ECONOMIC CHANGE AND MORTALITY IN FIRST WORLD COUNTRIES
Post War to the Mid 1980s

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1. INTRODUCTION

This chapter examines the influence of national economic changes on the health of populations in industrialized countries over 1950-1985. The most fundamental discriminator of health and longevity differentials within and among populations is socioeconomic status. Socioeconomic status, based on the rank ordering of populations by skill level and income, is also the most powerful and pervasive variable in chronic, mental, infectious, trauma-related and infant/child illnesses in industrialized (and developing) countries.

The economic and sociological literature make clear that socioeconomic status differences among individuals are a by product of former and contemporaneous changes in the overall economic system. Earlier studies have identified several of the types of economic change which have influenced socioeconomic status, and thus health, over the 1950-1980 period. We now examine whether these relationships continue, and can be estimated, into the first half of the 1980s. In terms of economic change, the early-mid 1980s is a particularly difficult period. International recession combined with a sharp restructuring of many of the western industrial economies, away from manufacturing and toward service sector employment. Slow economic growth and high unemployment moving to increasingly higher levels in many industrial countries, as well as decline in male labor force participation has tended to characterize this period.

Further compounding the problem is a great reluctance in many governments to stimulate their economies for fear, it is argued, of simultaneously stimulating inflation - especially in the context of markedly increased international competition. The health and welfare sectors, which ordinarily benefit the disadvantaged, impoverished, and economically vulnerable have also been cut back in several countries as a result of diminished economic growth.

From a scientific viewpoint, it is important to ascertain the continuities and discontinuities in the structure of the relation between economic change and health. From the standpoint of policy, it is necessary to learn which national decisions significantly affect the public health.

For these purposes we examine the experience of the `Group of Seven' largest Western industrial economies - Canada, Federal Republic of Germany, France, Italy, Japan, United Kingdom and the United States. We also examine two European countries with high per capita incomes and highly developed welfare systems within Scandinavia and the European Community - namely Norway and the Netherlands. The question is whether continuous relations can be estimated between changes in the national economy and mortality rates, especially including 1980-1985.

Economic change and socioeconomic status

What has been the physical and mental health impact of the international recession of 1980-1982 in the Western industrialized countries?

To answer this question we focus first on the general relations between post-World War II recession, and overall growth, and health. We may consider these relations from within the framework of epidemiology.

The principal factor in the epidemiology of illness and overall mortality is socioeconomic status. Studies in industrialized countries conducted over the past fifteen years are uniform in showing an inverse relationship between socioeconomic status and the overall mortality rate. This relation has been measured in North America: Canada (Billette and Hill (1978), Miller (1983)), United States (Haan, Kaplan and Camacho (1987), Kitagawa and Hauser (1973), Lerner (1980), Seltzer and Jablon (1977)), Western Europe: especially England and Wales (Antonovsky (1967), Fröhlich, Great Britain Dept. of Health and Social Services (1980), Logan (1982), Liem and Liem (1979), Pamuk (1985)) and France (Leclerc, Lart and Goldberg (1984), Levy and Wilner (1976)) and the Nordic countries of Finland (Nayha (1977), Salonen (1982), Valkonen (1982)), Norway (Holme (1980)) and Sweden (Dahlgren (1982), Dahlgren and Diderichsen (1986)), and the Pacific region: Australia (Neef and Thomas (1987)), New Zealand (Pearce (1983 and 1985)) and Japan (Kagamimori (1981 and 1983)). One of the best known of the socioeconomic status health relations involves infant mortality, even in industrialized countries such as the United States (Gortmaker (1979), Lerner and Stutz (1978), Stockwell, Swanson and Wicks (1988), Stockwell and Wicks (1980), Wise (1985)), England and Wales (Pamuk (1985)) and Scotland (Forbes and Pickering (1985)). The relation has also been observed traditionally with respect to severe mental disorders (e.g. Fagin (1981), Holme (1980), Liem and Liem (1978), Sole (1962)).

Socioeconomic status is principally a byproduct of changes in the national economy - real per capita income growth, based on productivity; changes in the economic (i.e. industrial) structure; economic instability as indicated by recessions and policies relating to economic inequality. This economy-illness relationship can be found at multiple levels: individual, regional (Gardner, Crawford and Morris (1969)), and national (Preston (1976), St. Leger, Cochran and Moore (1979)). Thus, routine national economic policy decisions directly affect the population's socioeconomic level and, therefore, its health status.

There is evidence that the mechanisms through which socioeconomic status changes affect health are stress, changes in social integration patterns, increased harmful exposure to

industrial toxins, and stress-related alterations in lifestyle which includes increased consumption of alcohol, tobacco, and calories. These mechanisms can act singly or in synergistic combinations. In theory, therefore, there can be mixed effects of economic growth - and, by inference, of recession - on health. However, the overwhelming evidence shows that the benefits of economic growth dominate, in a manner that is congruent with the basic findings on socioeconomic status and health. Nonetheless, some important qualifications must be added to this generalization.

Economic growth

In general, economic growth is fundamentally beneficial to health and longevity. It provides the basis for enhanced nutrition, sanitation, transportation, climate control, and reduced injury through investment in industrial and traffic engineering. It is the basis of reduction in the physical exhaustiveness of work and the long-term reduction in working hours per week (i.e. increased leisure). Economic growth also underlies social welfare support of dependent populations - the elderly, infirm and disabled - and income support of poorer working segments of society.

Economic growth provides the basis of investment in the production and dissemination of knowledge. From a psychological view, increased real per capita income permits members of a population to be respected in their demand for valued products and services. Economic growth signals heightened personal achievement, creativity and overall mastery of environmental challenges.

Significant detrimental effects of economic growth involve adjustment to technological developments in the work place, and the migration of populations from regions of industrial decline to those of expansion. While these effects will be felt to a moderate degree in the whole society, the more severe stress implications (of work stress and lack of social integration) will be experienced by firms and individuals who have been badly hurt by recession and have a difficult time `recovering' in the early phase of the subsequent economic upturn. For many of those firms and individuals, the upturn takes the form of rather stressful `rapid growth'.

The greatest dangers to health historically arising out of economic growth (i.e. increased real disposable income) appear to involve patterns of increased consumption and production where the significance of the health risks are unknown to the population for at least a generation (tobacco, fats, alcohol, toxic chemicals).

Recession

Economic recession is indicated by increases in unemployment and business failure rates, and declines in overall income, wages, and stock market prices, and labor force participation. In general, recession has the reverse effect on health of economic growth. In the short-medium term it brings about a cluster of some of the most severe stresses that are common in modern society - occupational failure, status loss, income loss and finally, forced downward mobility.

The key problems thought to result from such stresses are: psychophysiological illness, affecting cardiovascular and immune systems (Henry (1982), Rabkin (1976 and 1982), Rozanski, Bairey, Noel and David (1988)), classic `psychosomatic' illness, i.e. perception of transient or chronic pain or ill health, in the absence of diagnosable physical illness (Mechanic (1976 and 1979)); lapse in concentration (affecting, e.g. accidents) depression, aggression and

other mental disturbances (Rabkin (1982)); and `alienation', i.e. a severe decline in motivation linked to loss, frustration and antagonism.

These psychophysiological and behavioral responses obviously threaten to greatly disrupt social functioning and, therefore, social integration, i.e. the supportive networks of family, friendships and community. However, more directly and immediately injurious to social integration is the recessional loss of jobs, and loss and financial damage to work organizations. In addition, social integration in itself is now understood to be a significant risk to physical and mental health (Brown and Harris (1978)).

Recession is also a principal source of work stress, involving major anxiety to workers and management over losses of job, career and income in a situation that they are unable to control because the economic decline is industry-wide, nationwide, or even international.

Over the long-term the output of recession is downward mobility to the population that does not fully recover during the immediately subsequent national economic `recovery'. A substantial proportion of this population will be reemployed but at a significantly lower level of job status and income (Flaim and Sehgal (1985), Horvath (1987)). Over the longer term they will suffer relative income loss as compared with their age-peers and the remainder of society who were not as injured by the recession. A major segment of this group will also need to migrate to a new employment source. They will leave behind their families and friends and their former work associates. Like themselves, many of those left behind will experience the loss of community and social integration that is crucial to social support and thus to health and longevity.

The long term health effects of recession on mortality are also indirect and stem from the well known (e.g. Cooper and Rice (1976), Levin and Wilner (1976)) impact of ill health on subsequent income deterioration. The impact of serious physical and mental health problems, stemming from recession, involves additional economic losses due to lowered job performance, discriminatory practices, continued unemployment and early retirement.

Stages of recessional impact on health

Recession can therefore be seen to do damage to health almost immediately (i.e. during recession), in the subsequent upturn, and in the medium (4-9 years) and longer (10-15 year) term.

a. During recession: loss of income and employment; fear of loss of employment, income, and damage to career among those who continue working; work stress related to loss of autonomy, closer supervision, more tense and demoralized work environment;
b. In the subsequent upturn, among the population that has not recovered from the previous recession: problems of migration/family-community dislocation in securing new employment; attempt to reintegrate into new employment setting, often at considerably lower wages, skill level and job tenure; short-medium-term downward mobility leading to acute economic inequalities between those who have not recovered and the general population that is experiencing recovery;
c. Over the longer term (if recovery does not take place for the population in question): downward mobility leading to permanent establishment of lower socioeconomic class patterns of life. The mechanisms involved in the long-term relation between recession and deteriorated health include: new incidence of physical or mental illness, resulting

from recession-induced psychophysiologic stress, leading in turn to decreased earning capacity and social contacts and, finally, to even more severe illness.

In addition, the coping mechanisms used to respond to recessional stress - such as involve family disruption, use of alcohol, tobacco and calories, and other high risk behaviors (that are psychophysiologically pleasurable in the short-term) - are harmful in acute and chronic, life-threatening illness.

Work stress in the firm damaged by recession

Firms that are damaged during recession not only experience work stress during the recession but also during the phases of the subsequent upturn (i.e. national `recovery', `expansion', and `prosperity'). If recovery is unsuccessful, but the firm is at least able to survive, then work stress tends to be increased over the long-term (10-15 years) as well.

The experience of work stress in firms that have lost heavily during recession (high proportional losses of revenues and high layoff rates) can be described according to phases of the economic cycle as follows:

a. During the recession, increased work stress is based on direct threats to survival of the firm. This includes reduced staffing; fear of unemployment, damage to career, loss of income; closer supervision of staff based on smaller margins of error; lessened social support among workers who are competing to retain employment; potential adverse changes in working conditions related to weakened position of labor.

b. Increased work intensity, during the early `recovery' phase of the economic upturn, based on financial inability of the damaged firm to hire new staff despite sharp increases in demand for output (product or services).

c. In the middle of the `expansion' phase of the upturn, after sufficient working capital is acquired and large-scale hiring is possible, we begin to observe problems of rapid integration of new employees of diverse backgrounds, skill, age, and ethnicity. The problems of coordination of work activities under these circumstances make for relatively high error and accident rates.

In addition, the difficulties of staff integration involve a situation of low levels of social support among workers. This is especially problematic because new employees will be expected to perform almost immediately - i.e. with shortened training schedules - at a high level to meet growing consumer demand. (Indeed, these new employees are hired specifically as a means of coping with the pressure of high market demand in the middle of the upturn.)

d. In the last, or `prosperity' phase of the upturn, wages tend to be relatively high, and there is more rapid investment in, and infusion of, technology - i.e. mechanization of the work process. As a result of the introduction of labor-saving equipment there may arise significant threats to the jobs of newly hired staff, and those near retirement. Those threats, however, will usually not be realized until the subsequent recession when unemployment rates again begin to rise.

2. MORTALITY, ILLNESS AND ECONOMIC CYCLES: EMPIRICAL STUDIES

The relation between recession, principally measured by unemployment rates, and elevated mortality rates has been found in many industrialized countries, over different time spans, using different models (Brenner (1976, 1979, 1979, 1980, 1980, 1983, 1984, 1987, 1987), Gortmaker (1979)). Studies over the last decade continue to reaffirm this generalization despite earlier questioning (Gravelle, Hutchinson and Stern (1981)) whether the basic relation might be

confined to: a specific time span, a single country or region, or the use of specific measures of recession, - i.e. the official unemployment rate.

The length of lag to the initial peak of mortality following recession is expected to vary according to (1) the specificity of the dependent variable (i.e. mortality/illness) by cause, age and sex, (2) the span of time covered, (3) other independent variables controlled, (4) the depth of recession during the time span analyzed and (5) the proportions of relatively high-status, and healthy, populations affected.

The first major peak of overall mortality following recession has often been found at a lag of 2-3 years. This, of course, does not mean that the relation begins at these lags. However, the relation, which frequently starts during the recession, may come to a point of greater intensity within 2-3 years. This lagged early peak effect may reflect increased inequality between those who do not recover from recession and the remaining population which is advancing in economic status. It may also partly reflect patterns of migration to new employment sources and increased work stress following recession in firms that have not recovered. Even when the initial 2-3 year peak is observed, however, more recent studies show it to be part of a longer effect of recession which runs for at least a decade for chronic diseases and overall mortality. At the same time, indices of impaired mental health, such as mental hospital admission and suicide rates, tend to show their earliest peak during recession (Brenner (1979, 1980, 1984)) although additional lagged effects continue for several years.

Among chronic disease, cardiovascular illnesses have been investigated most intensively for their relations to economic cycles. Recession, measured by increased rates of unemployment and business failures, has been found related to increases in heart disease mortality rates in nine industrialized countries (Brenner (1987), see also Brenner (1971, 1982, 1983, Bunn and Drane (1977 and 1979), Forbes and Player (1981)). Cardiovascular mortality rates have usually been found directly associated with unemployment rates at initial peaks of one year (Brenner and Mooney (1982), Brenner (1983), Forbes and Player (1981)), two years (Brenner (1971)) or three years (Brenner (1987), Bunn and Drane (1977), Bunn (1979)). The cardiovascular disease results have been remarkably consistent despite major differences in analytic methods used (Brenner (1971), Brenner and Mooney (1982), Brenner (1987)), changes in the dominance of major categories of heart disease and the rise, and subsequent decline (in several countries), of ischaemic heart disease.

Another chronic disease that has been repeatedly studied is liver cirrhosis, which is greatly influenced by habitually heavy use of alcohol. While chronic dietary use of alcohol is the principal risk to cirrhosis on a nationwide basis, the coping functions of alcohol, to economic change-induced stresses and losses, appear to play an important role. Unemployment rates are related to short- and long-term increases in cirrhosis mortality since the end of the prohibition era in the United States (Brenner (1975), Brenner and Mooney (1982), Brenner (1984)). Similar relations for cirrhosis have been found for Australia, Canada, England and Wales, Scotland, Federal Republic of Germany, France and Sweden (Brenner and Mooney (1982), Brenner (1983 and 1984)).

Infant mortality rates, traditionally understood to be sensitive to economic conditions, have similarly been related to unemployment rates, within a year or two, for the United States (Brenner (1973, 1976 and 1980)) England and Wales (Brenner (1979 and 1983)) and Sweden (Brenner (1987)). Analyses for England and Wales over 1920-1950 found similar relations of unemployment rates to infant mortality for the major causes of death (Brenner (1983)). That study and an earlier one that disaggregated the total United States infant mortality rate by age of

child (Brenner (1973)) suggest that damage results from both impaired fetal development and adverse changes in the economic environment after birth.

Suicide is the cause of death with the largest number and variety of studies in the unemployment and health literature. In many countries, including the United States, suicide rates have relatively little trend, and since the relationship with unemployment often occurs within a year`s lag, the suicide hypothesis is somewhat easier to test than others involving chronic diseases. A positive relation between unemployment and the suicide rate has been demonstrated in several studies (Brenner (1971, 1979, 1984), Henry and Short (1954), and see the extensive review by Platt (1984)), continuing a theoretical tradition that had originated with Durkheim (1951).

Analysis of suicide leads directly to other measures of mental disorder, to which a good deal of attention has been directed over the last two decades. Many of these studies (e.g. beginning with Catalano and Dooley (1977)) were stimulated to some extent by Mental Illness and the Economy (Brenner (1973)), which reported for persons under 65 a strong inverse relation between the employment rate and first admissions to mental hospitals in New York State over a span of more than 50 years, 1914-1967, and a similar relation of admissions to an index of business cycles for 1841-1909, generally with a lag of one or two years. Generally, studies of large populations over long time spans (at least 25 years) using annual data on mental hospital admissions have found the strongest direct associations between unemployment and admissions for the working-age population (Brenner (1976), Marshall and Funch (1979), Stokes and Chochran).

Unemployment as social stress

Although the health effects of high unemployment rates are not confined to the unemployed, much research has understandably focused on the particular risks entailed in the status of being unemployed. The adverse mental health consequences and short-term physical symptoms of unemployment have been the subject of study on the individual level of analysis since at least the 1930s, and have been amply reviewed (Brenner and Mooney (1982), O'Brien (1986), Warr (1987)). Stimulated in part by the macro studies and by the extent and persistence of unemployment in the 1980s, a large number of individual, or micro-level studies have been undertaken, and several have measured the longer-term strength of this relation.

The impact of unemployment would be expected to vary by sex and age, material resources, social support, occupational status, stage in career, duration of unemployment, as well as other conditional variables, i.e. aspects of culture, personality, or the social structure of the environment. Although most research deals with middle-aged men, some important exceptions include studies of women (Gardner, Crawford and Morris (1969) p.9; Brown and Harris (1978)) families (Fagin (1981)) and school leavers (Stokes (1981), Kaufman (1982)) in Britain, and the elderly in the United States. Publications have also focused on the specific experience of unemployed professionals in contrast with blue-collar workers (Kaufman (1982), Little (1976)).

A number of investigators have examined psychological aspects of unemployment: considering job loss in the context of the meaning of work to the individual, analyzing the dynamics as a process of sequence of stages, and assessing levels of depression, anxiety, self-esteem and other measures of attitude and affect (Amundson and Borgen (1982), Cohn (1978), Hill (1978), Jahoda (1979), Kaufman (1982), Warr (1982)). Attachment to work, or degree or

involvement (Warr (1982)), is a theme developed by Froehlich (Gardner, Crawford and Morris (1969)) as a contrast between an expressive and an instrumental orientation to work. He hypothesizes that instrumentally-oriented unemployed workers will suffer less from unemployment than those with expressive orientations, for whom work is an end in itself.

Duration of unemployment is a critical condition repeatedly cited, but not as often analyzed. The early work of Cobb and Kasl (1977) documented important physiological response to anticipation of unemployment before the job loss actually occurs. Local levels of unemployment operate as conditions for individual responses to unemployment, as can be inferred, for instance, from Colledge's (1981) study of the health affects of unemployment in the relatively depressed area of North Tyneside or Stoke's study (1981) of unemployment among school leavers. The regional orientation of Rayman and Bluestone's (1982) study of the Hartford aircraft industry again acknowledges the importance of the context of economic and social conditions.

The unemployment-health relation is often interpreted as a problem of social stress, with the experience of unemployment itself, as well as associated losses of income and changes in living habits, understood as stressful life events (e.g. Liem and Liem (1979)). Leaving aside some considerable measurement issues, investigators have identified many characteristics of stressful events that influence their health consequences (Rabkin and Struening (1976)). Of course, magnitude, duration, predictability, and controllability (Matthews and Glass (1981), Rabkin and Struening (1976)), are of particular relevance to unemployment research. Among the contextual variables (Dohrenwend and Dohrenwend eds. (1981)) receiving the most attention as modifiers or buffers of social stress are social networks and social support (Berkman (1980), Cobb (1976), Gore (1981), Hamburg and Killilea (1979), Liem and Liem (1979)).

Studies of unemployment at the individual level have basically confirmed findings observed earlier at the national level, both in terms of types of health responses and lag relations. Most recently, in the United States the study emphasis has been on anxiety, depression and general health (Kessler, House and Turner (1987), Linn, Sandifer and Stein (1985)) and on psychophysiological responses and learned helplessness (Baum, Raymond and Reddy (1986)). Canadian reports have focused on psychological distress and health services utilization (D'Arcy (1986)).

The most precise analyses of causal relations linking unemployment and morbidity and mortality rates are found in the United Kingdom. Studies by Moser et al. (Moser, Fox and Jones (1984), Moser, Goldblatt, Fox and Jones (1987)) have shown a long term (i.e. at least ten-years cumulative lag) effect of unemployment on elevated mortality rates controlling for social class. They find that both unemployed male subjects and their wives show significantly elevated mortality rates in relation to the unemployment of the men. They further are able to determine that the adverse effects of unemployment, rather than initial poor health of those who become unemployed, account for the excess mortality of the unemployed. These analyses have been supported by cross-sectional studies showing substantial differences in the prevalence of illness among the unemployed compared to the employed (Arber (1987), Cook et al. (1982)).

Work stress

The research literature leads one to believe that the principal effect of unemployment and business failures is on those who actually lose employment and on their families. It is probably also true that a substantial effect of increased unemployment rates is on those who continue to work in economically damaged firms, with fear of employment loss and increased work stress. Among the more stressful characteristics of work, the following are potentially relevant during the downturn and early recovery: quantitative work overload associated with increased demand for productivity; the combination of time pressure and responsibility (Kahn (1981)); expectation-resource discrepancies, including inadequate information (Kahn and Quinn (1970)); decline in worker control (Nerell and Wadlund (1981)); decline in group support among workers; and inadequate financial reward for work done (Lazarus (1981)).

3. 1980-1982 RECESSION AND ITS AFTERMATH

We now wish to observe whether the standard relations can be observed beyond 1980, and especially include the 1980-82 recession and its `recovery'. If so, then the short-term effects of 1980-82 loss/anxiety/tension, etc. will be supplemented by the cumulative effects of previous recessions so as to produce the total health effect we measure during 1980-1982.

In addition, the specific recession of 1980-82, and particularly its `recovery/expansion' aftermath, have special characteristics. As indicated earlier, an important traditional feature of recession is that it is accompanied by increased economic inequality. The initial reason for this is that while in general the population is losing in per capita real income, an important minority is losing heavily - especially as a result of increased unemployment and business failures. A second reason is that much of the population that loses heavily during recession does not fully `recover' during the national recovery phase of the economic upturn. This means that the non-recovering population finds itself in a situation of increased economic inequality in relation to the population majority whose incomes are increasing sharply during the upturn. At any rate, in general the population inequality decreases during recession and declines with increased, and sustained, economic growth.

The classically expected decline in inequality, however, did not occur after the 1980-82 recession. Instead, after 1982 in Western Europe (and even Canada and Australia), unemployment either stabilized or continued to increase, thus greatly increasing economic inequalities (Organization for Economic Cooperation and Development (1987), Sachs (1983)). In the United States, where unemployment fell after the recession, inequalities increased (Bluestone and Harrison (1982), Dooley and Gottschalk (1985), Hamburg and Killilea (1979)) as a result of wage declines (Council of Economic Advisers (1988)). The sustained European unemployment and depressed real wage growth (Sachs (1983)), and declining American wages, are understood to have had, in part, similar origins; namely, the large-scale decline in manufacturing employment (Bluestone and Harrison (1982), McKersie and Sengenberger (1983), Neef and Thomas (1987)). Manufacturing employment declines in the Western industrialized world have been related to (Amundson and Borgen (1982)) increasingly rapid mechanization of work (e.g. Bekemans ed. (1982)) especially associated with computer integration, (Antonovsky (1976)) increased competition from manufacturers in newly industrialized countries with lower labor costs and (Arber (1987)) export of capital (i.e. investment) from industrialized countries to subsidiaries, or independent manufacturers, in newly as well as other highly industrialized countries.

Adding further to economic inequalities has been the new dominance of monetarist macroeconomic policy which, especially in much of Europe, has permitted the use of high unemployment rates (resulting from high interest rates) to be the principal instrument for maintaining low rates of inflation (Solomon ed. (1984), Thurow (1985), Tobin (1986)). Equally damaging in several countries in Western Europe and North America, social welfare budgets have declined partially in response to slower economic growth and to profound ideological changes in attitude toward social equity (Brown ed. (1988), Organization for Economic Cooperation and Development (1981)).

In sum, the 1980-82 recession served to increase inequalities which were further accelerated in the subsequent recovery/expansion in much of the Western industrialized world. The pattern of increased overall inequality, in the face of the upturn following the largest recession since the great depression of the 1930s, represents a break in the historic incidence of inequality in relation to the economic cycle. This matter is of essential importance to health, since it is precisely inequality (or the socioeconomic status differential) that is epidemiologically related to adverse health outcomes.

Variables and lag patterns

We wish to take into account three basic elements which have a bearing on socioeconomic status differentials and their relation to health: (1) economic growth, (2) economic instability (recession, rapid economic growth and their consequences) and (3) economic inequality (influenced by recession, structural change and social welfare expenditures). We therefore examine the following economic indicators: per capita real disposable income, wage rates, unemployment rates, labor force participation rates, business failure (i.e. bankruptcy) rates, and stock market prices (in economies in which they are especially prominent, e.g. Japan, United States).

These indicators express the multidimensional aspects of economic change for both firms (e.g. performance in relation to work stress) and individuals (e.g. alterations in employment and earnings patterns). In particular, with respect to the 1980-82 recession and its aftermath in Western Europe, unemployment increases and labor force participation declines are especially indicative of economic inequality. In the United States, on the other hand, unemployment and business failure rates are particularly expressive of the early 1980s recession, while continuing high business failure rates in specific industries (e.g. agriculture, banking) and declining wage rates reveal the basis of expanding post-recession inequality. The fact that we are able to include - and thus control for - several economic indicators in the models means that such factors as unemployment then become more precisely literal measures rather than proxies for other economic phenomena that are related to the business cycle.

It is necessary to control for changes in consumption and production patterns that are linked to economic changes (and may partially mask their effects). We therefore include in the model per capita consumption of alcohol (by beverage type), cigarettes and fats. Also included are chemical production and national health care expenditures where these data are readily available.

For the economic indicators, short-, medium-term and long-term relations to health over approximately 0-3, 4-9 and 10-15 years lag are expected, based initially on the phases of the business cycle (loss/gain, anxiety/optimism, workload, etc) and lengthier developments dependent on economic growth (socioeconomic advancement verses downward mobility). In some countries, however, where the impact of the recovery period (immediately following

recession) may be especially damaging (e.g. United States), the uniform lag relations (in which the entire lag structure shows the same positive or negative sign for variables such as unemployment) may not begin until two or three years after the peak of recession (Brenner (1984)).

The lag relations to mortality outcomes for the consumption factors of alcohol, tobacco and fat also involve short, medium and long periods. Epidemiologically, lengthy periods of at least 0-15 years would be required to represent the cumulative relation of these forms of consumption to the development of chronic disease - the major sources of 55-64 mortality. While such lags are expected for all three types of consumption, specific alcoholic beverages (especially spirits) are often found to have especially harmful effects at short lags (e.g. in suicide, homicide, accidents, hypertension, cirrhosis).

Multivariate time series approach

A time-series regression approach is required because lengthy as well as short lags must be estimated, and effects of multiple variables must be included in each equation. Further, we need to estimate distributed lagged effects, cumulatively over several years (Kmenta (1986), Judge et al. (1985)). Since typically between five and ten major predictive variables are involved, it is necessary to use a distributed lag estimation procedure that expends a minimal number of degrees of freedom. An appropriate procedure is the Shiller technique which is based on a prior specification of the smoothness (of the weighting) of the lag structures (Shiller (1973)). In the Shiller procedure one degree of freedom is expended for each explanatory variable, regardless of length of lag.

Principal hypotheses, then, relate to extent (i.e. range) of lag structure and signs of the relationships. In the case of this study a stepwise approach is taken in which one variable (with its full lag structure) is entered into the equation at a time. This permits us to observe whether the hypothesis as to lag structure is exactly correct or whether some modification of the specified range is required if the variable is to be statistically significant and have the same sign in all of its lags. The procedure of only accepting lag structures with uniform signs helps to minimize the common time-series problem of alternating signs in lag relations due to serial correlation (i.e. correlation among lagged values of the same independent variable).

An important potential constraint in our procedure relates to the fact that, on theoretical grounds, a lag length of at least 0-15 years may be hypothesized for the relation of e.g. fat consumption to mortality rates. The testing of this hypothesis requires data on fat consumption starting fifteen years before the beginning of the mortality series (i.e. over 1935-1985, since the mortality is examined over 1950-1985). To the extent that data on explanatory variables are unavailable in the fifteen years prior to 1950, the analysis is constricted for the explanatory variable in question. (see table for data availability.)

Findings

Relations between economic changes, other epidemiologic risks, and 55-64 mortality rates are presented in **tables 1-8** and **figures 1-8**. Analyses for the Netherlands are given in chapter 12 in this volume (Brenner (1989)). The basic equations shown in this chapter (tables 1-8) are used to account for annual changes (i.e. first differences) in the mortality rates. The annual change

models are emphasized in this chapter because we wish to be certain that each year's change in mortality has been subject to analysis; a contrasting approach might examine only the broad trends in mortality rates. **Figures 1-8** graphically indicate which specific year's changes are well accounted for by the model and which are not.

These annual change models can be translated, with nearly identical elements, to a form that will then account for movements in the original time series of mortality rates as they are normally plotted. Examples of the latter are **table 9** and **figure 9** for Japan (cf. the annual change model in **table 5** and **figure 5**) and **tables 1** and **figure 1** in the analysis of the Netherlands' mortality (Brenner (1989)).

We now examine the influence of each of the explanatory factors on 55-64 mortality rates in the nine countries under study.

Income

In all nine countries the basic inverse relation between per capita real income and mortality is observed. It is a cumulative relation of income changes ranging over 0-18 years, but more typically 0-14 years. However, in two countries, the Federal Republic of Germany and Norway, the longest observed lag is eight years. The lag relation starts at the zero year (i.e. mortality increases within the same year that income falls) in four countries (France, Norway, Japan, United States) at one year's lag in the United Kingdom, and at two year's lag in Canada and the Netherlands.

Wages

In addition to the inverse relation for per capita income found in all nine countries, an inverse relation is also found for wages in six countries. In three countries (France, Italy, United States) lag structures are long and robust, much like the relations for income per capita. In Japan only a medium-term relation, and in Canada and Norway only short-term relations, can be measured.

This finding appears to support the inequality hypothesis, based on the observation, in some countries (notably the United States), that wage levels had sharply diverged from per capita family income - the latter rising since 1982 and the former stable or declining. The difference between the trends in per capita income and wages partly reflects the distinction between one as against two principal earners per family - i.e. via the entrance of women into industry (especially service) in large numbers.

It should be kept in mind, at the same time, that a number of other factors separate wages from per capita disposable income. In many countries non-wage incomes are between 30 and 40 percent of personal income (e.g. in the United States non-wage income represented an average of approximately 38 percent of personal income over 1939-1986). Non-wage income includes transfer payments, interest, dividends, rent and property income. In addition, per capita disposable income is distinguished from wages by the fact that it does not include taxes while wages do. The overall set of differences between per capita disposable income and wages results in an average .40 to .55 percent explanation of variance between them in annual changes (first differences).

To be further assured that (higher) wages make an additional contribution to reduced mortality we can introduce per capita income and wages at different levels (i.e. second versus

first differences) so as to further minimize multicollinearity. In that case, both variables continue to show statistical significance as is seen in Canada, Japan, Norway and United States, and can be demonstrated in France and Italy. Altogether, where wages are statistically significant, they do not conflict with per capita income or other independent variables; rather, without wages the significant levels of individual explanatory factors, and overall F and R^2 for the total equation are lower.

Unemployment rates

In all countries short-, medium- and long-term positive and significant relations can be measured, over a range as long as 0-15 years; but the typical lag length is approximately 12-14 years. The lag relation begins at year zero in four countries (France, Italy, Netherlands and the United Kingdom), at one year in the Federal Republic of Germany and Japan and at three years in Canada, Norway and the United States.

Labor force participation and business failure rates

Labor force participation (inverse relation to mortality) and business failure (i.e. bankruptcy) rates (positive relation to mortality) appear to be somewhat competing indices, and typically those countries in which labor force participation is found significant over short-, medium- and long-term lags, `business failures' is not; where business failures are found significant over the full range of lags, labor force participation is not. Two exceptions are Italy and Japan where both are significant over extensive lag periods.

Labor force participation is significant and negatively related to mortality in six countries: France, Italy, Japan, Netherlands, Norway and the United Kingdom. `Business failures' is significant and positively related to mortality in six countries as well. However, in four - Canada, Federal Republic of Germany, Japan, United States - the fully extended lag structure can be observed while in France and Italy only the shorter lags can be estimated (over 0-4, 0-5 years respectively).

Stock market

Stock market index data, broadly measuring national business performance, were examined in Japan and the United States for relations to mortality. The relations were found in the hypothesized direction (negative sign) over a broad range of lags; the observed range is 1-16 years in Japan and 3-11 years in the United States.

Consumption factors

1. Cigarette Consumption
   Found in all countries to be associated with increased mortality, the relation for cigarette consumption is typically over 5-15 years of lag, sometimes as long as 17 or 18 years. In one country the effect could not be measured later than eight years (Federal Republic of Germany) and in that country the relation can be observed as early as zero lag.
2. Alcohol Consumption

In seven of the nine countries positive relations are found for alcohol consumption over the medium-long term. Japan did not show the relation. That relation can be as long as 15 or over 20 years (Canada, Federal Republic of Germany), and can begin as early as zero or one year's lag (United States, Netherlands). Effects of wine are seen only in Canada (0-7 years), France (1-15 years) and Italy (1-20 years). For spirits, extensive lags are seen for the United States (1-9 years) and the Federal Republic of Germany (3-12 years), and over the short term (0-2 years) for Canada and the Netherlands.

3. Fat Consumption
   Fat consumption, examined in eight countries, was found significant in all countries typically over at least a decade. In the case of Japan, fish consumption was investigated instead because of its hypothesized beneficial effects in cardiovascular disease and, unlike most of the western countries, is the traditional source of animal protein and fat. An inverse relation to mortality was found for fish consumption per capita in Japan over 0-16 years.

Chemical production

In two countries, Japan and the United States, chemical production per capita was investigated for presumed effects in cancer, respiratory and metabolic disease. Relations were found at 0-10 and 1-10 years for Japan and the United States respectively.

Health care expenditures

Again, in Japan and the United States, national health care expenditures per capita were tested over 0-15 years. In the United States a beneficial (negative) relation to mortality was found over 0-13 years while in Japan it was found over 4-11 years.

Summary of findings

Using several different indicators of the state of the economy, all nine countries show the relation between recession and mortality in the 55-64 age group from the early 1950s to 1985. It is a continuous cumulative relation, comprising short, medium and long lags within a broad structure involving a length of approximately 0-15 years. This means that recession has a long-term effect on socioeconomic status, and therefore on health, that continues for more than a decade. It also means that the economic climate in each of the intervening years has a moderating effect on the final outcome. At the same time, stable economic growth is the major source of mortality decline in the post-war era.

The two basic variables by which this relation can be measured are real per capita income (inverse relation) and the unemployment rate (positive relation). In addition to income in the majority of countries examined, the wage rate exerts a beneficial effect which may reflect changes in the magnitude of economic inequality. Supplementing the unemployment rate relations to mortality are those for labor force participation (inverse relation) in a majority of countries, which indicate movement completely, and immediately, out of the formal economy. Similarly, in the majority of countries, the business failure (i.e. bankruptcy) rate has an extensive relation to mortality; the full relationship, however, is measured most readily in those countries in which labor force participation is not already part of the equation. Therefore, measurement of the relation between recession and mortality requires at least the inclusion of

income and unemployment; it must be supplemented in many countries by labor force participation, business failures, or both; in several countries it requires changes in real wages as well.

There is also abundant evidence for the inclusion, in our models, of the influence of tobacco, alcohol and fat consumption over extended lag periods. Failure to do so can lead to under- or overestimation of the impact of economic changes on mortality.

4. CONCLUSIONS

The relationship between national economic changes and mortality has been estimated, for many industrialized nations, until 1980. The classic finding is that adverse changes in the economy, such as unemployment, are related to contemporaneous and subsequent mortality increases while improvements in the standard of living are related to short- and long-term mortality declines.

These relationships are now examined over the post World War II period extending to 1980-1985 for various industrialized countries. The countries examined include the `Group of Seven' major industrial economies, namely, Canada, Federal Republic of Germany, France, Italy, Japan, the United Kingdom and the United States as well as Norway, representing an example of the Scandinavian experience, and the Netherlands, in honor of the Conference held at Erasmus University Rotterdam.

Mortality in late middle age (55-64 years) was analyzed because it is comparatively high in the economically active population, but frequently preventable. The basic findings are similar across countries: increases in national income per capita and wage levels are related to mortality rate declines; increased unemployment and decreased labor force participation are related to short- and long-term mortality increases; business failure increases and stock market declines are related to relatively rapid increases in mortality. These relationships control for the effects, on mortality, of traditional epidemiologic risk factors; specifically, per capita cigarette, alcohol and fat consumption are positively related to mortality over a 0-15 year period.

It is clear that national economic policies which result in increased economic inequality due to increased unemployment, decreased labor force participation or decreased wage rates are related to higher mortality. Similarly, policies which maintain recessional rates of business failure and stock market prices are related to increased mortality. National economic policy to promote economic growth and minimize economic inequality thus are among the most important health policies. These findings are supported, and interpreted, by the fact that low socioeconomic status is one of the most consistent epidemiologic predictors of high mortality rates - even in industrialized countries with highly developed welfare systems.

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Table 1. Time series multiple regression total mortality rates: 55-64
Canada, 1951-1985; annual changes

	Order of entry of variable	Lag*** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income[+] per capita	2	2- 12	-.26250-04	.3128E-05	-8.3939
Wages[+] per capita*	6	0- 2	-.5479E-04	.15598-04	-3.5127
Unemployment rate	8	3- 12	.17020-01	.1174E-02	14.4921
Business failure rate	7	0- 8	.2268E-03	.3866E-04	5.8657
Consumption					
Spirits per capita	5	0- 2	.3066E-01	.1023E-01	2.9984
Wine per capita	4	0- 7	.1355E-02	.6183E-03	2.1911
Beer per capita	3	2- 15	.4514E-02	.3730E-03	12.1038
Cigarettes per capita	1	7- 14	.1387E-03	.7752E-05	17.8973
Other controls					
Constant			-.3208E-01	.1446E-02	-22.1870
RHO**			.2637	.2045	1.2898

R^2 .9681 $R^{\wedge 2}$	.9567
Durbin-Watson	1.9818
F (8, 25) =	94.91895

[+]Adjusted for inflation.
*Second Differences; mortality rate and other independent variables are transformed to first differences.
** Iterative Search procedure used to minimize residual autoregression.
*** Shiller distributed lag estimation.

FIGURE 1
Annual changes in mortality rates and fit of annual change model (table 1)
Ages 55-64 (Canada 1951-1985)

Actual vs fitted mortality

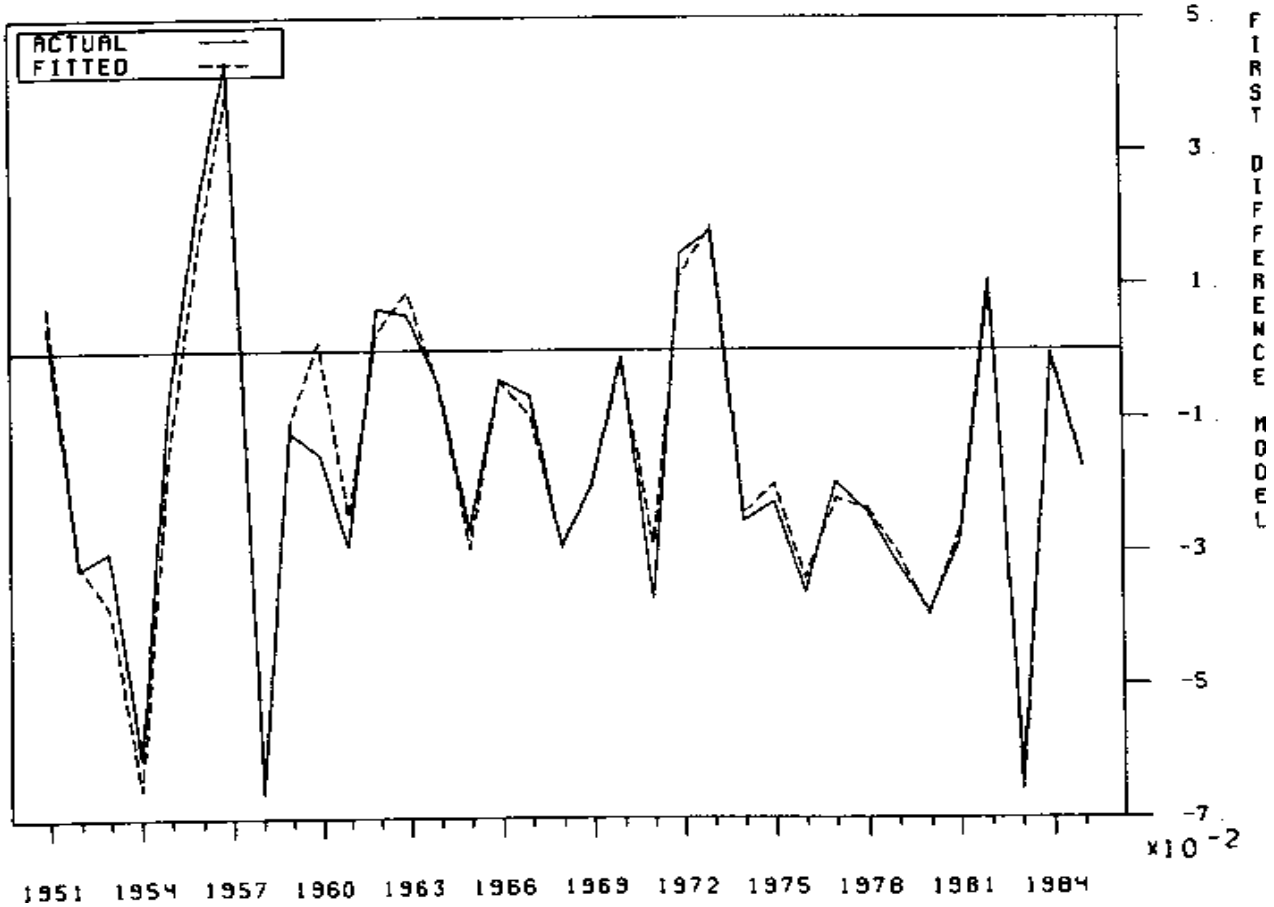


Table 2. Time series multiple regression total mortality rates: 55-64
Federal Republic of Germany, 1955-1985; annual changes

	Order of entry of variable	Lag** (years)	Coefficient	Standard error	T statistic
Economic					
National income+ per capita*	3	2- 8	-1.2574	.2633E-01	-47.7599
Unemployment rate	5	1- 15	.5585	.4036E-01	13.8381
Business failure rate*	4	2- 20	103.7640	2.4097	43.0612
Consumption					
Spirits per capita*	6	3- 12	5.5909	.2631	21.2540
Beer per capita*	7	4- 24	.5990E-01	.3432E-02	17.4556
Cigarettes per capita*	2	0- 8	.9811E-02	.2872E-03	34.1640
Fat per capita*	1	1- 13	.63454-02	.1053E-03	60.2823

R^2 .9960 $R^{\wedge 2}$ .9950
Durbin-Watson 1.9007
F (7, 24) = 857.6008

+Adjusted for inflation.
* Second Differences; mortality rate and other independent variables are transformed to first differences.
** Shiller distributed lag estimation.

FIGURE 2
Annual changes in mortality rates and fit of annual change model (table 2)
Ages 55-64 (Federal Republic of Germany 1955-1985)

Actual vs fitted changes in mortality

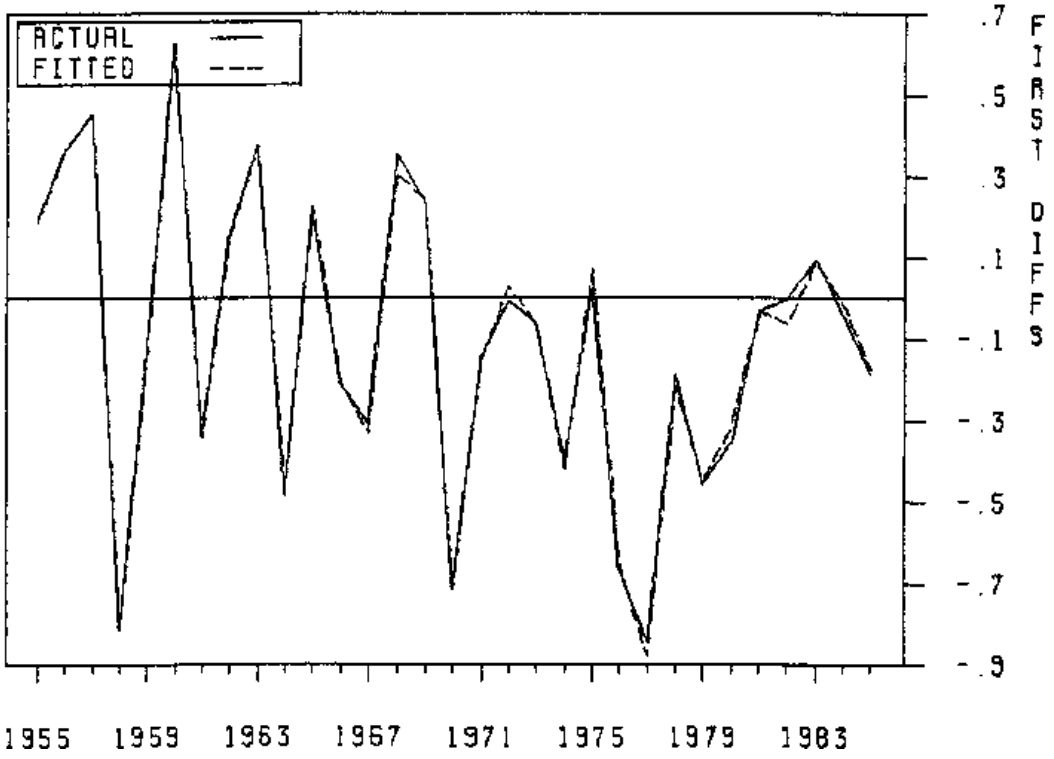


Table 3. Time series multiple regression total mortality rates: 55-64
France, 1951-1985; annual changes

	Order of entry of variable	Lag** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income+ per capita	6	2- 11	-.1607E-06	.1773E-07	-9.0660
Wages+ per capita	3	3- 14	-.1020E-02	.1560E-03	-6.5362
Labor force participation rate	5	0- 13	-.8274E-02	.1067E-02	-7.7546
Unemployment rate	7	0- 15	.8682E-01	.8922E-02	9.7312
Business failure rate	2	0- 4	.2301E-03	.3148E-04	7.3078
Consumption					
Wine per capita	1	1- 15	.1389E-01	.2953E-03	47.0368
Cigarettes per capita*	4	3- 12	.7488E-03	.9917E-04	7.5509
Fat per capita	8	4- 10	.3218E-04	.1714E-04	1.8773

R^2 .9897 $R^{\wedge 2}$ .9871
Durbin-Watson 1.9307
F (8, 27) = 325.5738

+Adjusted for inflation.
* Second Differences; mortality rate and other independent variables are transformed to first differences.
** Shiller distributed lag estimation.

FIGURE 3
Annual changes in mortality rates and fit of annual change model (table 3) Ages 55-64 (France 1951-1985)

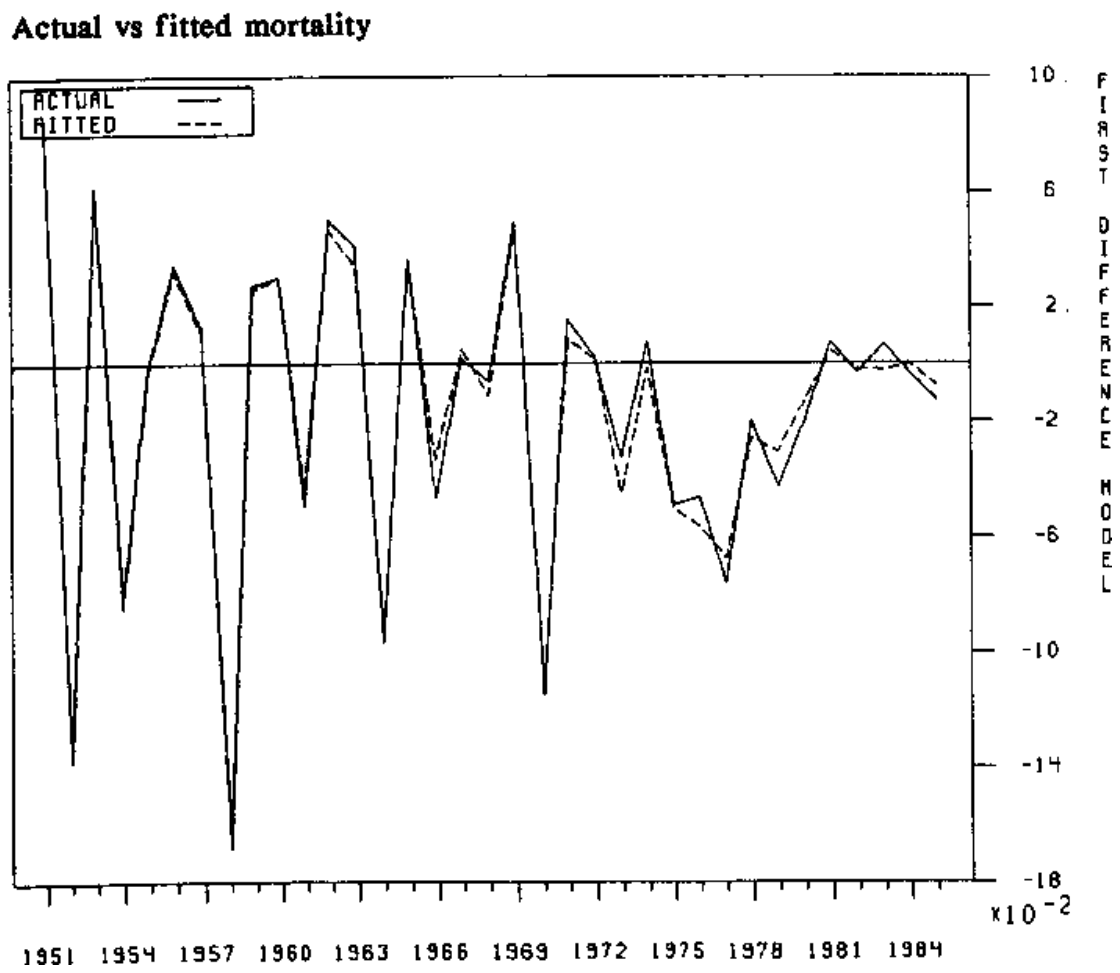


Table 4. Time series multiple regression total mortality rates: 55-64
Italy, 1953-1984; annual changes

	Order of entry of variable	Lag*** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income+ per capita	3	2- 11	-.4068	.3704E-01	-10.9818
Wages+ per capita	8	1- 10	-.1070	.4974E-01	-2.1526
Labor force participation rate	9	0- 20	-4.4275	1.1778	-3.7590
Unemployment rate	1	0- 13	.8788E-01	.8760E-02	10.0322
Business failure rate	5	0- 5	.4288E-02	.1369E-02	3.1329
Consumption					
Wine per capita	2	1- 20	.5939E-01	.2263E-02	26.2446
Beer per capita	6	2- 14	.8614E-01	.9745E-02	8.8485
Cigarettes per capita	4	6- 17	.2904E-01	.4620E-02	6.2845
Fat per capita*	7	5- 15	14.4546	5.1709	2.7954
Other controls					
RHO**			-.5829	.1733	-3.3638

R^2 .9856 $R^{\wedge 2}$ .9797
Durbin-Watson 2.2206
F (9, 22) = 167.48

\+ Adjusted for inflation.

* Second Differences; mortality rate and other independent variables are transformed to first differences.

** Beach-McKinnon transformation used to minimize residual autoregression.

*** Shiller distributed lag estimation.

FIGURE 4
Annual changes in mortality rates and fit of annual change model (table 4)
Ages 55-64 (Italy 1953-1984)

Actual vs fitted mortality

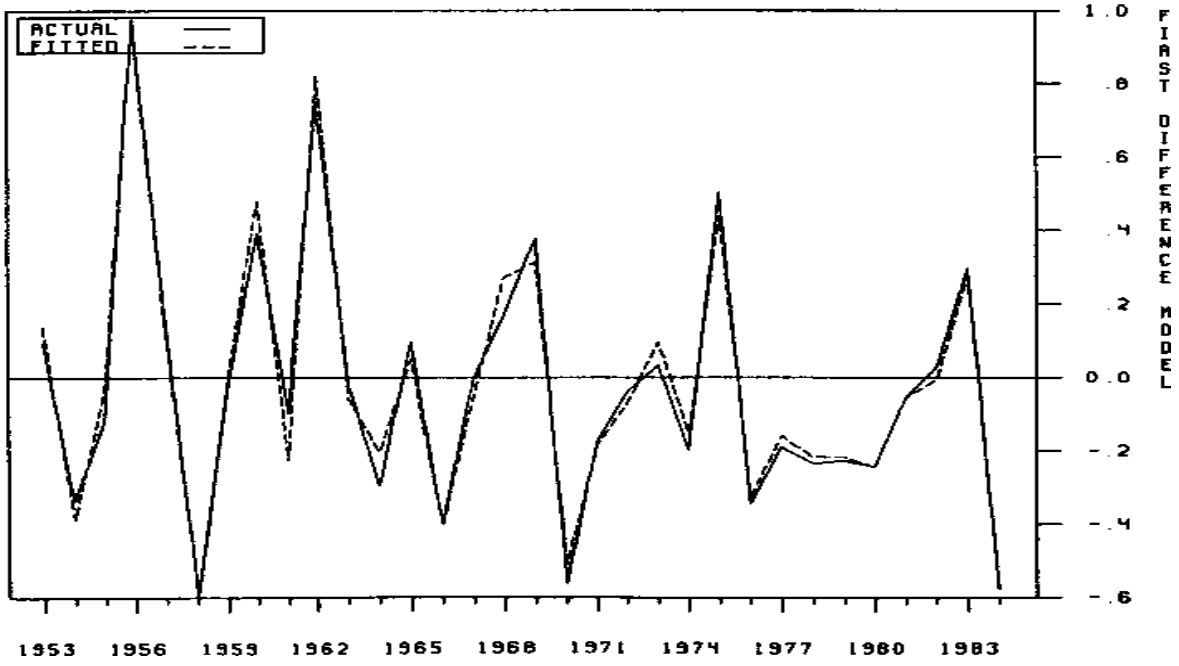


Table 5. Time series multiple regression total mortality rates: 55-64
Japan, 1950-1985; annual changes

	Order of entry of variable	Lag*** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income+ per capita*	8	0- 14	-.3084E-01	.9368E-02	-3.2922
Wages+ per capita	2	5- 9	-.3333E-02	.3017E-03	-11.0466
Labor force participation rate	10	0-18	-10.4590	5.3364	-1.9599
Unemployment rate	1	1- 16	30.9060	1.5668	19.7250
Business failure rate*	3	0- 13	30.4745	3.5261	8.6427
Stock market index+*	9	1- 16	-.5579E-03	.1463E-03	-3.8128
Consumption					
Cigarettes per capita*	5	7- 16	27.0567	3.3113	8.1716
Fish per capita*	4	0- 16	-7.4883	1.6303	-4.5932
Other controls					
Chemical production per capita*	6	0- 10	1.0380	.1346	7.7256
Health expenditure+ per capita*	7	4- 11	-6.6343	1.7385	-3.8162
Constant			-.7698E-02	.1451E-02	-5.3043
RHO**			-.3114	.2051	-1.5179

R^2 .9710 $R^{\wedge 2}$	.9578	+	Adjusted for inflation.
Durbin-Watson	2.3293	*	Second Differences; mortality rate and other independent variables are transformed to first differences.
F (11, 24) =	80.4998	**	Beach-McKinnon transformation used to minimize residual autoregression.
		***	Shiller distributed lag estimation based on smoothness priors.

FIGURE 5
Annual changes in mortality rates and fit of annual change model (table 6)
Ages 55-64 (Japan 1950-1985)

Actual vs fitted changes in mortality

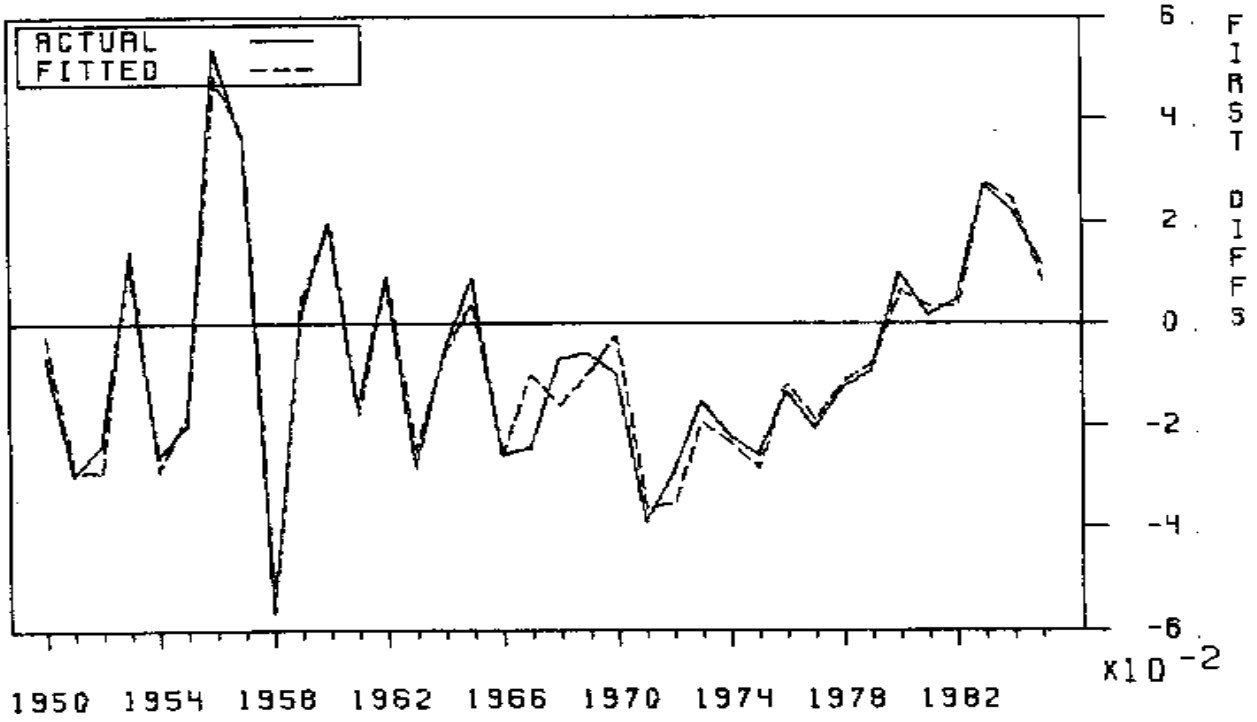


Table 6. Time series multiple regression total mortality rates: 55-64
Norway, 1950-1985; annual changes

	Order of entry of variable	Lag*** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income+ per capita*	6	0- 8	-.2219E-01	.3375E-02	-6.5742
Wages+ per capita (male)	3	0- 3	-42.4298	4.0557	-10.4617
Labor force participation rate*	5	0- 7	-5.8385	.7503	-7.7815
Unemployment rate S*	7	0	.5354	.2171	2.4664
Unemployment rate ML*	8	3- 13	5.0823	1.3389	3.7960
Consumption					
Beer per capita*	2	3- 6	1027.658	148.6339	6.9140
Cigarettes per capita	1	6- 11	.6783	.4803E-01	14.1230
Fat per capita*	4	4- 7	.65984E-08	.1297E-08	5.0876
Other controls					
Constant			.1467E-01	.1740E-02	8.4884
RHO**			.2769	.1966	1.4080

R^2 .9382 $R^{\wedge 2}$	.9169	+	Adjusted for inflation.
Durbin-Watson	1.8738	*	Second Differences; mortality rate and other independent variables are transformed to first differences.
F (8, 26) =	49.3676		
S:	Short lags	**	Beach-McKinnon transformation used to minimize residual autoregression.
ML:	Medium-long lags	***	Shiller distributed lag estimation.

FIGURE 6
Annual changes in mortality rates and fit of annual change model (table 5)
Ages 55–64 (Norway 1950–1985)

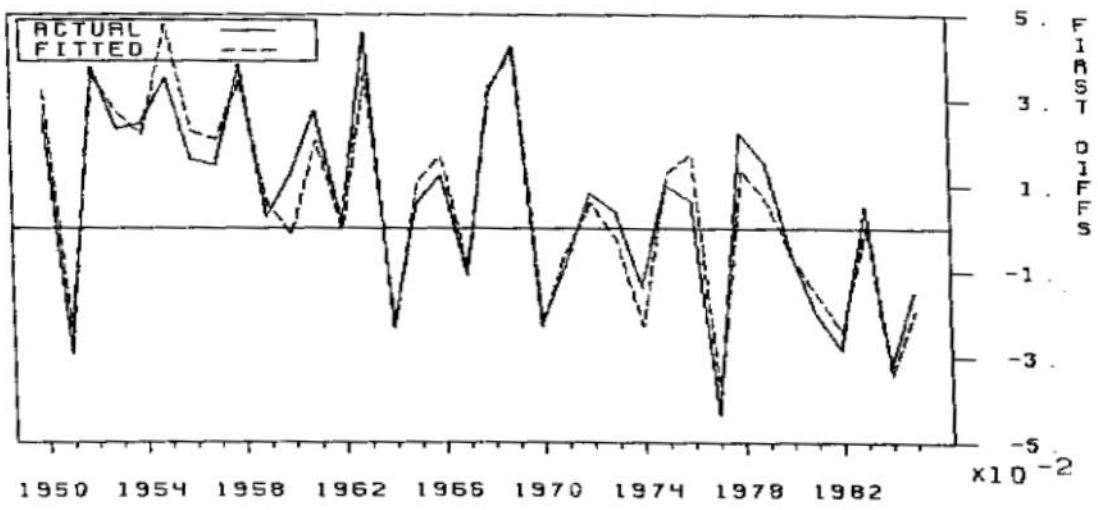


Table 7. Time series multiple regression total mortality rates: 55-64
United Kingdom, 1950-1986; annual changes

	Order of entry of variable	Lag*** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income+ per capita	1	1- 11	-.1352E-03	.3654E-04	-3.7012
Labor force participation rate	2	3- 11	-.2359E-01	.3000E-02	-7.8607
Unemployment rate *	6	0- 9	.1306	.2263E-01	5.7722
Consumption					
Beer per capita	3	6- 10	.3265E-02	.5900E-03	5.5331
Cigarettes per capita*	5	0- 13	.1563E-02	.1458E-03	10.7257
Fat per capita*	4	0- 8	.23964-01	.3564E-02	6.7232
Other controls					
RHO**			.3190	.1895	1.6838

R^2 .9239 $R^{\wedge 2}$	.9087	+	Adjusted for inflation.
Durbin-Watson	1.9313	*	Second Differences; mortality rate and other independent variables are transformed to first differences.
F (6, 30) =	60.7242	**	Beach-McKinnon transformation used to minimize residual autoregression.
		***	Shiller distributed lag estimation.

FIGURE 7
Annual changes in mortality rates and fit of annual change model (table 7)
Ages 55-64 (United Kingdom 1950-1986)

Actual vs fitted mortality

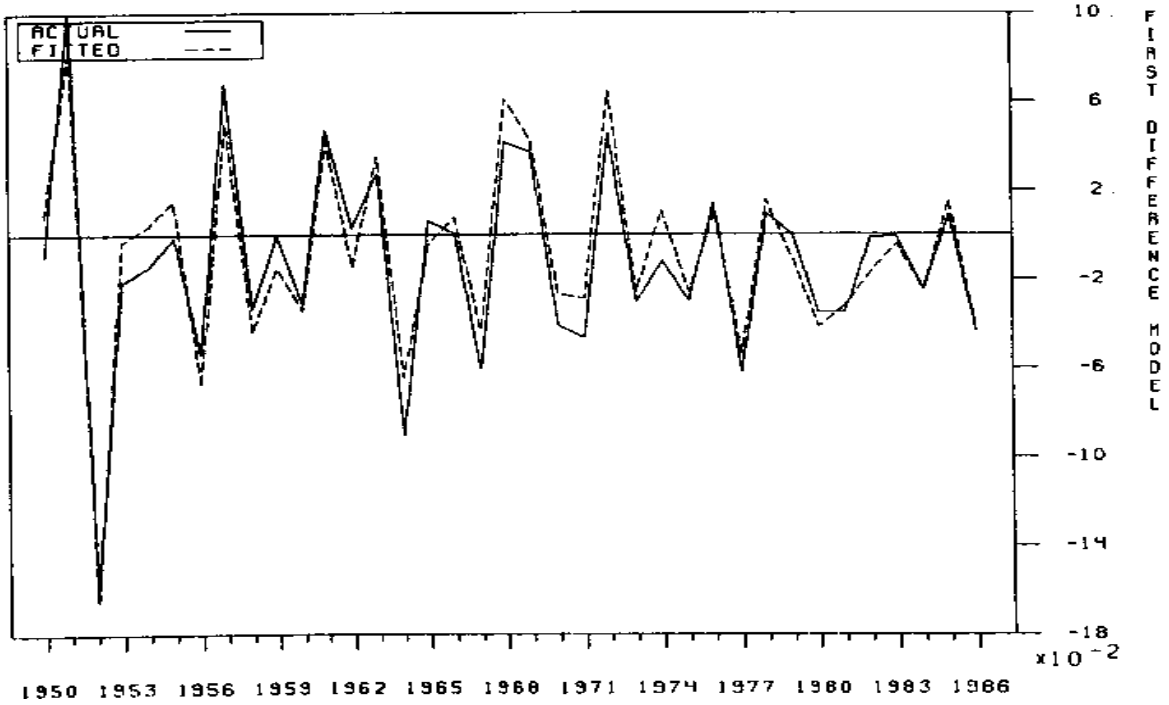


Table 8. Time series multiple regression total mortality rates: 55-64
United States, 1950-1986; total white; annual changes

	Order of entry of variable	Lag*** (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income^{+} per capita*	6	0- 18	-.6051	.4988E-01	-12.1306
Wages^{+} per capita	3	1- 14	-23188.72	5751.555	-4.0317
Unemployment rate	7	3- 14	19.0289	3.0939	6.1504
Business failure rate	1	0- 15	5.2314	.6333	8.2607
Stock market index^{+}*	4	3- 11	-12.8832	1.4698	-8.7653
Consumption					
Spirits per capita*	11	1- 9	361.9086	107.3550	3.3711
Beer per capita*	9	0- 7	26.1978	6.8147	3.8443
Cigarettes per capita*	2	5- 18	.8229	.4080E-01	20.1687
Fat per capita	8	0- 13	.34974E-01	.5107E-02	6.8482
Other controls					
Chemical production* per capita	5	1- 10	41.3394	2.4128	17.1334
Health expenditures^{+} per capita	10	0- 13	-97.7997	19.7783	-4.9448
RHO**			-.4143	.2279	-1.8180

R^2 .9832 $R^{\wedge 2}$	.9756	$^{+}$	Adjusted for inflation.
Durbin-Watson	2.2068	*	Second Differences; mortality rate and other independent variables are transformed to first differences.
F (11, 24) =	128.0115	**	Beach-McKinnon transformation used to minimize residual autoregression.
		***	Shiller distributed lag estimation.

FIGURE 8
Annual changes in mortality rates and fit of annual change model (table 8)
Ages 55-64 (white population, United States 1950-1985)

Actual vs fitted changes in mortality

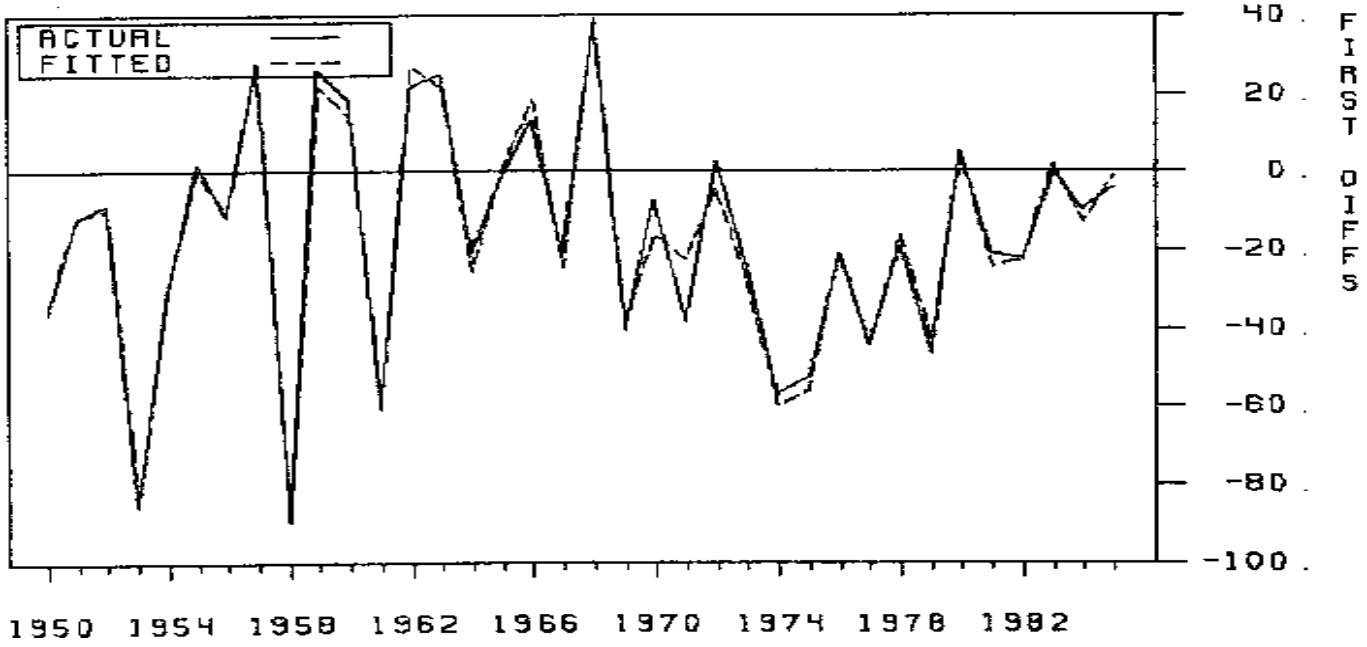
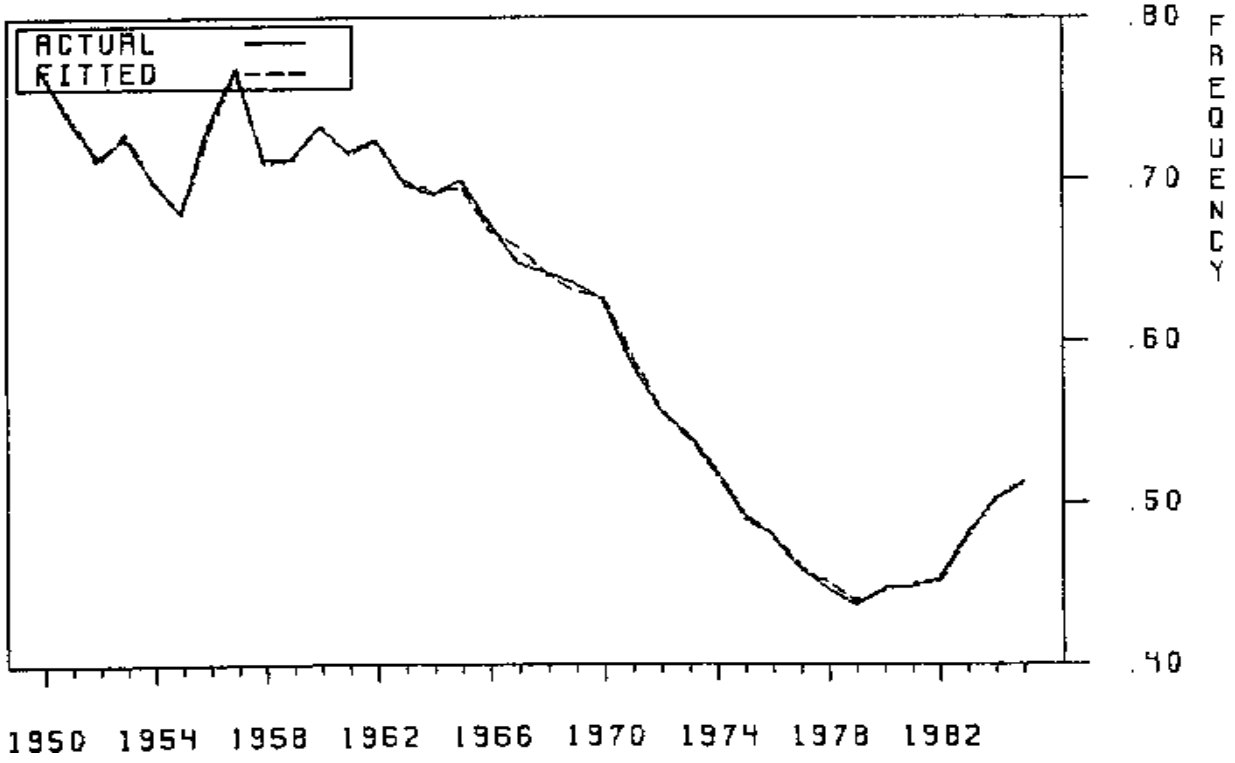


Table 9. Time series multiple regression total mortality rates: 55-64 Japan, 1950-1985

	Order of entry of variable	Lag (years)	Coefficient	Standard error	T statistic
Economic					
Personal disposable income[+] per capita*	8	0- 14	-.3069E-01	.9604E-02	-3.1956
Wages[+] per capita	2	5- 9	-.3467E-02	.3069E-02	15.4276
Labor force participation rate	10	0- 18	-10.7351	4.3986	-2.4406
Unemployment rate	1	1- 16	30.4871	1.0379	29.3743
Business failure rate*	3	0- 13	30.4704	2.8246	10.7874
Stock market index[+]*	9	1- 16	-.5666E-03	.1039E-03	-5.4535
Consumption					
Cigarettes per capita*	5	7- 16	26.9441	2.8593	9.4233
Fish per capita*	4	0- 16	-7.0173	1.0226	-6.8624
Other controls					
Chemical production per capita*	6	0- 10	1.0738	.1320	8.1336
Health expenditures[+] per capita*	7	4- 11	-7.3549	1.564	-4.7019
Constant			1.1545	.1825	6.3246
Trend			-.7379E-02	.1052E-02	-7.0167
R^2 .9994 $R^{\wedge 2}$	.9991	+	Adjusted for inflation.		
Durbin-Watson	2.0981	*	Differences		
F (12, 23) =	3458.208	**	Search transformation used to minimize residual autoregression		

FIGURE 9
Actual rates and fit of level model (table 9)
Ages 55-64 (Japan 1950-1985)



APPENDIX I

Data sources

Principal sources of data

Vital statistics

Population

1950-1985 Annual Epidemiological and Vital Statistics, WHO, Geneva, Superceded in 1962 by WHO World Health Statistics Annual.

Mortality

1950-1985/6 Annual Epidemiological and Vital Statistics.

Economic Indices

1926/30-1985/6 Annual abstracts of statistics for each country.

Unemployment

Business failures (Bankruptcies)

National income

Disposable income

Inflation: consumer prices

Alcohol consumption

1936-1949 Annual abstract of statistics for each country.

1950-1972 International statistics on Alcohol Beverages. Finnish Foundation for Alcohol Studies.

1973-1975 Hoeveel alcoholhoudende dranken worden er in de wereld gedronken? Produktschap voor Gedistilleerde Dranken, Schiedam, Netherlands.

Past 1975 Updates obtained by personal communication with the Distilled Spirits Council of the United States (DISCUS).

Cigarette consumption

1920/30-1974 Beese D.H. ed., Tobacco Consumption in various Countries, 4th ed. Tobacco Research Council, London.

Past 1974 Updates obtained by personal communication with the Tobacco Research Council.

Fat consumption*

1931/33-1985 Annual abstract of statistics for each country.

* Data vary by years of availability; e.g. data voor Canada and United Kingdom begin in 1940.

Statistical yearbooks

Canada	CANADA YEARBOOK
Federal Republic of Germany	STATISTISCHES JAHRBUCH
France	ANNUAIRE STATISTIQUE DE LA FRANCE
Italy	ANNUARIO STATISTICO ITALIANO
Japan	STATISTICAL YEARBOOK OF JAPAN
Netherlands	JAARCIJFERS VOOR NEDERLAND
Norway	STATISTISK ARBOK
United Kingdom	ANNUAL ABSTRACT OF STATISTICS
United States	STATISTICAL ABSTRACT OF THE UNITED STATES

Supplementary international sources

International Labour Office, Yearbook of Labour Statistics
International Labour Office, Bulletin of Labour Statistics