3.8	17.6	35.3	66.7
Diseases of the respiratory system	4.6	4.3	4.0	2.6	4.8	8.9	4.8	5.5	3.8	4.7	5.0
Diseases of the digestive system, oral cavity, salivary glands, and jaws	4.6	5.1	1.2	7.4	7.6	3.1	4.3	1.7	8.4	6.7	2.5
Diseases of the genitourinary system	1.3	0.8	0.4	0.9	0.9	1.3	1.6	0.6	2.4	1.7	1.7
Complications of pregnancy, childbirth, and puerperium	[3]	—	—	—	—	—	0.1	0.3	0.8	[3]	—
Diseases of the skin and subcutaneous tissue	0.1	[3]	[3]	[3]	[3]	[3]	0.1	[3]	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.3	0.1	[3]	0.2	0.1	0.1	0.5	0.3	1.1	0.6	0.3
Congenital anomalies and certain causes of perinatal mortality	6.8	8.7	26.4	0.6	0.1	[3]	5.6	37.0	1.0	0.3	[3]
Symptoms and ill-defined conditions	3.0	3.8	6.9	3.4	1.8	1.1	2.5	7.5	4.3	1.7	0.9
Accidents, poisonings, and violence	18.4	31.4	46.6	48.4	10.4	2.6	10.3	28.2	28.0	6.7	1.8
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.
[2] Less than 1,000 years.
[3] Less than 0.1 percent.

Estimating techniques and problems: present value of future earnings. To compute the present value of future earnings, we used the following formula, closely following Rice. V_a is the present value of future earnings of a male at age a such that

$$V_{1975a} = \sum_{n=a}^{85+} \frac{X_n W_n P_a^n}{(1+i)^{n-a}}$$

where 1975 is our base year

a is mid-year age per a given cohort

X_n = annual mean earnings of all males with earnings in an age group where the midpoint is age n

i = discount rate

$W_n P_a^n$ = number of labor force years per person in an age group

$$= \frac{\sum_{j=t}^{t+r-1} L_j W_j}{L_a}$$

where

j = specific age group under consideration

t = beginning of age group

r = number of years in this age group

L_j = number of males surviving to j out of a cohort of 100,000 male births

W_j = age group work-experience rate

L_a = number of males living at mid-year age a for given subgroup out of a cohort of 100,000 live male births

For females, our computations differed slightly to take into account those women who were keeping house and not otherwise employed. Thus, our computations had two components.

$$V_a = \sum_{n=a}^{85+} \frac{X_n W_n P_a{}^n}{(1+i)^{n-a}} + \sum_{n=a}^{85+} \frac{X_n{}^k K_n P_a{}^n}{(1+i)^{n-a}}$$

where

$\sum_{n=a}^{85+} \frac{X_n W_n P_a{}^n}{(1+i)^{n-a}}$ is simliar to the formula used for males and

$\sum_{n=a}^{85+} \frac{X_r{}^k K_n P_a{}^n}{(1+i)^{n-a}}$ differs from the previous formula in that

$X_n{}^k$ = inputed household value for women otherwise not in labor force, and

K_n = average keeping house participation rate in the age group with midpoint n.

Methodological problems inherent in this approach include the treatment of consumption and the appropriate discount rate to be used in converting the flow of future production to its present asset value. The appropriate discount rate has been discussed in Chapter 3. Much has been written on the question of whether an individual's consumption should be subtracted from his or her economic value.

It has been argued that the loss society incurs when a person dies is equal to his production minus consumption and, therefore, one should view the social loss as the individual's net output (*18*). However, such a methodology deals with the individual person in a way that challenges our basic values of

Table 36. Present value of future earnings, assuming constant rates of labor force participation and including household values, in thousands of dollars

Age group (years)	Interest rate = 10 percent		Interest rate = 2.5 percent	
	1975 dollars	Year 2000 dollars	1975 dollars	Year 2000 dollars
Males:				
0–1	$ 55	$130	$796	$1,874
1–4	55	131	802	2,070
5–14	120	283	847	1,993
15–24	228	536	863	2,034
25–34	313	738	776	1,829
35–44	302	709	573	1,350
45–54	229	540	340	800
55–64	116	275	135	320
65–74	24	56	27	63
75–84	5	13	6	14
85 and over.	1	2	1	2
Females:				
0–1	43	100	552	1,301
1–4	43	101	555	1,310
5–14	94	220	585	1,381
15–24	165	391	581	1,371
25–34	199	468	493	1,163
35–44	175	412	359	845
45–54	135	319	226	531
55–64	85	201	116	274
65–74	29	70	37	89
75–84	11	26	12	29
85 and over .	4	9	4	9

individual worth. Those concerned with valuations of an individual human life would scarcely consider a net computation appropriate in developed societies. Thus, we decided to make no allowance for consumption.

We should also note that certain economists have rejected the human capital approach; they are critical because the only value attached to an individual is the output he or she produces. Due to the discounting process, children whose participation in the labor force will not begin for several years, and those who are not actively contributing to the GNP have a low value placed on their lives. Neither the individual's value of his or her own life is considered in the human capital approach nor are any values of the person by his family and friends.

Application. Applying present value of future earnings to year 2000 deaths, we obtained the following mortality losses in billions of dollars:

Interest rate	*1975 dollars*	*Year 2000 dollars*
2.5 percent	$303.5	$715.2
10 percent	151.3	356.4

Tables 37 and 38 show these mortality losses by age, sex, and cause when the interest rate is 2.5 percent, while tables 39 and 40 show their distribution with an interest rate at 10 percent. The difference between these tables showing losses in constant dollars and those showing losses in year 2000 dollars lies only in the magnitude of the GNP deflator.

With the interest rate set at 2.5 percent, accidents, poisonings, and violence cause the greatest loss (28 percent) followed by circulatory diseases (25 percent), and neoplasms (16 percent). With a 10 percent rate, the major causes of mortality are the same, although there is a change in the ordering of disease categories. Circulatory diseases cause the greatest losses (35 percent) followed by accidents, poisonings, and violence (22 percent), and neoplasms (21 percent). The ranking for females is somewhat different; neoplasms are more important than accidents, poisonings, and violence. If these results are compared with those obtained with the discount rate of 2.5 percent, the rankings of disease categories are the same, but, with the 10 percent discount rate, the magnitudes are substantially different. Circulatory diseases caused 25 percent of all mortality loss with the discount rate of 2.5 percent, but with the discount rate at 10 percent, circulatory diseases caused 35 percent of all loss. When the discount rate was set at 2.5 percent, accidents, poisonings, and violence caused 28 percent of all loss, but at 10 percent, the figure drops to 22 percent. Neoplasms caused 16 percent of losses when the interest rate is assumed to be 2.5 percent; at 10 percent, neoplasms caused 21 percent of all losses.

Clearly, the choice of interest rate affects the relative proportions of losses attributable to specific diseases. The higher the interest rate, the lower the present value of future earnings, particularly children's future earnings. Those in older age groups are more likely to die of circulatory diseases than are younger persons. Therefore, because the present value of their earnings is relatively higher at the 10 percent rate than the 2.5 percent rate, circulatory diseases will become relatively more important as causes of mortality loss as the discount rate increases. Similarly, neoplasms will increase in relative importance with an increase in the discount rate. However, accidents, poisonings, and violence will decrease with increasing discount rates, since these are causes of mortality loss primarily among younger age groups.

The costs of premature death in the year 2000 measured by the total loss in production over the expected years of normal working life vary according to the assumption of work force participation. For those in the work force (that is excluding imputed value of household services) the range in costs between increasing and decreasing work force participation is 13.7 percent when costs are calculated at the 10 percent discount rate and 16.0 percent when costs are calculated at the 2.5 percent discount rate. Mortality losses in year 2000, as measured by the present value of lost future earnings, can range from $151.3 billion to $303.5 billion in constant 1975 dollars and from $356.4 billion to $715.2 billion in year 2000 dollars, depending on the discount rate used to calculate these losses. The figures in this chapter are based on the assumptions of constant labor force participation rates and the inclusion of household values .Other calculations for different assumptions about labor force participation rates were also made. Of all assumptions presented in this chapter, the one that affects these magnitudes most is the interest rate, although others are also significant as inferences are drawn by age, sex, and cause.

Table 37. Lost future earnings in millions of 1975 dollars discounted at 2.5 percent, assuming constant labor force participation rates and including household values

Disease category	Total males and females[1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Millions of 1975 dollars										
Infective and parasitic diseases	$ 4,974	$ 3,174	$ 1,737	$ 731	$ 637	$ 66	$ 1,800	$ 957	$ 426	$ 327	$ 89
Neoplasms	48,319	28,983	2,005	680	17,733	2,438	19,336	1,013	4,569	11,059	2,694
Endocrine, nutritional and metabolic diseases	4,706	2,694	483	801	1,193	216	2,012	230	441	850	491
Diseases of the blood and blood-forming organs	1,250	743	351	224	145	20	507	190	152	122	43
Mental disorders	3,909	3,148	664	1,610	842	31	760	118	378	229	34
Diseases of the nervous system and sense organs	6,133	4,050	2,210	1,077	692	69	2,083	913	570	494	104
Diseases of the circulatory system	77,042	52,319	1,721	12,091	32,814	5,691	24,724	925	3,582	10,650	9,565
Diseases of the respiratory system	12,923	8,669	2,519	1,692	3,533	924	4,253	1,289	785	1,439	737
Diseases of the digestive system, oral cavity, salivary glands, and jaws	16,299	11,618	768	4,827	5,689	333	4,680	405	1,707	2,161	407
Diseases of the genitourinary system	3,201	1,744	307	625	671	139	1,457	160	491	539	266
Complications of pregnancy, childbirth and puerperium	270	—	—	—	—	—	270	95	174	1	—
Diseases of the skin and subcutaneous tissue	292	154	41	49	55	7	138	22	51	43	21
Diseases of the musculoskeletal system and connective tissue	937	357	65	129	146	16	580	81	232	211	54
Congenital anomalies and certain causes of perinatal mortality	25,372	16,612	16,073	385	146	6	8,759	8,442	209	97	11
Symptoms and ill-defined conditions	11,423	8,072	4,374	2,190	1,392	115	3,350	1,741	886	572	149
Accidents, poisonings, and violence	86,485	71,230	31,962	31,047	7,944	276	15,254	6,902	5,843	2,217	290
Total[1]	303,542	213,573	65,288	64,291	73,641	10,353	89,968	23,490	20,499	31,017	14,960

Table 37. (continued) Lost future earnings in millions of 1975 dollars discounted at 2.5 percent, assuming constant labor force participation rates and including household values

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Percentage distribution										
Infective and parasitic diseases	1.6	1.4	2.6	1.1	0.8	0.6	2.0	4.0	2.0	1.0	0.5
Neoplasms	15.9	13.5	3.0	10.5	24.0	23.5	21.4	4.3	22.2	35.6	18.0
Endocrine, nutritional and metabolic diseases	1.5	1.2	0.7	1.2	1.6	2.0	2.2	0.9	2.1	2.7	3.2
Diseases of the blood and blood-forming organs	0.4	0.3	0.5	0.3	0.1	0.1	0.5	0.8	0.7	0.3	0.2
Mental disorders	1.2	1.4	1.0	2.5	1.1	0.2	0.8	0.5	1.8	0.7	0.2
Diseases of the nervous system and sense organs	2.0	1.8	3.3	1.6	0.9	0.6	2.3	3.8	2.7	1.5	0.7
Diseases of the circulatory system	25.3	24.5	2.6	18.8	44.5	54.9	27.4	3.9	17.4	34.3	63.9
Diseases of the respiratory system	4.2	4.0	3.8	2.6	4.7	8.9	4.7	5.4	3.8	4.6	4.9
Diseases of the digestive system, oral cavity, salivary glands, and jaws	5.3	5.4	1.1	7.5	7.7	3.2	5.2	1.7	8.3	6.9	2.7
Diseases of the genitourinary system	1.0	0.8	0.4	0.9	0.9	1.3	1.6	0.6	2.3	1.7	1.7
Complications of pregnancy, childbirth and puerperium	[2]	—	—	—	—	—	0.3	0.4	0.8	[2]	[2]
Diseases of the skin and subcutaneous tissue	[2]	[2]	[2]	[2]	[2]	[2]	0.1	[2]	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.3	0.1	0.1	0.2	0.2	0.1	0.6	0.3	1.1	0.6	0.3
Congenital anomalies and certain causes of perinatal mortality	8.3	7.7	24.6	0.5	0.1	[2]	9.7	35.9	1.0	0.3	[2]
Symptoms and ill-defined conditions	3.7	3.7	6.6	3.4	1.8	1.1	3.7	7.4	4.3	1.8	0.9
Accidents, poisonings, and violence	28.4	33.3	48.9	48.2	10.7	2.6	16.9	29.3	28.4	7.1	1.9
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.

[2] Less than 0.1 percent.

Table 38. Lost future earnings, in millions of year 2000 dollars discounted at 2.5 percent, assuming constant labor force participation rates and including household values

Disease category	Total males and females[1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
Infective and parasitic diseases	$ 11,721	$ 7,477	$ 4,093	$ 1,724	$ 1,501	$ 157	$ 4,244	$ 2,256	$ 1,005	$ 771	$ 211
Neoplasms	113,858	68,270	4,724	16,028	41,775	5,742	45,588	2,389	10,769	26,075	6,352
Endocrine, nutritional, and diseases	11,089	6,346	1,138	1,888	2,811	509	4,744	542	1,039	2,004	1,158
Diseases of the blood and blood-forming organs	2,947	1,750	828	529	343	48	1,197	449	358	288	102
Mental disorders	9,210	7,417	1,566	3,793	1,985	72	1,793	279	890	541	81
Diseases of the nervous system and sense organs	14,451	9,540	5,209	2,537	1,630	164	4,910	2,153	1,344	1,166	247
Diseases of the circulatory system	181,564	123,236	4,055	28,481	77,300	13,400	58,328	2,182	8,444	25,114	22,587
Diseases of the respiratory system	30,452	20,422	5,935	3,986	8,324	2,175	10,030	3,040	1,852	3,394	1,743
Diseases of the digestive system, oral cavity, salivary glands, and jaws	38,404	27,370	1,810	11,370	13,403	785	11,034	954	4,024	5,095	959
Diseases of the genitourinary system	7,545	4,108	725	1,473	1,582	327	3,436	377	1,157	1,271	630
Complications of pregnancy, childbirth, and puerperium	637	—	—	—	—	—	637	225	409	2	—
Diseases of the skin and subcutaneous tissue	690	363	98	117	129	18	327	53	120	102	50
Diseases of the musculoskeletal system and connective tissue	2,210	842	153	306	345	38	1,368	193	547	499	129
Congenital anomalies and certain causes of perinatal mortality	59,784	39,134	37,866	907	346	16	20,649	19,900	494	228	27
Symptoms and ill-defined conditions	26,915	19,017	10,306	5,160	3,280	271	7,898	4,105	2,090	1,351	351
Accidents, poisonings, and violence	203,757	167,796	75,299	73,130	18,715	651	35,961	16,271	13,774	5,229	687
Total[1]	715,239	503,093	153,808	151,434	173,474	24,377	212,146	55,374	48,322	73,132	35,317

[1] Totals may not add up due to truncation of numbers.

Table 39. Lost future earnings, in millions of 1975 dollars discounted at 10 percent, assuming constant labor force participation rates and including household values

Disease category	Total males and females[1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Millions of 1975 dollars										
Infective and parasitic diseases	$ 1,642	$ 1,052	$ 177	$ 349	$ 466	$ 60	$ 589	$ 109	$ 195	$ 202	$ 73
Neoplasms	31,091	19,340	387	3,382	13,379	2,188	11,750	202	2,144	7,215	2,188
Endocrine, nutritional, and diseases	2,752	1,545	63	398	888	194	1,207	33	205	564	403
Diseases of the blood and blood-forming organs	496	284	52	104	108	18	212	29	68	79	35
Mental disorders	1,927	1,550	162	757	289	27	377	28	174	145	28
Diseases of the nervous system and sense organs	2,210	1,420	345	506	505	62	790	125	261	317	85
Diseases of the circulatory system	52,997	35,978	317	6,109	24,413	5,137	17,019	180	1,677	7,118	8,043
Diseases of the respiratory system	6,739	4,648	292	824	2,697	833	2,091	155	361	954	619
Diseases of the digestive system, oral cavity, salivary glands, and jaws	9,522	6,937	102	2,414	4,121	299	2,584	62	797	1,389	334
Diseases of the genitourinary system	1,819	983	56	301	499	125	835	31	229	354	220
Complications of pregnancy, childbirth, and puerperium	102	—	—	—	—	—	102	27	74	—	—
Diseases of the skin and subcutaneous tissue	149	75	4	23	40	7	73	4	23	27	17
Diseases of the musculoskeletal system and connective tissue	506	198	13	62	107	14	308	19	106	137	44
Congenital anomalies and certain causes of perinatal mortality	2,348	1,478	1,189	178	105	5	869	705	92	62	9
Symptoms and ill-defined conditions	3,806	2,710	565	1,025	1,015	103	1,095	194	408	368	123
Accidents, poisonings, and violence	33,136	27,381	7,338	14,142	5,651	248	5,755	1,512	2,597	1,404	240
Total[1]	151,250	105,586	11,071	30,580	54,606	9,328	45,664	3,423	9,419	20,351	12,469

Table 39. (continued) Lost future earnings, in millions of 1975 dollars discounted at 10 percent, assuming constant labor force participation rates and including household values

Disease category	Total males and females [1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Percentage distribution										
Infective and parasitic diseases	1.0	0.9	1.6	1.1	0.8	0.6	1.2	3.2	2.0	1.0	0.5
Neoplasms	20.5	18.3	3.5	11.0	24.5	23.4	25.7	5.9	22.7	35.4	17.5
Endocrine, nutritional, and diseases	1.8	1.4	0.5	1.3	1.6	2.0	2.6	0.9	2.1	2.7	3.2
Diseases of the blood and blood-forming organs	0.3	0.2	0.4	0.3	0.1	0.1	0.4	0.8	0.7	0.3	0.2
Mental disorders	1.2	1.4	1.4	2.4	1.1	0.2	0.8	0.8	1.8	0.7	0.2
Diseases of the nervous system and sense organs	1.4	1.3	3.1	1.6	0.9	0.6	1.7	3.6	2.7	1.5	0.6
Diseases of the circulatory system	35.0	34.0	2.8	19.9	44.7	55.0	37.2	5.2	17.8	34.9	64.5
Diseases of the respiratory system	4.4	4.4	2.6	2.6	4.9	8.9	4.5	4.5	3.8	4.6	4.9
Diseases of the digestive system, oral cavity, salivary glands, and jaws	6.2	6.5	0.9	7.8	7.5	3.2	5.6	1.8	8.4	6.8	2.6
Diseases of the genitourinary system	1.2	0.9	0.5	0.9	0.9	1.3	1.8	0.9	2.4	1.7	1.7
Complications of pregnancy, childbirth, and puerperium	[2]	—	—	—	—	—	0.2	0.7	0.7	[2]	—
Diseases of the skin and subcutaneous tissue	[2]	[2]	[2]	[2]	[2]	[2]	0.1	0.1	0.2	0.1	0.1
Diseases of the musculoskeletal system and connective tissue	0.3	0.1	0.1	0.2	0.1	0.1	0.6	0.5	1.1	0.6	0.3
Congenital anomalies and certain causes of perinatal mortality	1.5	1.4	10.7	0.5	0.1	[2]	1.9	20.6	0.9	0.3	[2]
Symptoms and ill-defined conditions	2.5	2.5	5.1	3.3	1.8	1.1	2.3	5.6	4.3	1.8	0.9
Accidents, poisonings, and violence	21.9	25.9	66.2	46.2	10.3	2.6	12.6	44.1	27.5	6.9	1.9
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.

[2] Less than 0.1 percent.

Table 40. Lost future earnings, in millions of year 2000 dollars discounted at 10 percent, assuming constant labor force participation rates and including household values

Disease category	Total males and females[1]	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
Infective and parasitic diseases	$ 3,871	$ 2,481	$ 418	$ 823	$ 1,098	$ 141	$ 1,389	$ 259	$ 460	$ 496	$ 174
Neoplasms	73,264	45,563	914	7,967	31,524	5,159	27,700	477	5,055	17,006	5,159
Endocrine, nutritional and metabolic diseases	6,486	3,640	150	938	2,093	458	2,845	78	485	1,331	951
Diseases of the blood and blood-forming organs	1,171	670	125	246	255	44	500	68	161	186	84
Mental disorders	4,542	3,652	383	1,785	1,417	65	889	68	410	343	67
Diseases of the nervous system and sense organs	5,209	3,345	813	1,194	1,190	147	1,863	296	617	749	201
Diseases of the circulatory system	124,877	84,758	747	14,391	57,509	12,111	40,118	425	3,953	16,780	18,959
Diseases of the respiratory system	15,880	10,951	688	1,941	6,355	1,965	4,929	365	853	2,250	1,460
Diseases of the digestive system, oral cavity, salivary glands, and jaws	22,435	16,342	241	5,687	9,708	705	6,092	148	1,881	3,276	787
Diseases of the genitourinary system	4,286	2,276	134	709	1,177	296	1,969	74	540	835	520
Complications of pregnancy, childbirth, and puerperium	241	—	—	—	—	—	241	64	177	1	—
Diseases of the skin and subcutaneous tissue	352	178	11	55	95	16	173	10	55	65	42
Diseases of the musculoskeletal system and connective tissue	1,193	467	32	147	253	34	726	46	251	323	105
Congenital anomalies and certain causes of perinatal mortality	5,534	3,484	2,802	419	248	14	2,050	1,664	219	146	22
Symptoms and ill-defined conditions	8,968	6,385	1,333	2,415	2,392	243	2,582	459	963	868	292
Accidents, poisonings, and violence	78,073	64,506	17,292	33,315	13,313	585	13,567	3,565	6,122	3,312	567
Total[1]	356,376	248,734	26,087	72,035	128,632	21,980	107,642	8,070	22,206	47,974	29,388

[1]Totals may not add up due to truncation of numbers.

Chapter 7. Economic Costs of Disability, Year 2000

In economic terms, disability is measured by the loss of working time during the year and the reduced production as a consequence of the reduced working time. Sickness also causes debility, which, while not reducing work hours, diminishes productivity. In this report we do not consider the costs of debility.

We ask, first, what is the likely extent of disability in the year 2000? The extent of disability is estimated separately for four subgroups of the population, and then the costs are added together to derive an aggregate. The four subgroups are (*a*) the currently employed population; (*b*) persons keeping house; (*c*) the noninstitutionalized people who are not in the labor force due to disease or disability; and (*d*) the population residing in institutions for the sick or disabled.

We estimate the economic costs of morbidity (exclusive of debility cost) for fiscal year 2000 at $366.1 billion at year 2000 prices and $155.4 billion at 1975 prices, using the projected GNP deflator for the price adjustment. In 1975, the estimated costs of morbidity were $57.8 billion. An estimate of the loss in production time attributable to morbidity alone amounts to about 9.4 million productive years lost.

The value of the lost work time and productivity in the economy is divided among the population subgroups as follows:

Subgroup	*1975 prices* [1]	*2000 prices* [1]
Total	$155.4	$366.1
In work force	61.0	143.8
Keeping house	23.3	55.0
Not in work force	51.9	122.2
In institutions	19.2	45.1

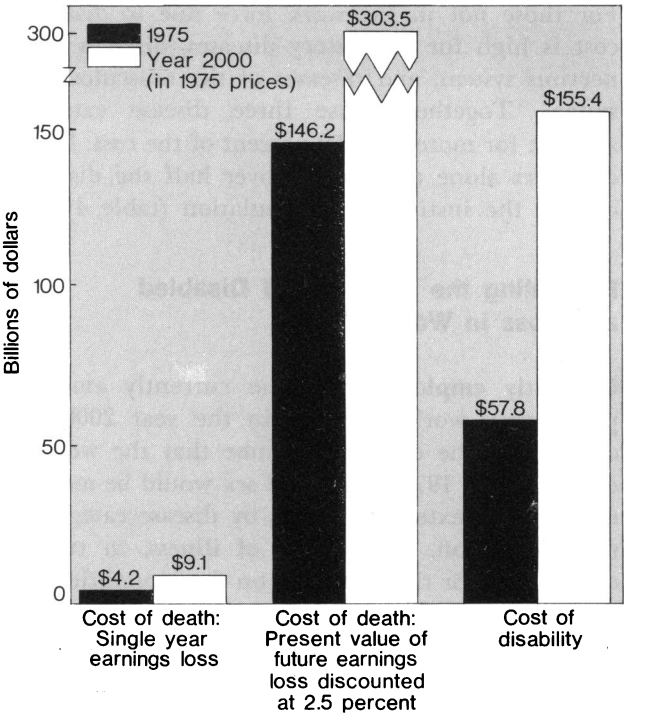
[1] In billions of dollars.

More detailed information is provided in tables 41 and 42.

These economic costs, defined as losses in earnings attributable to disability, represent 6 percent of year 2000 earnings and 4 percent of year 2000 GNP. Cost of disability, as defined, is far higher than the cost of premature death when cost of death is counted only for the single year—over 15 times as large. But disability costs are lower, about one-half the cost of death, when account is taken of the stream of earnings lost over time (fig. 9).

By disease category, the changes in the relative cost of disability between 1975 and the year 2000 are, on the whole, relatively small. Respiratory diseases, diseases of the musculoskeletal system, circulatory diseases, mental disorders, and accidents, poisoning, and violence account for about two-thirds of the total costs of disability in both years. Costs of mental disorders and of circulatory diseases are estimated to be about 2 percent lower in 2000 than in 1975. Respiratory diseases, largely due to a projected increase in the number of women smokers, are up 1

Figure 9. Cost of mortality and disability for 1975 and year 2000, in billions of dollars



percent and so is the accidents, poisoning, and violence category.

Among those in the work force, respiratory diseases are estimated to continue, even by year 2000, to account for the greatest losses in working time and earnings. Accidents, poisonings, and violence are expected to rank second and diseases of the musculoskeletal system and connective tissue third (tables 43 and 44).

Diseases that are expected to be most important in keeping women from doing their household work are respiratory diseases, diseases of the circulatory system, and diseases of the musculoskeletal system and connective tissue (tables 45 and 46).

For persons not in the labor market because of ill health but not institutionalized, diseases of the circulatory system are expected to rank first, followed by diseases of the nervous system and sense organs (tables 41, 42).

Mental disorders are expected to account for the largest share of morbidity costs of the institutionalized population despite the progress made toward deinstitutionalization of the mentally ill. Diseases of the circulatory system are expected to rank second (tables 47 and 48).

For the four subgroups of the disabled population, the diseases categories that are most important differ. For workers, diseases of the respiratory system and accidents account for almost half the total costs. For those not in the work force due to disability, cost is high for circulatory diseases, diseases of the nervous system, and diseases of the musculoskeletal system. Together, these three disease categories account for more than 50 percent of the cost. Mental disorders alone account for over half the disability cost of the institutional population (table 41).

Estimating the Numbers of Disabled and Loss in Working Time

Currently employed. For the currently employed population, work-loss years in the year 2000 were estimated. The estimates assume that the work-loss experience of 1975 by age and sex would be modified only by the extent of illness by disease category in the population. The extent of illness, in turn, is determined for the year 2000 on the assumption that disability rates by age and sex would change proportionately to death rates. The assumption of a link between death rates and cases of sickness is far from unfamiliar, but there are reasons to question seriously whether, over time, improvements in sickness rates are uniformly linked to improvements in mortality.

The assumption that the number of deaths and the number of work-loss years by condition, age, and sex would move proportionately is open to many reasonable objections. Yet a close examination of the responses of experts questioned in the PSL Delphi study predicting death rates in the year 2000 revealed that their general opinion concurred with the previous assumption (53, 54). In any case, information was not at hand that would permit an adjustment by disease category especially appropriate for each disease.

To obtain an estimate of the cost of disability loss among the currently employed, the following procedure was adopted. Estimates of the number of work-loss years by condition, age, and sex had been derived from unpublished NCHS data for our report "Costs of Illness and Disease, Fiscal Year 1975" (67). A ratio of death rates in the year 2000 to death rates in 1974 by condition, age, and sex was applied to these estimates to project work-loss years in the year 2000.

The average number of work-loss years per employed person in 1974 as modified by our death rate index by age, sex, and condition was applied to the estimate of the labor force in the year 2000. This estimate was obtained by applying 1975 labor force participation rates to the projected year 2000 population by age and sex. Two other assumptions on labor force participation rates were also used, namely, a continuing reduction in labor force participation of men aged 45 and older, and a return to earlier experience in which a larger proportion of men 45 years and older were working full-time than more recent data show. Labor force participation rates were discussed in detail in Chapter 6.

The differences in labor force participation rates for the year 2000 under the three assumptions concerning the rates for selected age groups are summarized in table 49.

Clearly, the costs of loss of productivity as a consequence of work loss attributable to diseases and injury are a function of the numbers of workers, or the proportions of persons by age and sex who have an active attachment to jobs or the job market. At constant labor force participation rates, almost half of the total cost of disability among males in the work force is the cost for those 45 years and older (table 43). Given decreasing labor force participation

rates, these costs would be lower, and at increasing labor force participation rates, they would be substantially higher.

The large difference in rates of labor force participation, especially the decreasing rates of men 65 to 74 years old, means a major set of social costs. If improvement in mortality enlarges the worker pool in the upper age groups, there may be costs in lowered productivity attributable to sickness. However, the size of such economic costs depends upon work force participation. A small increase in the average participation rates changes the costs of disability. (We would be remiss if we did not point out that it also enlarges the size of the dependent population, increases the tax burden of the Social Security programs, and has feedback effects on the incentives of the economic system.)

Individuals keeping house. For the second subgroup, individuals keeping house, loss of housekeeping services due to illness is estimated on the assumption that the best indicator of loss of capacity to function in a household is days of bed disability.

Estimates of the number of bed-disability days by age and diagnosis had been derived from unpublished NCHS data for our 1975 report (*67*). As with work-loss years, these estimates were modified by the same death-rate index to reflect changes in the prevalence of diseases by age. An average number of bed-disability days per housewife as modified by the death-rate index was then obtained. This average was applied to the number of housewives projected for the year 2000.

Two projections of number of housewives by age were made based on differences in housekeeping rates. In one estimate, work force participation rates were left constant; it was assumed that the same proportion of women would keep house as in 1975. An alternative computation assumes that the labor force participation rate of women would increase and the numbers of women keeping house and not working would accordingly go down.

The percentages of the population keeping house under these two assumptions follow:

Age group	*Constant rates*	*Increasing rate of labor force participation*
25–34 years	41	29
35–44 years	41	31
45–54 years	42	34
55–64 years	56	54

For females under age 65 keeping house, respiratory diseases are the most costly in terms of disability. For those under 25, respiratory diseases account for about one-third of the disability costs. The relative importance of the respiratory diseases drops off progressively with age (table 45). This is in marked contrast to the distribution of costs for male workers. Among them, the proportion of disability costs attributable to respiratory diseases is somewhat higher for those 65 years of age than for the younger age groups (table 43).

Noninstitutionalized population unable to work. The numbers involved in a third subgroup, namely the disabled not in the labor force and not in institutions were estimated, using 1975 experience as a benchmark. Data on the proportion of the total population unable to work in 1975 because of ill health, by age and sex, were derived from the BLS report, "Employment and Earnings," issued in January 1976 (*55*) and from the Census Bureau's "Household and Family Characteristics" (*59*). These proportions were then applied to the projected year 2000 population by age and sex to obtain the numbers unable to work in the year 2000. The assumption was made, accordingly, that in the year 2000, those in each age-sex group in the population who are not in the labor force due to ill health would approximate the current experience, except as modified to take account of actual labor force participation rates by age and sex and numbers in the working population.

Institutional population. The latest available data on the institutional population, the fourth subgroup, are from the 1970 Census. During 1970, approximately 1.7 million persons were residing in institutions because of illness. The institutional population in the year 2000 was assumed to be 15 percent less in each category than it had been in 1970. The reduction reflects the actions being taken to assure facilities and services that would facilitate deinstitutionalization; this assumes the widely held view that institutionalization is not beneficial to most patients.

We did not, in making the estimates of disability costs of the institutional population, take full account of the shifts in hospital patient loads. The disability costs attributable to mental hospitals may be unduly high, but there would be offsetting increases in costs of mental disorders for the noninstitutional population unless a preventive for mental

Table 41. Morbidity losses in year 2000, in millions of 1975 dollars, assuming constant labor force participation rates and including household values

Disease category	Total	Noninstitutional				Institutional
		Total	Currently employed	Keeping house	Unable to work	
	Millions of dollars					
Infective and parasitic diseases	$ 5,090	$ 4,358	$ 2,697	$ 1,039	$ 622	$ 732
Neoplasms	3,221	3,080	1,161	986	933	141
Endocrine, nutritional and metabolic diseases	3,916	3,533	603	487	2,443	383
Diseases of the blood and blood-forming organs	823	782	226	245	311	41
Mental disorders	20,209	8,854	2,007	975	5,872	11,355
Diseases of the nervous system and sense organs	14,181	13,516	2,575	1,459	9,462	665
Diseases of the circulatory system	20,506	17,634	3,844	2,461	11,329	2,872
Diseases of the respiratory system	24,528	24,347	15,523	5,032	3,792	181
Diseases of the digestive system, oral cavity, salivary glands, and jaws	9,455	9,239	4,992	1,493	2,754	216
Diseases of the genitourinary system	6,177	6,100	3,265	2,005	830	77
Complications of pregnancy, childbirth, and puerperium	966	966	113	853	—	—
Diseases of the skin and subcutaneous tissue	1,306	1,296	797	240	259	10
Diseases of the musculoskeletal system and connective tissue	19,747	19,116	7,242	2,642	9,202	631
Congenital anomalies and certain causes of perinatal mortality	1,090	1,069	186	157	726	21
Symptoms and ill-defined conditions	4,710	3,769	2,669	1,101	—	941
Accidents, poisonings, and violence	17,130	16,839	13,025	2,149	1,665	291
Other	2,285	1,665	—	—	1,665	620
Total [1]	155,374	136,189	60,983	23,331	51,875	19,185
	Percentage distribution					
Infective and parasitic diseases	3.3	3.2	4.4	4.5	1.2	3.8
Neoplasms	2.1	2.3	1.9	4.2	1.8	0.7
Endocrine, nutritional and metabolic diseases	2.5	2.6	1.0	2.1	4.7	1.9
Diseases of the blood and blood-forming organs	0.5	0.6	0.4	1.1	0.6	0.2
Mental disorders	13.0	6.5	3.3	4.2	11.3	59.2
Diseases of the nervous system and sense organs	9.1	9.9	4.3	6.3	18.2	3.4
Diseases of the circulatory system	13.2	13.0	6.3	10.5	21.8	14.9
Diseases of the respiratory system	15.8	17.9	25.5	21.6	7.3	0.9
Diseases of the digestive system, oral cavity, salivary glands, and jaws	6.1	6.8	8.2	6.4	5.3	1.1
Diseases of the genitourinary system	4.0	4.5	5.4	8.6	1.6	0.4
Complications of pregnancy, childbirth, and puerperium	0.6	0.7	0.2	3.7	—	[2]
Diseases of the skin and subcutaneous tissue	0.8	1.0	1.3	1.0	0.5	3.2

Table 41. (continued) Morbidity losses in year 2000, in millions of 1975 dollars, assuming constant labor force participation rates and including household values

Disease category	Total	Noninstitutional				Institutional
		Total	Currently employed	Keeping house	Unable to work	
	Percentage distribution					
Diseases of the musculoskeletal system and connective tissue	12.7	14.0	11.9	11.3	17.7	0.1
Congenital anomalies and certain causes of perinatal mortality	0.7	0.8	0.3	0.7	1.4	4.9
Symptoms and ill-defined conditions	3.0	2.8	4.4	4.7	—	1.5
Accidents, poisonings, and violence	11.0	12.4	21.4	9.2	3.2	3.2
Other	1.5	1.2	—	—	3.2	—
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.
[2] Less than 0.1 percent.

Table 42. Total morbidity losses in year 2000, in millions of year 2000 dollars, assuming constant labor force participation rates and including household values

Disease category	Total	Noninstitutional				Institutional
		Total	Currently employed	Keeping house	Unable to work	
Infective and parasitic diseases	$ 11,998	$ 10,274	$ 6,358	$ 2,450	$ 1,466	$ 1,724
Neoplasms	7,590	7,260	2,737	2,324	2,199	330
Endocrine, nutritional and metabolic diseases	9,225	8,327	1,422	1,149	5,756	898
Diseases of the blood and blood-forming organs	1,943	1,845	533	579	733	98
Mental disorders	47,618	20,864	4,732	2,298	13,834	26,754
Diseases of the nervous system and sense organs	33,410	31,849	6,118	3,440	22,291	1,561
Diseases of the circulatory system	48,287	41,554	9,062	5,801	26,691	6,733
Diseases of the respiratory system	57,817	57,391	36,596	11,862	8,933	426
Diseases of the digestive system, oral cavity, salivary glands, and jaws	22,286	21,779	11,769	3,521	6,489	507
Diseases of the genitourinary system	14,560	14,379	7,695	4,727	1,955	181
Complications of pregnancy, childbirth, and puerperium	2,279	2,279	266	2,013	—	—
Diseases of the skin and subcutaneous tissue	3,079	3,056	1,879	566	611	23
Diseases of the musculoskeletal system and connective tissue	46,534	45,052	17,144	6,228	21,680	1,482
Congenital anomalies and certain causes of perinatal mortality	2,570	2,520	439	371	1,710	50
Symptoms and ill-defined conditions	11,097	8,887	6,292	2,595	—	2,210
Accidents, poisonings, and violence	40,378	39,697	30,707	5,067	3,923	681
Other	5,385	3,923	—	—	3,923	1,462
Total [1]	366,108	320,979	143,769	54,999	122,211	45,129

[1] Totals may not add up due to truncation of numbers.

Table 43. Morbidity losses in year 2000 for the currently employed, in millions of 1975 dollars, assuming constant labor force participation rates and including household values

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Millions of 1975 dollars										
Infective and parasitic diseases	$ 2,697	$ 1,471	$ 271	$ 858	$ 248	$ 91	$ 1,225	$ 192	$ 640	$ 338	$ 54
Neoplasms	1,161	580	[1]	75	444	60	581	53	292	190	39
Endocrine, nutritional, and metabolic diseases	603	399	10	104	280	4	204	[1]	109	95	[1]
Diseases of the blood and blood-forming organs	226	103	50	27	21	4	122	10	112	[1]	[1]
Mental disorders	2,007	1,157	26	406	704	20	850	83	301	465	[1]
Diseases of the nervous system and sense organs	2,595	1,333	166	477	654	33	1,262	99	696	452	13
Diseases of the circulatory system	3,844	2,125	12	543	1,436	133	1,719	1,008	199	497	12
Diseases of the respiratory system	15,523	9,856	944	4,607	3,908	395	5,667	169	3,268	2,163	66
Diseases of the digestive system, oral cavity, salivary glands, and jaws	4,992	3,526	68	1,571	1,768	118	1,465	241	628	543	52
Diseases of the genitourinary system	3,265	1,582	12	925	607	37	1,682	130	1,026	525	[1]
Complications of pregnancy, childbirth, and puerperium	113	—	—	—	—	—	113	63	50	[1]	—
Diseases of the skin and subcutaneous tissue	797	433	158	134	82	58	363	89	201	72	[1]
Diseases of the musculoskeletal system and connective tissue	7,272	4,888	158	1,970	2,566	192	2,384	5	1,012	1,308	58
Congenital anomalies and certain causes of perinatal mortality	186	130	[1]	61	69	[1]	55	[1]	53	[1]	[1]
Symptoms and ill-defined conditions	2,669	1,444	137	574	672	60	1,225	47	541	623	13
Accidents, poisonings, and violence	13,025	10,436	1,301	4,460	4,544	129	2,588	461	1,516	603	7
Total [2]	60,983	39,468	3,319	16,798	18,011	1,339	21,514	2,656	10,659	7,880	318

Table 43. (continued) Morbidity losses in year 2000 for the currently employed, in millions of 1975 dollars, assuming constant labor force participation rates and including household values

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
	Percentage distribution										
Infective and parasitic diseases	4.4	3.7	8.2	5.1	1.4	6.8	5.7	7.2	6.0	4.3	17.0
Neoplasms	1.9	1.5	[3]	0.4	2.5	4.5	2.7	2.0	2.7	2.4	12.3
Endocrine, nutritional and metabolic diseases	1.0	1.0	0.3	0.6	1.6	0.3	0.9	[3]	1.0	1.2	[3]
Diseases of the blood and blood-forming organs	0.4	0.3	1.5	0.2	0.1	0.3	0.6	0.4	1.1	[3]	[3]
Mental disorders	3.3	2.9	0.8	2.4	3.9	1.5	4.0	3.1	2.8	5.9	[3]
Diseases of the nervous system and sense organs	4.3	3.4	5.0	2.8	3.6	2.5	5.9	3.7	6.5	5.7	4.1
Diseases of the circulatory system	6.3	5.4	0.4	3.2	8.0	9.9	8.0	38.0	1.9	6.3	3.8
Diseases of the respiratory system	25.5	25.0	28.4	27.4	21.7	29.5	26.3	6.4	30.7	27.4	20.8
Diseases of the digestive system, oral cavity, salivary glands, and jaws	8.2	8.9	2.0	9.4	9.8	8.8	6.8	9.1	5.9	6.9	16.4
Diseases of the genitourinary system	5.4	4.0	0.4	5.5	3.4	2.8	7.8	4.9	9.6	6.7	[3]
Complications of pregnancy, childbirth, and puerperium	0.2	—	—	—	—	—	0.5	2.4	0.5	[3]	—
Diseases of the skin and subcutaneous tissue	1.3	1.1	4.8	0.8	0.5	4.3	1.7	3.4	1.9	0.9	[3]
Diseases of the musculoskeletal system and connective tissue	11.9	12.4	4.8	11.7	14.2	14.3	11.1	0.2	9.5	16.6	18.2
Congenital anomalies and certain causes of perinatal mortality	0.3	0.3	[3]	0.4	0.4	[3]	0.3	[3]	0.5	[3]	[3]
Symptoms and ill-defined conditions	4.4	3.7	4.1	3.4	3.7	4.5	5.7	1.8	5.1	7.9	4.1
Accidents, poisonings, and violence	21.4	26.4	39.2	26.6	25.2	9.6	12.0	17.4	14.2	7.9	2.2
Total [2]	100.0	100.0	100.0	100.0	100.0	100.0	100.00	100.0	100.0	100.0	100.0

[1] Less than $1 million.
[2] Totals may not add due to truncation of numbers.
[3] Less than 0.1 percent.

Table 44. Morbidity losses in year 2000 for the currently employed, in millions of year 2000 dollars, assuming constant labor force participation rates and including household values

Disease category	Total males and females	Males					Females				
		All ages	Under 25	25–44	45–64	65 and over	All ages	Under 25	25–44	45–64	65 and over
Infective and parasitic diseases	$6,358	$3,468	$ 639	$2,023	$ 585	$ 215	$2,888	$ 458	$1,509	$ 797	$127
Neoplasms	2,737	1,367	[1]	177	1,047	141	1,370	125	688	448	92
Endocrine, nutritional and metabolic diseases	1,422	941	24	245	660	9	481	[1]	257	224	[1]
Diseases of the blood and blood-forming organs	533	243	118	64	50	9	288	24	264	[1]	[1]
Mental disorders	4,732	2,728	61	957	1,660	47	2,004	196	710	1,096	[1]
Diseases of the nervous system and sense organs	6,118	3,143	391	1,125	1,542	78	2,975	233	1,641	1,066	31
Diseases of the circulatory system	9,062	5,010	28	1,280	3,385	314	4,053	2,376	469	1,172	28
Diseases of the respiratory system	36,596	23,236	2,226	10,861	9,213	931	13,360	398	7,704	5,099	156
Diseases of the digestive system, oral cavity, salivary glands, and jaws	11,769	8,313	160	3,704	4,168	278	3,454	568	1,481	1,280	123
Diseases of the genitourinary system	7,697	3,730	28	2,181	1,431	87	3,965	306	2,419	1,238	[1]
Complications of pregnancy, childbirth, and puerperium	266	—	—	—	—	—	266	149	118	[1]	—
Diseases of the skin and subcutaneous tissue	1,879	1,021	372	316	193	137	856	210	474	170	[1]
Diseases of the musculoskeletal system and connective tissue	17,144	11,524	372	4,644	6,049	453	5,620	12	2,386	3,084	137
Congenital anomalies and certain causes of perinatal mortality	439	306	[1]	144	163	[1]	130	[1]	125	[1]	[1]
Symptoms and ill-defined conditions	6,292	3,404	323	1,353	1,584	141	2,888	111	1,275	1,469	31
Accidents, poisonings, and violence	30,707	24,603	3,067	10,515	10,713	304	6,101	1,087	3,574	1,422	17
Total [2]	143,769	93,047	7,825	39,602	42,462	3,157	50,720	6,262	25,129	18,577	750

[1] Less than $1.0 million.

[2] Totals may not add up due to truncation of numbers.

Table 45. Morbidity losses in year 2000 for females keeping house, in millions of 1975 dollars, assuming constant labor force participation rates

Disease category	Total	Under 25	25–44	45–64	65 and over
	Millions of 1975 dollars				
Infective and parasitic diseases	$ 1,039	$ 320	$ 461	$ 221	$ 36
Neoplasms	986	62	326	547	50
Endocrine, nutritional and metabolic diseases	487	—	209	202	75
Diseases of the blood and blood-forming organs	245	34	100	92	17
Mental disorders	975	101	370	410	92
Diseases of the nervous system and sense organs	1,459	136	627	493	202
Diseases of the circulatory system	2,461	47	638	1,273	502
Diseases of the respiratory system	5,032	1,251	2,088	1,397	295
Diseases of the digestive system, oral cavity, salivary glands, and jaws	1,493	249	636	478	129
Diseases of the genitourinary system	2,005	354	1,042	537	71
Complications of pregnancy, childbirth, and puerperium	853	440	413	—	—
Diseases of the skin and subcutaneous tissue	240	26	136	60	17
Diseases of the musculoskeletal system and connective tissue	2,642	139	1,278	1,178	46
Congenital anomalies and certain causes of perinatal mortality	157	41	107	—	8
Symptoms and ill-defined conditions	1,100	176	448	342	133
Accidents, poisonings, and violence	2,149	425	1,067	532	123
Total [1]	23,331	3,807	9,951	7,767	1,803
	Percentage distribution				
Infective and parasitic diseases	4.5	8.4	4.6	2.8	2.0
Neoplasms	4.2	1.6	3.3	7.0	2.8
Endocrine, nutritional and metabolic diseases	2.1	—	2.1	2.6	4.2
Diseases of the blood and blood-forming organs	1.1	0.9	1.0	1.2	1.0
Mental disorders	4.2	2.7	3.7	5.3	5.2
Diseases of the nervous system and sense organs	6.3	3.6	6.3	6.4	11.2
Diseases of the circulatory system	10.5	1.2	6.4	16.4	27.8
Diseases of the respiratory system	21.6	32.9	21.0	18.0	16.4
Diseases of the digestive system, oral cavity, salivary glands, and jaws	6.4	6.5	6.4	6.2	7.2
Diseases of the genitourinary system	8.6	9.3	10.5	6.9	4.0
Complications of pregnancy, childbirth, and puerperium	3.7	11.6	4.2	—	—
Diseases of the skin and subcutaneous tissue	1.0	0.7	1.4	0.8	1.0
Diseases of the musculoskeletal system and connective tissue	11.3	3.7	12.8	15.2	2.6
Congenital anomalies and certain causes of perinatal mortality	0.7	1.1	1.1	—	0.5
Symptoms and ill-defined conditions	4.7	4.6	4.5	4.4	7.4
Accidents, poisonings, and violence	9.2	11.2	10.7	6.9	6.9
Total [1]	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add due to truncation of numbers.

Table 46. Morbidity losses in year 2000 for females keeping house, in millions of year 2000 dollars, assuming constant labor force participation rates

Disease category	Total	Under 25	25–44	45–64	65 and over
Infective and parasitic diseases	$2,449	$ 756	$1,087	$ 521	$ 85
Neoplasms	2,324	147	769	1,290	118
Endocrine, nutritional and metabolic diseases	1,149	—	493	477	178
Diseases of the blood and blood-forming organs	579	82	236	218	42
Mental disorders	2,298	238	873	967	219
Diseases of the nervous system and sense organs	3,440	320	1,480	1,162	476
Diseases of the circulatory system	5,801	110	1,505	3,001	1,183
Diseases of the respiratory system	11,862	2,949	4,922	3,294	696
Diseases of the digestive system, oral cavity, salivary glands, and jaws	3,521	587	1,500	1,128	305
Diseases of the genitourinary system	4,727	835	2,456	1,267	168
Complications of pregnancy, childbirth and puerperium	2,013	1,039	973	—	—
Diseases of the skin and subcutaneous tissue	566	61	321	141	41
Diseases of the musculoskeletal system and connective tissue	6,228	329	3,012	2,776	109
Congenital anomalies and certain causes of perinatal mortality	371	98	253	—	19
Symptoms and ill-defined conditions	2,595	416	1,056	806	315
Accidents, poisonings, and violence	5,067	1,004	2,516	1,254	291
Total [1]	54,999	8,977	23,459	18,309	4,252

[1] Totals may not add due to truncation of numbers.

disorders is found. Similarly, in these indirect cost estimates we have attributed disability costs to patients in tuberculosis hospitals. Earlier in Chapter 5, we assumed the acceleration in tuberculosis hospital closings would mean the closing of almost all tuberculosis hospitals by the year 2000. However, some patients who get tuberculosis, who earlier went to tuberculosis hospitals, would show up in the institutional population and incur a disability cost.

We made the assumption that those in institutions would have been expected to have had the same labor force and housekeeping experiences as the civilian noninstitutionalized population. The following steps were thus taken to estimate the morbidity costs for this subgroup.

The population residing in institutions was classified by age, sex, and type of institution from census data. The same rates were applied to year 2000 population, except as indicated earlier, for an assumed 15 percent reduction across-the-board.

To each of these age, sex, and institution groups was applied age- and sex-specific work experience and housekeeping rates.

Productivity Loss Due to Illness and Disability

The dollar costs attributable to illness and disability require quantification of the value of time lost from work as the value of loss in production of goods and services per unit of time. In making these estimates, average earnings projected by the MPS model for the year 2000 were used as a proxy for marginal product.

Earnings, both average and full-time, in the year 2000 were estimated, taking account of the average earnings gain over the period 1975–2000, on the assumption that there would be a proportionate gain for each age-sex group.

Estimated average earnings in the year 2000 are summarized for selected male age groups in both 1975 and year 2000 prices (see table 9 for additional data).

	Average earnings (dollars)	
Age groups	*1975*	*Year 2000*
25–34 years	$24,330	$57,342
35–44 years	29,062	68,446
45–54 years	30,791	72,532
55–64 years	26,825	63,183

As a step toward the computation of productivity and earnings loss, sickness days lost from work and bed disability days were converted to aggregate days of activity lost to the economy during a year. The number of work-loss days was divided by 245 to arrive at an estimate of the number of work-loss years. For bed days used to estimate annual loss of housekeeping services, 365 days a year were used as the conversion factor; that is, the number of potential days of housekeeping services during a year.

In addition to loss of earnings in the market place, the imputed value of services in the household during the year 2000 is estimated so that the economic cost of illness and injury includes these imputed values. Earnings, as usually defined, include market place earnings only. Such market place-determined earnings exclude the value of the work that is done in the household, although the household may be viewed as a production unit.

We have extended the idea that the value of unpaid work done at home should be counted when computing the value of lost production. A detailed discussion of home production values is presented in Chapter 6. Thus, for women not in the labor force whose main work is keeping house, we computed "earnings" data, following Brody (*57*). Table 50 presents the average market place earnings of men and women in the labor force and the values computed for their unpaid work done in the home.

In addition to the average earnings, we also used full-time market place earnings to compute the value of lost production of those people currently employed. Following is a representative sample of full-time market place earnings of males and females for the year 2000.

Age group (years)	*1975 dollars*		*Year 2000 dollars*	
	Males	*Females*	*Males*	*Females*
25–34	$25,349	$16,715	$59,742	$39,403
35–44	30,656	16,382	72,243	38,618
45–54	31,656	16,597	73,924	39,124
55–64	28,621	15,808	67,426	37,268

Essentially, given the method of estimating male-female earnings and productivity, sex differences in earnings are assumed to continue, despite affirmative action to equalize wages. This assumption needs to be kept in mind as a qualification of the estimated value of work loss due to illness and injury. Increasingly, as occupations are opened to women and within occupations affirmative action is taken on opportunities for promotion, women will be working in jobs with higher productivity and earnings and, accordingly, differentials may be expected to decrease.

Morbidity Costs by Disease Category

Time lost from work and the value of that working time for each group in the population was estimated by disease category, using 17 major categories of the ICDA codes.

For those in the work force, data for 1975 from the NCHS on work-loss days, by illness condition, age, sex, and diagnosis were used. Since any particular day of disability may be associated with more than one condition, the sum of days for conditions may add to more than the total number of person days of work loss. Prior to making the adjustment in current experience to reflect projected changes by age and sex in mortality, we scaled down the number of condition days by a constant in order to equal the number of person days of work loss. This meant scaling down the number of work-loss condition days for each disease by the same constant. However, some diseases are more likely than others to be the primary reason for the work loss, and thus there may be some bias due to the use of a constant factor in scaling.

From the work-loss days derived (converted to an annual basis), when multiplied by age- and sex-specific full-time earnings, the estimates of cost by disease and age- and sex-group were obtained. By aggregating the value or cost data, we were able to estimate total morbidity costs by diseases among the currently employed population.

For the subgroup of those keeping house, much the same estimating procedure was followed. The data on number of bed-disability condition days for women were available by age and diagnosis from 1974 unpublished NCHS data. These condition days were adjusted to total bed-disability days to avoid duplication. After converting days to an annual basis, age-specific housekeeping rates and the value of housewives' services were applied to the number of bed-disability years by illness.

Source material by disease on the subgroup of noninstitutionalized population unable to work was not available. The Bureau of Labor Statistics and the U.S. Bureau of the Census do not report numbers of persons not in the labor force due to illness by specific illness. The National Center for Health Statistics advised us that its data base was not large enough to provide accurate estimates of the distribu-

Table 47. Morbidity losses in year 2000 for the institutional population, in millions of 1975 dollars, assuming constant labor force participation rates and including household values of work

Disease category	Total [1]	Nursing homes	Chronic disease hospitals	Homes for the aged	Homes for the blind and the deaf	Homes for the mentally handicapped and mental hospitals	Tuberculosis hospitals	Homes for the physically handicapped
	Millions of dollars							
Infective and parasitic diseases	$ 732	$ 51	$ 24	$ 337	—	—	$319	—
Neoplasms	141	41	20	79	—	—	—	—
Endocrine, nutritional and metabolic diseases	383	93	44	245	—	—	—	—
Diseases of the blood and blood-forming organs	41	7	3	30	—	—	—	—
Mental disorders	11,355	157	76	950	—	$10,171	—	—
Diseases of the nervous system and sense organs	665	131	63	416	$53	—	—	—
Diseases of the circulatory system	2,872	704	340	1,827	—	—	—	—
Diseases of the respiratory system	181	31	15	134	—	—	—	—
Diseases of the digestive system, oral cavity, salivary glands and jaws	216	38	18	159	—	—	—	—
Diseases of the genitourinary system	77	21	10	45	—	—	—	—
Complications of pregnancy, childbirth, and puerperium	—	—	—	—	—	—	—	—
Diseases of the skin and subcutaneous tissue	10	6	3	—	—	—	—	—
Diseases of the musculoskeletal system and connective tissue	631	104	50	429	—	—	—	$46
Congenital anomalies and certain causes of perinatal mortality	21	4	2	15	—	—	—	—
Symptoms and ill-defined conditions	941	159	77	704	—	—	—	—
Accidents, poisonings and violence	291	93	44	153	—	—	—	—
Other	620	13	6	600	—	—	—	—
Total [1]	19,185	1,661	802	6,129	53	10,171	319	46

Table 47. (continued) Morbidity losses in year 2000 for the institutional population, in millions of 1975 dollars, assuming constant labor force participation rates and including household values of work

Disease category	Total [1]	Nursing homes	Chronic disease hospitals	Homes for the aged	Homes for the blind and the deaf	Homes for the mentally handicapped and mental hospitals	Tuberculosis hospitals	Homes for the physically handicapped
	Percentage distribution							
Infective and parasitic diseases	3.8	3.0	3.0	5.5	—	—	100.0	—
Neoplasms	0.7	2.4	2.4	1.2	—	—	—	—
Endocrine, nutritional and metabolic diseases	1.9	5.5	5.6	3.9	—	—	—	—
Diseases of the blood and blood-forming organs	0.2	0.4	0.4	0.4	—	—	—	—
Mental disorders	59.2	9.4	9.4	15.5	—	100.0	—	—
Diseases of the nervous system and sense organs	3.4	7.8	7.8	6.8	100.0	—	—	—
Diseases of the circulatory system	14.9	42.4	42.3	29.8	—	—	—	—
Diseases of the respiratory system	0.9	1.8	1.8	2.1	—	—	—	—
Diseases of the digestive system, oral cavity, salivary glands and jaws	1.1	2.3	2.2	2.6	—	—	—	—
Diseases of the genitourinary system	0.4	1.2	1.2	0.7	—	—	—	—
Complications of pregnancy, childbirth, and puerperium	[2]	[2]	[2]	[2]	—	—	—	—
Diseases of the skin and subcutaneous tissue	[2]	0.4	0.3	[2]	—	—	—	—
Diseases of the musculoskeletal system and connective tissue	3.2	6.3	6.2	7.0	—	—	—	100.0
Congenital anomalies and certain causes of perinatal mortality	0.1	0.2	0.2	0.2	—	—	—	—
Symptoms and ill-defined conditions	4.9	9.5	9.5	11.5	—	—	—	—
Accidents, poisonings and violence	1.5	5.5	5.6	2.5	—	—	—	—
Other	3.2	0.8	0.7	9.8	—	—	—	—
Total [1]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Totals may not add up due to truncation of numbers.

[2] Less than 0.1 percent.

Table 48. Morbidity losses in year 2000 for the institutional population, in millions of year 2000 dollars, assuming constant labor force participation rates and including household values of work

Disease category	Total [1]	Nursing homes	Chronic disease hospitals	Homes for the aged	Homes for the blind and the deaf	Homes for the mentally handicapped and mental hospitals	Tuberculosis hospitals	Homes for the physically handicapped
Infective and parasitic diseases	$ 1,724	$ 121	$ 55	$ 794	—	—	$752	—
Neoplasms	330	97	45	187	—	—	—	—
Endocrine, nutritional and metabolic diseases	898	219	101	577	—	—	—	—
Diseases of the blood and blood-forming organs	98	18	8	70	—	—	—	—
Mental disorders	26,754	371	171	2,239	—	$23,971	—	—
Diseases of the nervous system and sense organs	1,561	309	142	982	$127	—	—	—
Diseases of the circulatory system	6,733	1,660	765	4,306	—	—	—	—
Diseases of the respiratory system	426	74	34	317	—	—	—	—
Diseases of the digestive system, oral cavity, salivary glands and jaws	507	90	41	375	—	—	—	—
Diseases of the genitourinary system	181	50	23	106	—	—	—	—
Complications of pregnancy, childbirth and puerperium	—	—	—	—	—	—	—	—
Diseases of the skin and subcutaneous tissue	23	16	7	—	—	—	—	—
Diseases of the musculoskeletal system and connective tissue	1,482	247	113	1,011	—	—	—	$109
Congenital anomalies and certain causes of perinatal mortality	50	9	4	36	—	—	—	—
Symptoms and ill-defined conditions	2,210	375	173	1,661	—	—	—	—
Accidents, poisonings, and violence	681	219	101	361	—	—	—	—
Other	1,462	32	14	1,415	—	—	—	—
Total [1]	45,129	3,915	1,805	14,446	127	23,971	752	109

[1] Totals may not add up due to truncation of numbers.

tion of illness among the population who was unable to work. For year 2000 we used the distribution of costs by disease category employed by Cooper and Rice (*56*).

For the institutional population, the allocation of costs by disease was determined by the type of institution. All morbidity losses for those in mental institutions and in homes and schools for the mentally handicapped were allocated to mental disorders. Losses for those in institutions for the blind and deaf went to diseases of the nervous system and sense organs, and those losses for the physically handicapped institutionalized population were allocated to diseases of the bones and organs of movement. Morbidity costs for residents of general chronic disease hospitals and nursing homes were classified by diagnosis on the basis of NCHS data, which show the number of residents in homes with intensive and limited nursing care, by diagnosis. Morbidity losses for residents in homes for the aged were allocated by disease category on the basis of NCHS data, which also showed the numbers in homes providing personal care and those in homes not giving such care.

The percentage distributions of patients were applied to the estimated aggregate morbidity costs to allocate costs by disease category.

A conceptual difference exists between morbidity and mortality losses. The loss to society of an individual's production by death was counted only in the year in which that death is projected to occur, the year 2000, either by counting the loss of production due to death that year or, more properly, by discounting the future losses in earnings as well as that year's present loss.

Lack of data prevented us, in other reports as well as in this one, from counting future productivity losses due to morbidity as we did mortality losses. Some illnesses with onset in the year that we study are expected to have an economic impact extending into future years. Calculations of future losses due to morbidity in the study year require information on the incidence of new cases of a disease, the expected duration, and the consequent reductions in earnings. Although information on the incidence of new cases is currently available for a number of diseases, there is not much data on expected courses of illnesses and the impact on earnings. Therefore, in this report as in the others, we have concentrated on estimating morbidity losses occurring during the year and have used prevalence rather than incidence rates.

Some Qualifications

The estimates presented are subject to many uncertainties. Perhaps the largest unknown is the progress that will be made by the year 2000 toward the reduction of disease in the population. Will scientific advances wipe out or provide cures for diseases that now cause long-term impairment such as diabetes? Or will additional scientific progress be reflected in additional lengthened, but impaired lives and in more, rather than less, sickness?

Table 49. Labor force participation rates, year 2000, under three assumptions

Selected age groups	Constant rates	Increasing rates	Decreasing rates
Males:			
35–44	.96	.96	.93
45–54	.92	.93	.88
55–64	.77	.81	.65
65–74	.30	.38	.09
Females:			
35–44	.57	.68	.68
45–54	.56	.64	.64
55–64	.40	.42	.42
65–74	.15	.13	.13

Table 50. Average earnings in the market place and home production values for the employed, year 2000, by age group

Age group (years)	Market place average earnings: 1975 dollars	Market place average earnings: Year 2000 dollars	Home production values for employed: 1975 dollars	Home production values for employed: Year 2000 dollars
Males:				
15–24	$ 8,415	$19,838	$ 613	$ 1,443
25–34	22,227	52,396	2,103	4,946
35–44	26,882	63,309	2,180	5,137
45–54	28,658	67,494	2,133	5,038
55–64	24,939	58,794	1,886	4,389
65–74	13,172	31,051	1,701	4,008
75–84	11,117	26,207	1,354	3,191
85 or older	9,656	22,762	830	1,952
Females:				
15–24	5,737	13,525	1,434	3,378
25–34	11,199	26,401	7,174	16,911
35–44	10,975	25,871	8,036	18,943
45–54	11,938	28,141	6,227	14,680
55–64	11,440	26,968	5,635	13,283
65–74	6,167	14,538	3,543	8,353
75–84	6,022	14,197	1,819	4,287
85 or older	5,897	13,900	753	1,776

Labor force participation, particularly of men older than 45 years, is also uncertain. Since the count of costs of morbidity is restricted to the loss of output of those who, in the absence of disease or injury would have been working, the extent of active labor force participation is an important cost determinant. We show optional estimates that are dependent upon the extent of labor force participation.

The ways in which household services will develop and how they will relate to the monetary economy are most indefinite. Over the past decades, as work hours per week decreased and prices of household service climbed, there have been substantial increases in do-it-yourself activities. The use of leisure time for such pursuits has had much impact on the tradeoff between work and leisure and the valuation of such leisure hours. Add to the now historic growth in do-it-yourself activities, the new move towards equality of the sexes, and the emergence of the house-husband, and there is a range of values or costs that could be counted. How these factors work and over what period alters the balance.

Prospects

The future outlook, as the projected population ages, is essentially more illness in the population. Older persons have higher rates of illness for many categories of disease including heart disease, cancer, and diabetes. Only for the acute illnesses, such as respiratory conditions, do the rates decline with age.

We may expect the higher rates of illness to be reflected in increased work loss in the economy. However, the higher rates are tempered by the economic conditions that have reduced work force participation rates of older men. A continuation or acceleration of trends toward reduced work participation lowers the projected economic costs, but the real costs of sickness tend upward unless breakthroughs are made toward disease prevention and control.

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