THE ECONOMICS OF LONGEVITY AND MENTAL HEALTH: SOME AUSTRALIAN EVIDENCE*

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***Quality Assured**

Abstract

In the health economics literature, there is a long-standing scepticism of the efficacy of additional health services or health expenditure to improve societal health status. However, in recent years, this disposition has been subject to reappraisal. The purpose of this study is to determine the extent to which mental health services can be considered to be subject to the forces emphasised in the recent 'reappraisal' literature using Australian data. We seek an answer to the following question: 'have new treatments for mental illness contributed to the increases in longevity that have occurred?'

Usher was the first author to determine a dataset (for Canada) that measured welfare inclusive of longevity. This reformulation of the utility function is undertaken by all contributors to the 'reappraisal' literature, who follow Usher's conceptual approach of treating the valuation of lifetime extensions, over time, in an analogous way to treating temporal changes in the cost of living.

In our study, application of these procedures to Australia is undertaken by recourse to the Penn World Table 6.2, which facilitates comparison of the results of this study with US results. The data analysed involve the number of deaths (males and females), coded by the various revisions of the ICD, recorded as having arisen from mental disorders and suicide. The data for these two causes of death (our measure of societal mental illness) are not subject to a secular decline, as for other causes of death.

The results for Australia confirm the cause of death compositions reported in Becker, Philipson and Soares for world regions. Our results reveal also that there have been no improvements in mortality arising from mental disorders and suicide. Such a sobering conclusion leads us to the importance of research: it is from a heightened research effort that efficacious therapies for mental illness will be developed.

1. Introduction

It is an obvious point, but rarely made, that data sets may not always serve multiple purposes: data sets on, say, government expenditure may indicate nothing about individual welfare in the community. Since the early work on latent variables by Goldberger and Jöresgog,[1,2] it is well known in economics that existing data may be an imperfect measure of the theoretically relevant concept. The present study, having a concern with mental illness, sheds light on the implications of a 'reappraisal' that is currently occurring over a major limitation in economic measurement of human welfare, by demonstrating the particular implications of this reappraisal for mental illness, and for the direction of mental health policy.

Our study has its origins in a literature that arises from dissatisfaction with national accounting measures being used as a welfare index. Since the work of Nordhaus and Tobin,[3,4] which involved re-working national accounting measures to take account of various omissions (leisure, pollution etc.) from the conventional national income and product accounts, various measures have been proposed to take account of further criticisms. See Doessel and Gounder[5] and Ranis, Stewart and Stamman[6] for reviews. Many of those revisions have had an emphasis on environmental/pollution phenomena.[7] However it is useful to recall that Nordhaus and Tobin placed some emphasis on leisure time, i.e. the time not devoted to working in labour markets or engaging in household production: economic growth through time increased the availability of leisure. A more recent literature has placed emphasis on the temporal dimension of longevity, which has been neglected.

At much the same time as Nordhaus and Tobin were imputing values for 'missing phenomena', Usher[8] pointed to another missing variable relevant to human welfare, *viz.* increasing human longevity. Usher began by commenting that while the

conventional national accounting measures may be quite appropriate for stabilization purposes (via fiscal and monetary policy instruments), if those data are to be used as a measure of well being, then the omission of life expectancy is not trivial. 'If you ask a man (*sic*) whether he prefers economic conditions as they are today to those of fifty or a hundred years ago, he would probably answer that he prefers conditions as they are today and his preference might well have less to do with the material things we posses than with the fact that we live longer' (pp. 193-194). Usher's empirical work (for Canada and some other countries) produced the first estimates of 'income' inclusive of imputations for life expectancy (Tables 2 and 3).

Subsequently, Usher put his work in a wider welfare perspective,[9] and then there was silence, until Rosen[10] and Viscusi and Evans.[11] The later 1990s then witnessed a revival of interest in this issue, predominantly by *afficinados* of the health sector. The first work was that of Cutler and Richardson[12,13] and Cutler, McClellan and Newhouse.[14] This was followed by Nordhaus[15] and Murphy and Topel,[16] Becker, Philipson and Soares[17,18] and Burstöm, Johannesson and Diderichsen,[19] and more recently Cutler.[20,21]

However (as just pointed out), Usher was the pioneer of this literature. For Usher the question was one of intertemporal comparisons of living, which was, for him, a different dimension of living levels comparisons from the inter-country comparisons, which he had studied earlier.[22,23,24] Subsequently, Usher[9,25] re-visited the issue several times, the more interesting occasion being his *European Journal of Political Economy* article, in which he elaborates (theoretically) the difference between 'ordinary goods, food, clothing etc.' and 'personal goods' (leisure, comfort, reputation, risk of injury etc.), a distinction he briefly drew in the 1973 paper. The crucial distinction Usher is making is that the former category involves equal

marginal valuations by consumers, as all people (rich and poor) face the same prices, whereas in the case of personal goods consumers do not face uniform prices as *there is no market* where such goods can be traded. Thus we have a case of 'market failure', given the non-existence of a relevant market. Furthermore in this case the marginal valuations of personal goods, e.g. leisure etc., vary from person to person. In the present context, **longevity** (measured by mortality, survival probabilities or expected length of life) is subject to **different valuations** because people differ in their values of life.

At first glance it might be thought that 'personal goods' are synonymous with Samuelsonian 'public goods', given that people have different valuations of public goods.[26,27] However some reflection indicates that not all personal goods are public, although all public goods are personal goods: there are some personal goods which are private, as indicated by the examples given above.

The recent work on longevity in health economics has several motivations. First, for Murphy and Topel,[16] the concern is to determine the return on health-related research expenditures, i.e. Research and Development. For Burström *et al.*[19] the objective was to estimate the change in health capital in Sweden, using both life expectancy and QALYs: their over-arching concern was to measure health status at the community level, so as to be able to evaluate alternative strategies of health policy. However, the original work by Cutler (and colleagues) began from a policy ethos of cost-containment given that the productivity of the medical system is low 'limiting overall medical expenditure would improve welfare'[12] (p. 217). Cutler questioned this general policy prescription when he recognised that controlling medical expenditures is not a goal itself: what matters is the balance between medical expenditures and the valuation of health status gains produced by those expenditures.

Nordhaus[15] is also concerned with measuring 'the output of the health care sector and to *value* the output correctly' (p. 10, emphasis in original). His concern, as was Usher's, was that 'standard economic measures' took no account of the improvements in health status. His empirical results indicate that 'the economic value of increases in longevity … is about as large as the value of measured growth in nonhealth goods and services' (p. 35). For Nordhaus the message is clear: 'The new view of health economics should shape the way we think about health policy … In the early 1990s, the general hysteria about rising health costs lead many to believe that the health care system was wasteful and out of control … [However] the role of the health care system should be rethought. Over the last half-century, health care expenditures appear to have contributed as much to overall economic welfare as the rest of consumption expenditures' (p. 37).

Similarly, Becker, Philipson and Soares[17,18] have been concerned with the inadequacy of national accounting measures as a proxy for welfare: their view is neatly captured by the title of their paper, 'The Quantity and Quality of Life…'. They turn the usual conception upside down: it is usually thought that 'income' is a measurable quantity, i.e. 'quantitative', and other variables (amenities etc.) are 'qualitative'. Their perspective is radically different in that the 'quantity of life' is measured in years and the 'quality of life' is measured in income. As they say, 'Overall economic welfare depends on both the quality and quantity of life: yearly income and the number of years over which this income is enjoyed' (p. 277). Concentrating on 'full income', rather than simply a component (per capita GDP), paints quite a different picture of world inequality.

Given these views, we think it is appropriate to describe this recent development as a 'reappraisal'. The overarching rationale of this paper is to shed

light, conceptually and empirically, on the implications for mental illness of the 'reappraisal', which ultimately will result in more comprehensive measures of human welfare being developed. However, several components need to be examined in order to achieve this purpose. First, in the next section we place the 'reappraisal' literature in the health sector within the general economics literature: this health sector literature is not divorced from the more general issues in the economics discipline. Second, we outline the conceptual framework in which longevity (or length of life) takes a place, along with income, in the utility function, i.e. the Usher framework. Attention is then directed to some relevant descriptive economic and demographic data on Australia, generally, for the period 1901 to 2001. The next section is concerned with the determination of some values for life applicable to the Australian context. We then present some empirical results, generally in 20-year sub-periods from 1907 to 2001. Next, we locate mental disorders and suicide of the All Cause mortality rate for Australia, and discuss the implications of the rising mortality rate due to mental illness in the context of the reappraisal. We then present a conclusion.

2. Multiple Conceptual Landscapes

This 'reappraisal' literature in health economics has not taken place in a vacuum: there are multiple landscapes (in the sense of areas in which important conceptual progress has occurred) in the general discipline of economics, which relate in various ways to this recent health economic literature. The landscapes we consider are as follows: output measurement and valuation issues generally; concepts that have formed about the valuation of life itself; and the health expenditure/cost-containment 'problem' and how it has impacted upon health policy.

2.1 The Problem of Output Definition

We begin by considering a point made by Nordhaus that national accounts are, in various ways, 'incomplete and misleading', and health status is one of those omissions leading to mismeasurement. 'It is little understood outside the priesthood of national accounts that there is no serious attempt to measure the "real output" of the healthcare industry'[15] (p. 10). This does not imply that components of health expenditures (medical services, hospital services, insurance etc.) are ignored in the compilation of such accounts, and hence contribute to other measures such as price indices, e.g. the CPI. But it is this very process that is part of the problem: these are inputs into the production of health status, the final output, and (conceptually) it is the final output that should be measured and appropriately valued in the national accounts. This problem is not unique to health: the much-quoted paper by Nordhaus on 'the light bulb problem' is another manifestation of the same issue.[28] The final output, which people want, is 'illumination' or 'lighting', i.e. the casting of light so that people can see in darkness. However, what is actually measured in the national accounts are inputs such as light bulbs, electricity etc. Calculations undertaken by Nordhaus indicate that measuring inputs, rather than outputs, causes the productivity improvements associated with technological change to be ignored. Lighting (historically) has been provided by open fires, (Babylonian) oil-burning lamps, tallow candles, kerosene lamps, gas, Edison bulbs, compact fluorescents.

Nordhaus has calculated that the 'traditional' price (based on inputs) has risen by between nine and sixteen hundred times the 'true' price (based on illumination). This is equivalent to an annual upward bias of 3.6 per cent per year.

Essentially this bias has arisen because 'final output' and productivity change have not been measured. In fact, it has been estimated that the US CPI has an upward

bias (on average) of 1.1 per cent annually.[29] The implication is that GDP has been underestimated, as has economic growth.

It should not be thought that this issue has gone unrecognised in the health sector. A case study of the treatment of heart attacks, with particular reference to new products (specifically pharmaceuticals such as aspirin, beta-blockers etc.), showed that output (in terms of health status) was rising, and the price of output was falling.[30] The empirical results of this study were subsequently extended in time to take account of morbidity as well as mortality.[31] Another case study is that of cataract surgery, a treatment which has been subject to dramatic technological change, leading to cost-reductions and significant quality change.[32] Other case studies involve hedonic analyses of drugs for arthritis[33] and severe depression.[34,35] See also the various studies of Triplett.[36]

It is important to realise that the general problems of inappropriate output measurement are not confined to the health sector: it is an endemic problem particularly in service industries. Some of the other industries that are a source of mismeasurement in the national accounts are banking,[37] retailing[38] and insurance.[39] For a general overview, see Diewert, Nakamura and Sharpe.[40]

One key discovery for the treatment of ischaemic heart disease was the role of pharmaceuticals in improving health outcomes. Let us now recall that, for Schumpeter,[41] 'creative destruction' was a driving force behind economic growth, and as Bresnahan and Gordon[42] have argued, 'new goods are at the heart of economic progress' (p.1). Lichtenberg[43] asked the following question: can the increase in longevity be explained by the development and diffusion of new pharmaceuticals?

To answer that question, Lichtenberg analyses the effect of new drug utilisation (across diseases) on premature mortality from 1970 to 1991, measured by

life years lost, as first advocated by Dempsey.[44] Other variables likely to affect premature mortality are hypothesised to be medical education/counselling provided by medical practitioners, vaccines administered (to prevent diseases), and new surgical procedures. Regression results indicate that there is a positive (and highly significant) relationship between mortality reduction and new drug utilisation: up to 45 per cent of decreased mortality is explained by this variable. Applying then the value of a life-year saved employed by Cutler and Richardson[12], Lichtenberg then calculates the social rate of return on investment on new drugs to be 68 per cent.

2.2 The Valuation of Life

Economists became interested in putting a value on life in the 1960s, given a concern with undertaking cost-of-illness studies[45,46] and evaluating life-saving health therapies.[47] These early studies applied what is now called the human capital approach. In the late 1960s, two theoretically inclined economists, Schelling[48] and Mishan,[49] argued that the appropriate concept was willingness-to-pay for avoiding, not a particular death, but a general (anonymous) or statistical death, as measured by a reduction in the mortality rate. This measure is now universally called the 'value of a statistical life' (VSL). See Linnerooth[50] and Usher[9] for reviews of these various approaches. It was this Schelling-Mishan framework that Usher applied in the first paper to address the valuation of increased longevity, thus producing the first estimates (for Canada) of what has been (variously) called 'full income' ot the 'value of life expectancy gains' by Becker *et al.*,[18] 'economic gains for reductions in mortality' by Murphy and Topel,[16] 'health income' by Nordhaus[15], or 'income imputed for health status' (more generally).

Essentially, there are three general methodologies for determining the VSL. The first, and most applied of the three, is to estimate the VSL in an hedonic regression equation of wages, on numerous explanatory variables, one of which is mortality risk.[10,51] The second method is to apply the same regression technique to a price-risk context, where the price is that of a commodity such as seat belts in cars, smoke detectors in homes, bicycle helmets, etc.[52] The third method involves the contingent valuation (CV) technique, or some other stated preference approach to determine willingness-to-pay. See Jones-Lee *et* al.[53] for a study using the CV approach. Results of this CV approach are regarded as less reliable given various informational and incentive problems. This (now) voluminous literature has been surveyed by Tolley *et al*.[54] and (more recently) by Viscusi and Aldy.[51]

In the 'reappraisal' studies undertaken so far, various estimates of VSL have been employed. One of the empirical questions that we ask here is this: 'What is the value for Australia of the lives saved that are associated with the longevity gains'. But the following questions brings the focus back on to mental illness: 'How much of this increasing longevity is due to lives being saved from mental illness mortality and suicide?'

2.3 The Health Expenditure/Cost-Containment 'Problem'

Since Abel-Smith[55] specified a concept of health expenditure for the World Health Organization which*, inter alia*, was compatible with national accounting concepts (such as GDP), as specified in the System of National Accounts, many countries now collect data in that framework, and the OECD[56] routinely publishes aggregated data for an increasing number of countries using that framework. Thus there is now an

easily accessible database that measures the absolute, and relative, size of 'the health industry', as defined.

One of the long-standing empirical 'facts' about 'the health industry' in many countries is its increasing absolute size, and its size relative to the total economy (measured by, say, GDP). Generally, economists are not concerned with the relative size of industries (whether it be the car, iron ore, banana etc. industry), except as a descriptive measure (in industrial organisation studies). However, there is a vast literature, usually value-laden, about the relative size (it's too big) of the health industry. The usual policy prescription is that costs should be contained. A recent example is Bodenheimer.[57] One of the ironies is that there is also a quite large literature from economists on this issue.[58-61] See also note 1, and the literature cited therein, of Cutler and Richardson.[12] Some comment on this state of affairs is relevant.

There are a number of factors that underlie the concern about expenditure increases, and hence the policy of cost-containment. First, since the early empirical studies estimating health production functions by Silver[62] and Auster, Levenson and Sarachek,[63] there has been scepticism that increased health expenditures produced little, if any, improvement in community health status. See Connelly and Doessel[64] for a survey of this quite large literature.

However a recent empirical study for Australia, a country with a long-standing concern with cost-containment, particularly by constraining the size of the medical workforce, has shown a large, and positive effect on health, from increases in the medical workforce.[65]

Another factor that has contributed to the emphasis on cost-containment has been that tradition of work in health economics, commonly described as the supplier-induced demand hypothesis. This style of work emphasises that the self-regulating

forces of demand and supply are not efficacious in medical markets as the medical practitioner (the supplier) is also the agent exercising demand (on the consumer's behalf) for medical services. This argument rests on the assumption of an imperfect agency relationship between the medical practitioner and the consumer.

Since the early studies by Evans[66] and Fuchs,[67,68] forests have perished in the pursuit of the truth (or otherwise) of this argument. It is not our purpose here to survey this voluminous literature: our objective is simply to note that this literature has led to a policy of cost-containment by one means or another.[69]

It is a short step from supplier-induced demand arguments to straightforward rent-seeking behaviour, a literature that has its origins in the work of Tullock[70] and Krueger.[71] See Tollinson and Congleton for a comprehensive survey.[72] Not surprisingly it is a short step from (historically) regulated activities such as broadcasting, transport and various agricultural industries to the regulation of health insurance, hospitals and various health professions. Feldstein's book elaborates this perspective.[73]

We now turn our attention to describing the theoretical framework employed by the key contributors to this 'reappraisal literature'. All writers, to varying degrees, acknowledge their debt to Dan Usher, a Canadian economist, who was the first person to enter longevity into the utility function.

3. Utility Maximisation: The Usher Framework

It is useful to begin with Usher's discussion of 'Utility Maximisation with a Length-of-Life Variable'.[8] His equation (1), assuming each person aims to maximise welfare, is as follows:

$$U = U(U_1, P_1, U_2, P_2, ..., U_n, P_n) \quad (1)$$

where U is lifetime welfare,

P_i is the probability of living *í* years,

U_i is welfare if life extends for *í* years,

n is the length of life, and

í = 1, 2, ..., n.

The utility function, U_i, is quite conventional with consumption as the sole argument for t years. Thus

$$U_i = U_i (C_1, C_2, ..., C_n) \tag{2}$$

Equation (1) can, or course, be re-written as follows:

$$U = U (C_1, P_1, C_2, P_2, ..., C_n, P_n) \tag{1a}$$

Thus lifetime welfare depends on consumption in years 1, 2,..., n, and the probability of living in years 1, 2,..., n. These two arguments are also employed by the more recent papers by Cutler and Richardson: 'Expected utility is the discounted value of annual utility [of both consumption and health] over the person's potential life span'[12] (p. 227), and Nordhaus[15] starts by stating the following (p. 14): 'An individual is assumed to value consumption and health according to a lifetime utility function... The key assumption here is that utility is a function of the expected value of consumption weighted by the probability of survival.' The same framework is employed by Becker, Philipson and Soares: 'Consider the indirect utility function... of an individual with survival function S and lifetime income Y '[18] (p. 280). Elsewhere they write: 'Overall economic welfare depends on yearly income and the number of years over which this income is enjoyed' (p. 277). Equations (1) and (2) from Usher are in fact a discrete representation of a continuous process.

It is relevant to observe that the value of U_t, P_t and n are age-related, and the utility functions have the following properties:

$$\frac{\partial U_t}{\partial C_t} > 0 (i < t) \tag{3}$$

$$\frac{\partial U}{\partial C_t} > 0 \tag{4}$$

$$\frac{\partial U}{\partial P_i} > 0 \tag{5}$$

Such properties imply that a person takes the view that his/her welfare is increased if consumption in any year is increased or his/her probability of living is increased. In addition it is commonplace to assume that (1) has a specific functional form, *viz*. it is multiplicative, i.e.

$$U = \sum_{t=1}^{n} P_t . U_t \tag{1b}$$

Usher's objective was somewhat different from the health economists of the late 1990s and early 2000s: his concern was to create a more comprehensive measure of human welfare than the national accounting measures, e.g. 'Our problem is to expand the concept of real income per head to impute for the fall in mortality rates'[8] (p. 203). It should be observed that this objective is shared by Becker, Philipson and Soares, however the canvas on which they paint is not that of a single country, but the world! However all authors employ Usher's framework to which we now direct attention.

Given that it is *U* of equation (1) which we need to analyse, **and** the non-measurability of *U*, a proxy or surrogate variable for *U* is needed. Usher argues that this problem is no different from that of 'measuring real consumption in circumstances where prices are changing over time. In that case, we choose a base year and define real consumption in any other year to be the amount of money needed to make one as well off in the base year as one was in the other year. By analogy we define a term $\hat{C}(t)$ to be the value of net national product by which one would be as

well off with mortality rates of the base year as one was in year *t* with actual mortality rates, $\boldsymbol{D_j(t)}$ of that year' [8] (p. 205). Let *B* be the base year. Thus $\hat{C}(t)$ is defined by the following equation

$$U[\hat{C}(t), \boldsymbol{D(B)}] = U[C(t), \boldsymbol{D(t)}] \quad (6)$$

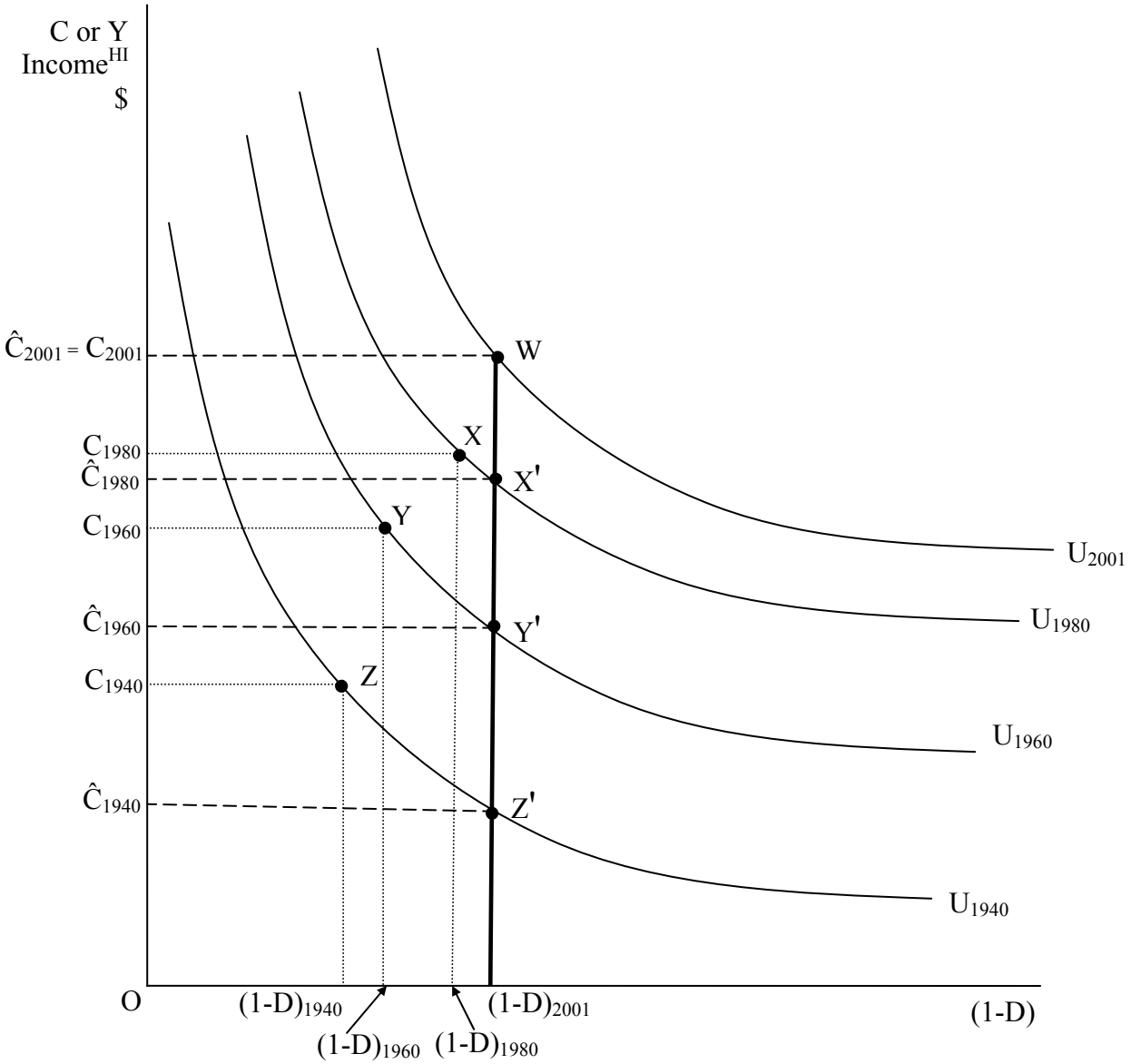
where $\boldsymbol{D(t)}$ is a vector of age-specific mortality rates in year *t.* More specifically, $\hat{C}(t)$ is defined as 'the value of net national product at which one would be as well off with mortality rates of the base year as one was in the year *t* with actual net national product, *C*(*t*), and actual mortality rates, $\boldsymbol{D_j(t)}$, of that year.' (p. 205).

This procedure can be described by reference to Figure 1 which depicts consumption-longevity space: longevity is on the X-axis as the variable is specified as 1 minus the mortality rate (*D*). Alternatively, the X-axis can be specified as length of life (measured in years), a procedure followed by Becker, Philipson and Soares (2003). Usher argues the case in terms of three people, living in three separate years (he chooses 1926, 1961 and 1968). They can live for two periods, facing probabilities $\boldsymbol{D(t)}$ of death at the start of the second period and they have the same utility function, i.e.

$$U(t) = U[C(t), \boldsymbol{D(t)}] \quad (7)$$

Alternatively, one can describe the procedure, as do Becker, Philipson and Soares,[17] in terms of a representative consumer ('a hypothetical life-cycle individual') for a particular country at different points in time.

The four indifference curves in Figure 1 (U_{2001}, U_{1980}, U_{1960} and U_{1940}) contain the actual combinations of consumption (*C*) and longevity (1-*D*) for the four years. (Our choice of these particular years is not crucial, but relates to empirical work to be reported below.) These points for (*C*) and (1-*D*) are labelled W, X, Y and Z. If one accepts consumption, a national accounting measure as the only temporal measure of



Note**:** The Y-axis measures different indices (and concepts) of welfare. It can be used to indicate measures of Income (Y) (per capita GDP or NNP), or per capita consumption (C), or health-imputed income (Income^{HI}) i.e. "health income", "the value of life expectancy gains" or "the economic gains from reductions in mortality". See text.

Figure 1. Imputation for longevity in a utility function incorporating both consumption and longevity

welfare, then C_{2001}, C_{1980}, C_{1960} and C_{1940} on the Y-axis are the relevant data for welfare comparisons. Comparisons of such data, whether they be of consumption or

some concept of income (GDP, NNP etc.) are standard fare in most studies of welfare. Economic growth through time, as conventionally measured, is calculated by reference to such data (at W, X, Y and Z).

We now ask the following question: assuming 2001 is the base year, what level of consumption (or income) in 1980 would make a person as well off in 1980 but with the 2001 probability of living (1-D_{2001})? The answer to this question is obtained by moving to the point X $'$ on U_{1980}: thus the answer is $\hat{C}_{1980}$. Note that what the person is prepared to pay for the increased longevity associated with 2001 is indicated by the difference between C_{1980} and $\hat{C}_{1980}$. One can repeat this exercise sequentially for the other indifference curves, i.e. U_{1960} and U_{1940}, and locate the points Y $'$ and Z $'$ which indicate the points at which the person would be indifferent to a particular consumption level in 1960 and 1940 at which they would have the same utility **with** the 2001 level of longevity. Thus one obtains the points $\hat{C}_{1960}$ and $\hat{C}_{1940}$. In fact there are four such points, because in the base year, 2001, $C = \hat{C}$. Usher[8] describes these points as 'consumption inclusive of a premium for the improvement in mortality rate' (p.206), and 'income inclusive of an imputation for increased life expectancy' (p.218).

In concluding this section, it is useful to ask the following question: 'how does this analysis differ from a study that ignores longevity?' Another way of asking this question is as follows: 'how does this analysis, based on the utility function (equation 1 *ff*), which has two arguments, consumption and a longevity measure, differ from a utility function with a single argument of consumption?' The short answer is that all the indifference curves in Figure 1 are linear and parallel to the X-axis in the

conventional case. In other words, the conventional emphasis on measuring consumption or income is a special case: Figure 1 indicates the more general case.

Finally, it is relevant to observe also that there is no unanimity in the post-Usher literature on how to describe, or define, data on $\hat{C}$. Becker, Philipson and Soares[17] use the term 'full income', Nordhaus[15] uses the term 'health income' (p.28), and Murphy and Topel[16] use the term 'value of the improvements in life expectancy' (p. 56).

4. Some Background Australian Data

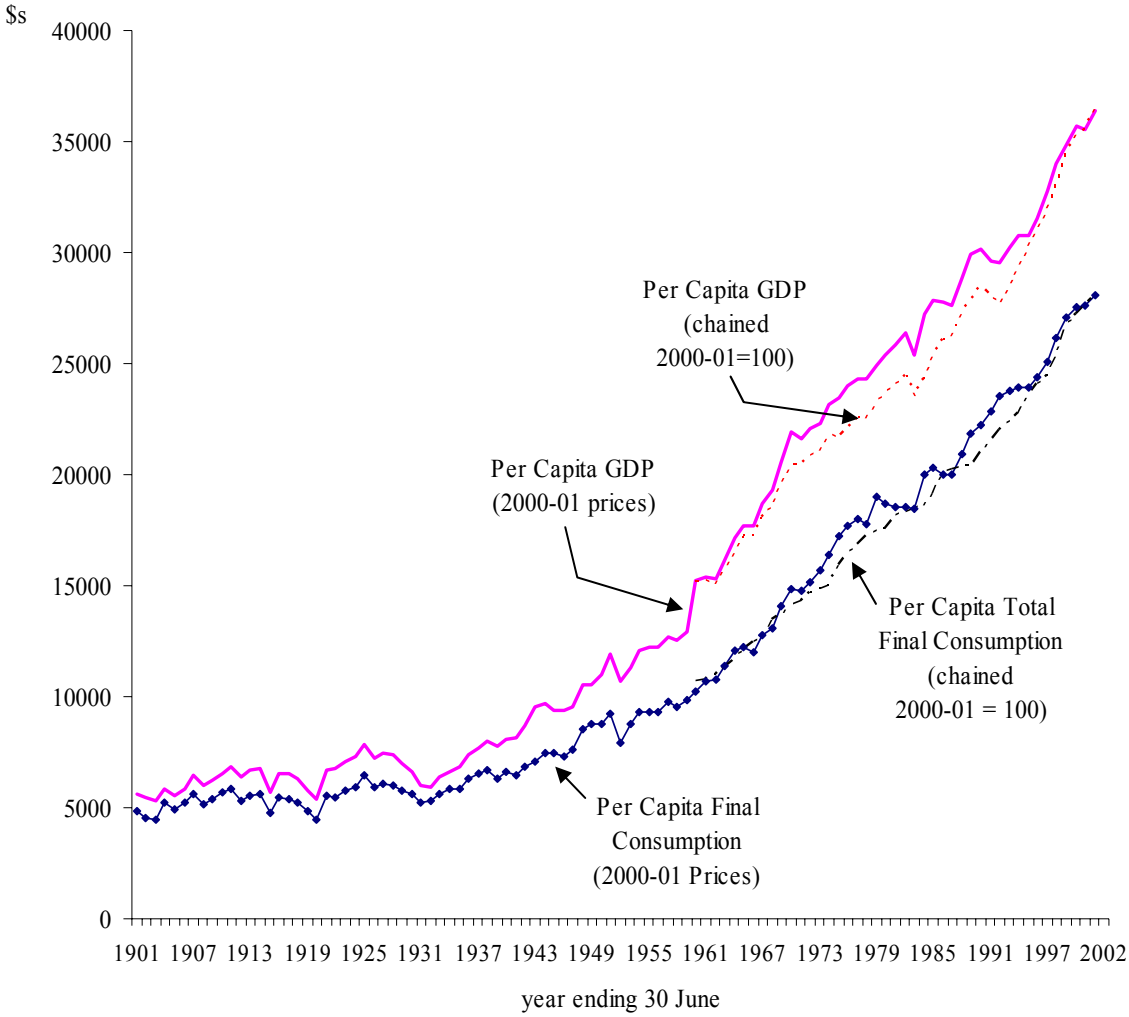
This section presents data about three contrasting topics: the trend in per capita GDP in Australia from 1900 to 2004, improvements in longevity in that same period for Australia; and finally we present some values of statistical life for Australia.

4.1 Increases in GDP Per Capita

We begin with some descriptive statistics of relevant trends in per capita GDP and consumption in Australia for the period 1901–2004, using two data sets.

Figure 2 shows two data sets, one of per capita GDP and the other of per capita consumption in the period 1900-01 to 2001-02. The data sets from 1900-01 are composite constant price series (base 2000-01) spliced from private researchers, such as Butlin[74] for the early decades of the twentieth century, and the Australia Bureau of Statistics in later years. The two (chained) sets for the period 1959-60 to 2001-02 have been constructed on a consistent conceptual basis (i.e. the System of National Accounts) by the ABS using 2000-01 as the reference year. We have calculated compound annual growth rates (not reported here) on the four data sets from 1959-60, and those results indicate that the differences in the growth dimensions of the relevant data sets (income on income, consumption on consumption) are not large.

Furthermore, inspection of the data in Figure 2 indicates that the differences are not large. Thus we have some reason to have confidence in the constant-price, composite series from 1900-01.



Sources: Australian Bureau of Statistics[74] (Tables 25.5 and 29.1), 75 (Tables 2 and 6), 76 (Table 19), 77 (Table 1A or Tables 38,39)

Note: 2000-01 is the base year for the constant price series and the reference year for the chained series.

Figure 2. Per capita final consumption expenditure (chained), per capita GDP (chained), per capita consumption (constant prices) and per capita GDP (constant prices), various years from 1901

In the period 1901-2002 per capita GDP increased at a compound annual growth rate of 1.85 per cent and per capita consumption increased by 1.74 per cent

per annum. Although there is some consensus that consumption (or net national product) is the more relevant variable on which to concentrate for welfare comparisons, we will use income for pragmatic reasons associated with data reliability and imperfect measures of depreciation in the national accounts.

The data in Figure 2 indicate that the Australian economy, in large part, reflects the state of the international economy, sharing the downturns (in the 1930s and 1970s) and the intervening periods of (variable) prosperity.

A general point is that per capita GDP in the period to 1940 barely increased.[79] By way of contrast, real per capita GDP doubled in the period to 1971. In fact, the period from 1940 to the early 1970s has been described as the 'long boom', characterised, not only by growing per capita income, but also (virtually) full employment (unemployment exceeded three per cent in only two years), and a high rate of population growth (the population increased from 6,997,000 in 1940 to 12,407,000 in 1970).[80] It should be observed that rising per capita income also characterised other economies in this period (Western Europe, Japan, Canada and the US.[81]

4.2 Increases in Longevity

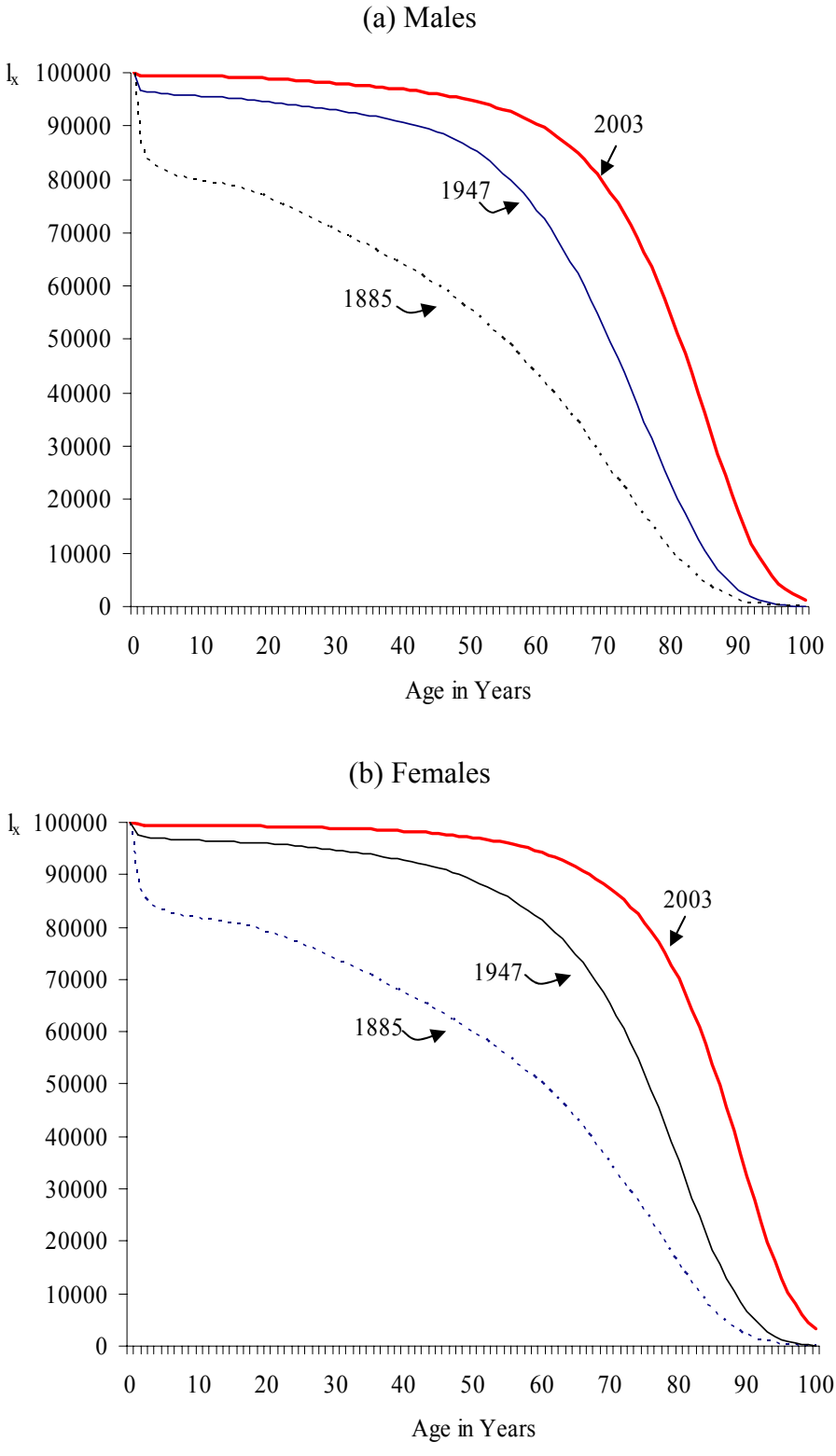
Attention is now directed to some trends in Australian demography over much the same period considered in Figure 2.

In the period since 1881-1890, there have been 23 life tables constructed for Australia, the analysis being undertaken by various agencies, the Commonwealth Bureau of Census and Statistics for 1881-1934, the Commonwealth (later Australian) Actuary for 1946-1998, and the Australia Bureau of Statistics, since 1999. Since 1994 there has been an annual life table produced. In earlier periods they were less

frequent. These different frequencies explain the temporal non-uniformity in subsequent diagrams. See Young for a discussion of the early period.[82]

Figure 3 shows the survival curves for three years, *viz*. 1885, 1947 and 2003. The survival curve has shifted markedly in this period as a result of declining mortality. It is clear that Australia, like the United States, has experienced the phenomenon referred to as 'the rectangularisation of the survival curve'[84] more generally Australia has experienced the demographic transition as described by, say, Lee.[85] It should not be thought that the decreases in mortality were uniform by age group: clearly since the late 19th century, infant and child mortality experienced significant decreases, and by 1947 these rates were but a fraction of their early values. A wealth of detail on the various causes of death (tuberculosis, infection etc, and their temporal changes) is available, and some will be considered below. We now turn to another variable which is a component of the life table, i.e. life expectancy.

In the 109 years to 2003, male life expectancy has risen markedly from 47.2 to 78.1 years, the comparable data for females being from 50.8 to 83 years. See Figure 4. There are some important temporal differences in life expectancy at older ages, especially for males. Life expectancy for the middle aged and the elderly increased markedly in the early 1970s, a phenomenon first documented in the Borrie *Report* of 1975.[87] The demographic projections undertaken by this research group initiated the (Australian) debate on the economic issues associated with an 'ageing society'.[88.,89]

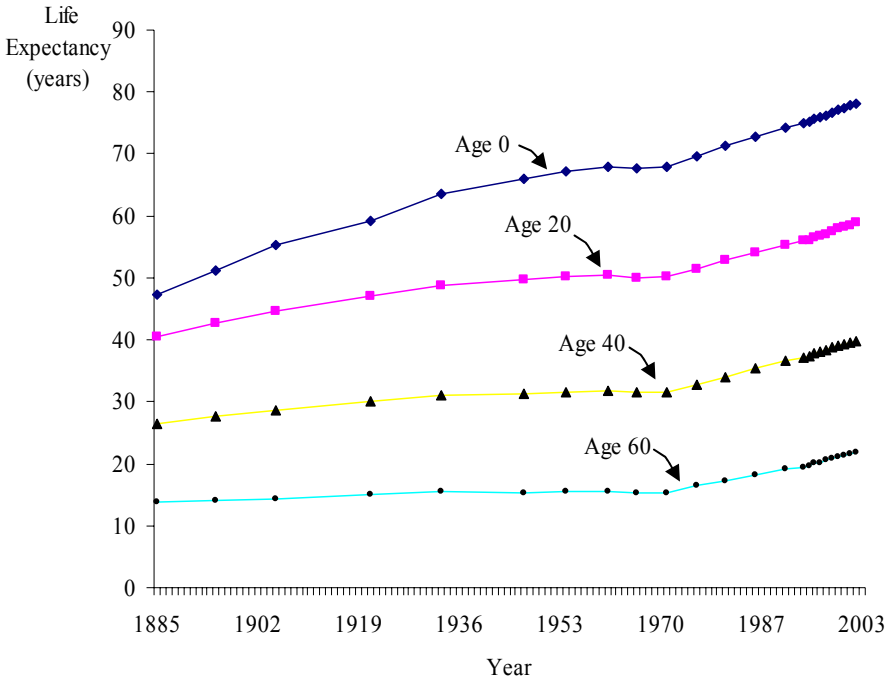


Source: Australian Bureau of Statistics [83] (Tables 50 and 54)

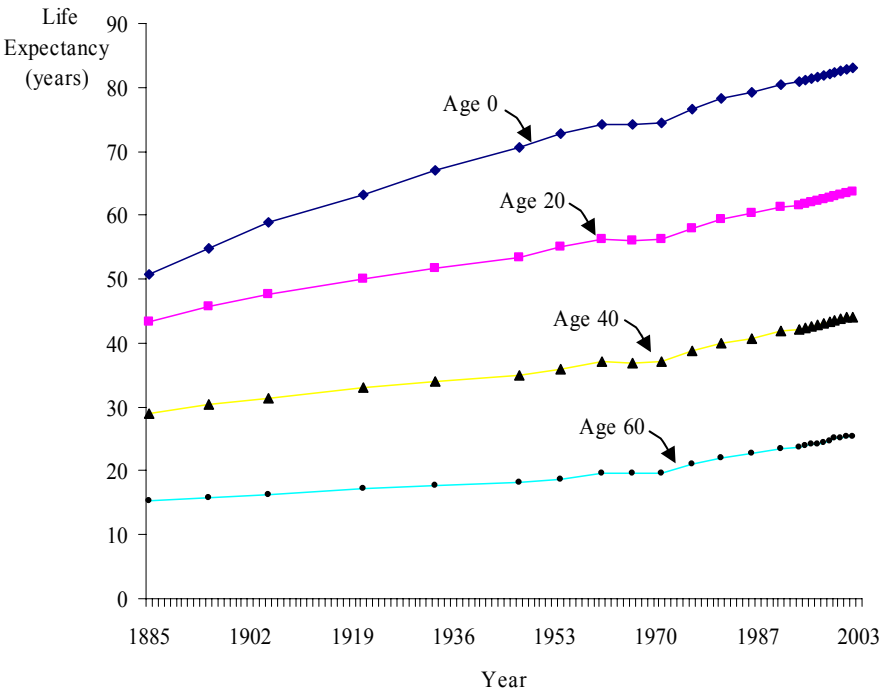
Notes: 1885 is the midpoint of the period 1881-1890, 1947 is the midpoint of the three-year period 1946-1948, 2003 is the midpoint of the three year period of 2002-2004.
l_x is the number of persons surviving to the exact age *x* out of 100,000 births.

Figure 3. Survival curves for Australian males and females, 1885, 1947 and 2003

(a) Males



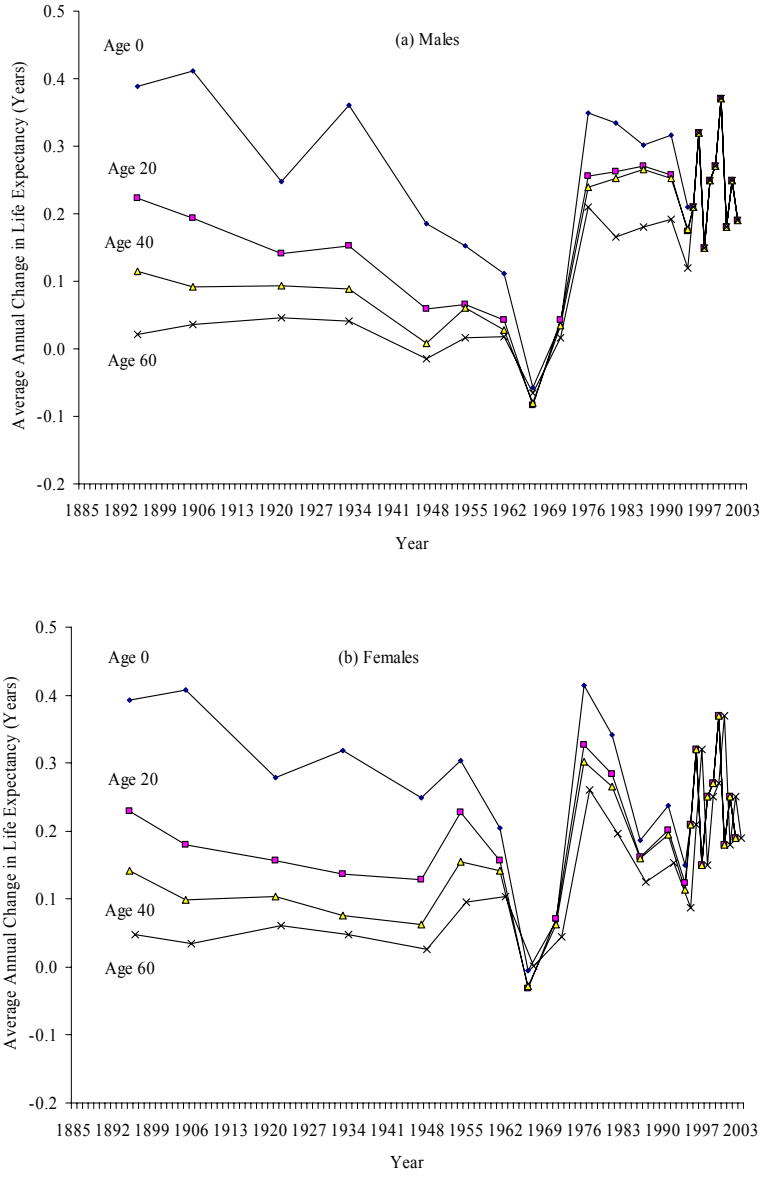
(b) Females



Source: Australian Bureau of Statistics [83] (Tables 49 and 53)

Figure 4. Life expectancy for Australian males and females at four separate ages from 1885 to 2003

Figure 5 shows the annual change in life expectancy for both males and females in the period considered from the Australian life tables. Note that the general trends are much the same for males and females.



Source: Australian Bureau of Statistics [83] (Tables 49 and 53)

Figure 5. Average annual change in life expectancy for Australian males and females at four separate ages from 1885 to 2003

There are three noteworthy points. First, as indicated in Cutler and Richardson[12] for the US, the mid-1960s were a low point of life expectancy change

for Australia: in fact there was a slight decrease in life expectancy from 1961 to 1966. Second, the life expectancy gains for different age groups decreased (and converged) up until the mid-1960s. Third, although the period since the late 1960s continued to exhibit convergence, there was a sharp increase from the late 1960s to the mid-1970s, and the annual increase has remained high since that time.

Another measure of longevity, i.e. mortality rates, will be considered below.

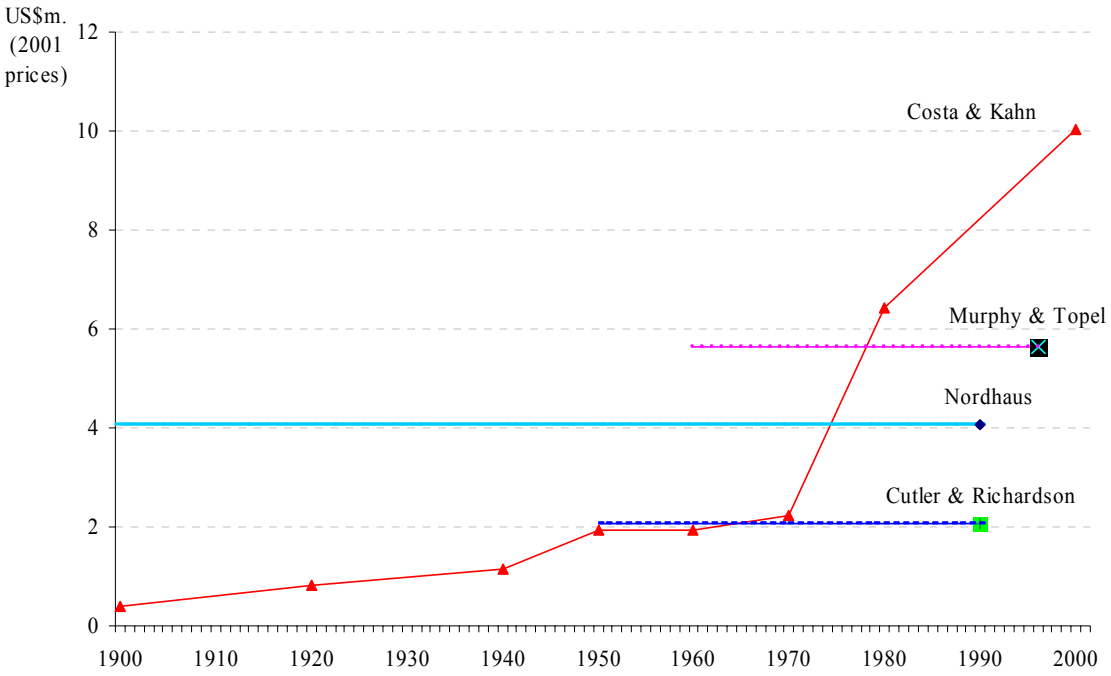
Clearly the Hobbesian perception of life being 'solitary, poor, nasty, brutish and short' is not a correct description of Australia's twentieth century experience.[90]

Attention now turns to a discussion of the empirical literature that has produced numerical values for a statistical life. After a general discussion of the literature, the focus turns to Australian estimate of the value of a statistical life.

4.3 Some Values of Statistical Life for Australia

The literature on VSL was discussed in Section 2.2. A limitation of previous studies on VSL has been the use of a single value through time for the valuation of life. Effectively this assumes that VSL is constant despite the passage of economic growth. It might be argued that, as the quantity of safety has increased, the compensating wage differential would also have increased.[10] Put otherwise, as incomes rise, people will value life more highly. Several recent studies, using time-series data, have calculated the income elasticity of the VSL to exceed unity. Hammitt, Liu and Liu have determined values of 2-3 for the income elasticity of longevity in the rapidly developing Taiwanese economy for the period 1982-1997,[91] and Costa and Kahn have calculated values for the US (in 1920 to 1980) in the range 1.5 to 1.7.[92]

Figure 6 presents a graphical account of the data for VSL adopted by Cutler and Richardson,[12] Nordhaus,[15] Murphy and Topel,[16] and the time period for which those values applied.



Sources: Cutler and Richardson,[12] Nordhaus,[15] Murphy and Topel,[16] Costa and Kahn[92]

Notes: All data for VSL have been converted into US $s (2001prices) using the US Consumer Price Index. [93 (Table B 60)]

Figure 6. Time Series Estimates of the Value of a Statistical Life (VSL) Employed in Four Separate US Studies of the Economic Value of Mortality Decreases, US $m. (2001 prices)

For example, the VSL adopted by Cutler and Richardson was US$2,069,000 (2001 prices), and that value was for the period 1950-1990. In addition, and most importantly, the Costa and Khan data are also indicated. Figure 6 starkly shows the effect of assuming a point estimate for a particular year applies through time: Costa and Khan's time-series relationship is intuitively more appealing than the alternative procedure embodied in the three other works depicted in Figure 6.

This Australian study will assume that the US temporal relativities (calculated by Costa and Kahn) for the US VSL apply also to Australian data. What we will do is apply those relativities, not to US estimates of VSL, but to conservative Australian estimates of the VSL.

There are two studies of the VSL in Australia, one for 1984-85 by Kniesner and Leeth,[94] and the other by Miller *et al*. for 1991.[95] The former has a VSL of A$ 3,614,212 (2000-01 prices) and the latter has a value of A$11,722,376 (2000-01 prices). Viscusi and Aldy[51] regard the former as being on the 'low' side whereas the latter is regarded as being on the 'high' side. In fact, they place some importance on the median value of US $7 million. Figure 7 indicates these two Australian studies (expressed in $US), as well as the (point) estimates for the three US studies, and the temporal data of Costa and Kahn.[92]

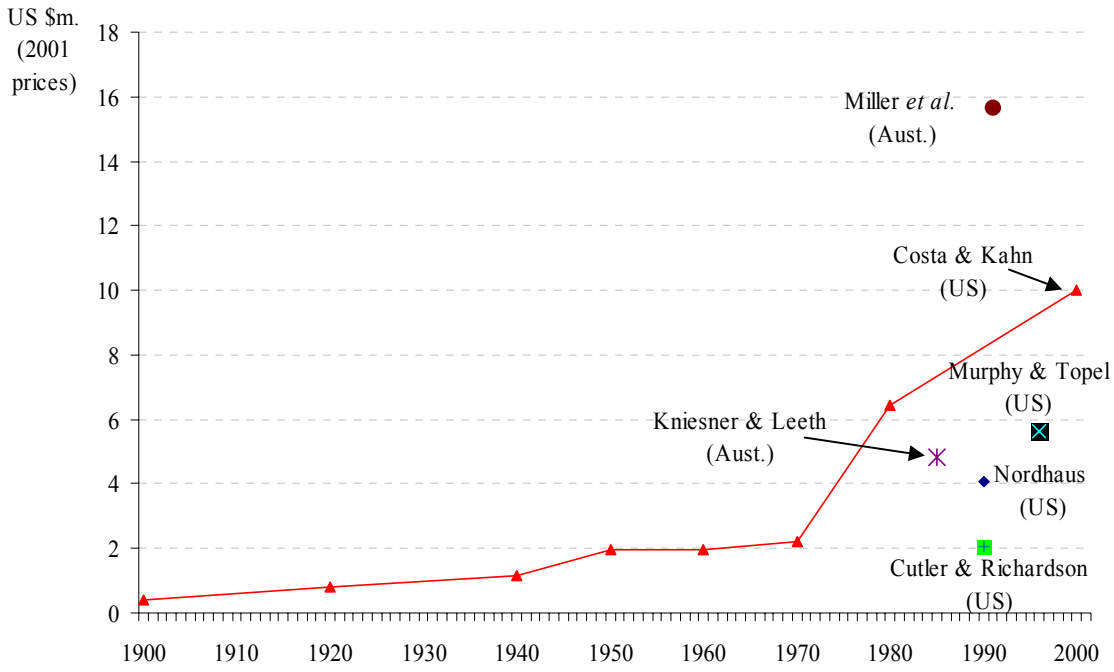
Our procedure is to employ two 'conservative' assumptions of the VSL estimate for Australia: more specifically, we calculate the Australian equivalent of the Nordhaus[15] (US) datum and the Australian equivalent Cutler-Richardson[13] (US) datum. Subsequently, we will refer to the 'Nordhaus figures' as an 'upper bound estimate' and the 'Cutler-Richardson figures' as a 'lower bound estimate'. Both of these studies, unlike Costa and Kahn's time series work, employ point estimates and assume that those estimates apply in other time periods. However, we will apply the temporal relativities implicit in the Costa and Kahn study to the Australian dollar equivalent VSL for both Nordhaus and Cutler-Richardson. All relevant exchange rate conversions have been undertaken by reference to the *Penn World Table Version 6.2*.[96]

5. The Valuation of Australian Longevity Gains

We now begin to bring together the empirical components of this paper to produce a measure of the economic value of longevity experienced since 1907, the first year for which reliable Australian mortality data are available.

All empirical work reported below involves age-standardised data, the 1991 age distribution being the reference point.

Our procedure has been to split the period 1907-2001 into five sub periods: 1907-1921 (15 years), 1922-1941 (20years), 1942-1961 (20 years), 1962-1981 (20

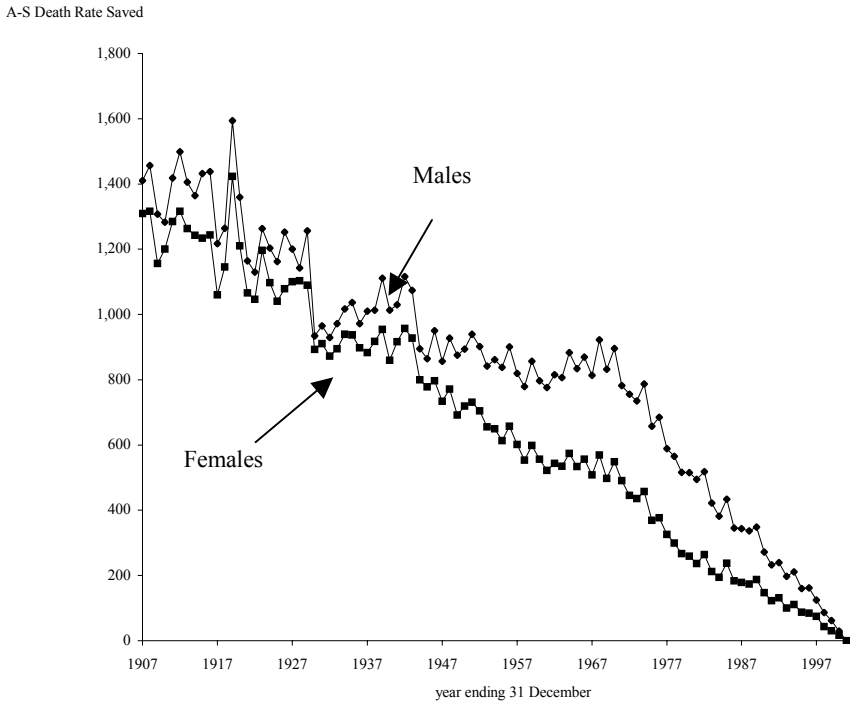


Sources: Cutler and Richardson,[12] Nordhaus,[15] Murphy and Topel,[16] Costa and Kahn,[92] Kneiser and Leeth,[94] Miller *et al*.[95]

Figure 7. Six Estimates of the Value of a Statistical Life (VSL) from Four US Studies and Two Australian Studies, Various Years, US $m. (2001 prices)

years) and 1982-2001 (20 years). In terms of VSL, we have interpolated values for the mid points of the sub-periods listed above.

The first, and very important, component of the analysis is the application of the 2001 mortality experience to earlier years, the central feature of Figure 1. Figure 8 shows the difference in the death rates (for males and females) if the 2001 death rate applied. Note that the male 'savings' or 'gains' in longevity exceed those for females. This is a reflection of two factors, *viz*. that recorded male mortality has exceeded female mortality historically, and that the 'gap' between the two rates had narrowed by 2001. The second point is that the graphs in Figure 8 converge to the X-axis,

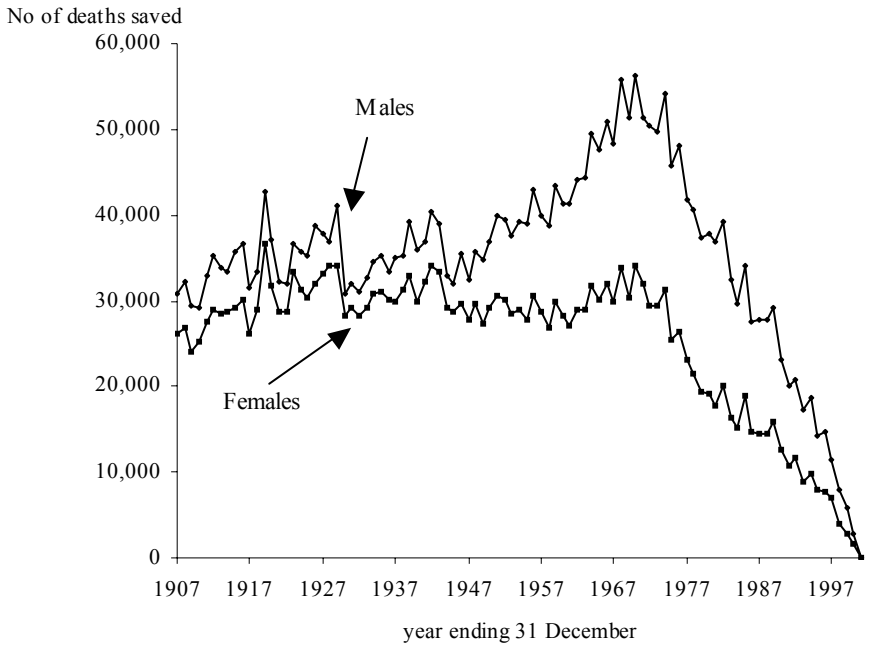


Source: Australian Institute of Health and Welfare[97]

Figure 8. Gains in the age-standardised death rate, assuming the 2001 death rate applied, males and females, Australia, 1907 to 2001

and cut that axis in 2001. This is a manifestation of the fact that the 'gains' in mortality fall the closer one approaches 2001 (which is a reflection of the higher mortality rates the further back one goes in time), and that the 'gains' are zero (by definition) in 2001.

The next step is to transform the differences in death rates in Figure 8 into numbers of death saved, given the 'low' death rates of 2001. Figure 9 depicts the outcome of this step. The outcome reflects two factors, *viz*. the difference in death rates over the period (as reflected in Figure 8), and the size of the population in the



Source: Australian Institute of Health and Welfare[97]

Figure 9. Number of deaths saved, assuming the 2001 death rate applied, males and females, Australia, 1907 to 2001

various years. As with Figure 8 the male gains exceed the female gains, which is our *a priori* expectation. It is noteworthy that non-uniformity characterises both graphs. Female deaths are (more or less) constant from 1940 to the mid-1970s, whereas male

deaths 'saved' increase from 1940, and reach a maximum in the early 1970s, reflecting the non-existence of mortality improvements in the 1960s, a phenomenon referred to above. This non-uniformity is a manifestation of the interaction of the two variables mentioned above.

Table 1 presents the answer to the question: 'what is the value of the longevity gains experienced in Australia since 1907?' The first column of the Table presents an aggregation of GDP for the five sub-periods we have been considering, as well as the entire period from 1907 to 2001. The GDP data are relevant because of the discussions above concerning adjustments to GDP. The next two columns present the aggregate values of the longevity gains for Australia, based on a lower (Cutler-Richardson) and upper (Nordhaus) bounds of the VSL, expressed in A$ (2000-01 prices). Our calculated values are 'plausible', in that they lie in the range 0-100 per cent: any results outside that range (either negative or exceeding 100 per cent) would be most implausible! Thus, this part of our study confirms the results (in broad outline) of the US studies, and the single Swedish study, which have imputed a value for the increasing length-of-life experienced in these countries in recent times.

6. The Relative Numerical Importance of Mental Illness in Longevity Gains

Attention is now directed to putting mental illness into this context of increasing longevity and the rising valuation of that longevity.

Figure 10 presents the mortality rate (All Causes) for Australia in the period 1907-2004, as well as some particular causes of death. Concentrating for the moment on the All Cause rate, it is clear that Australia has experienced a striking secular decline in mortality associated with various demographic phenomenon called 'the rectangularisation of the survival curve', 'the demographic transition', etc. [84, 85, 98, 99]

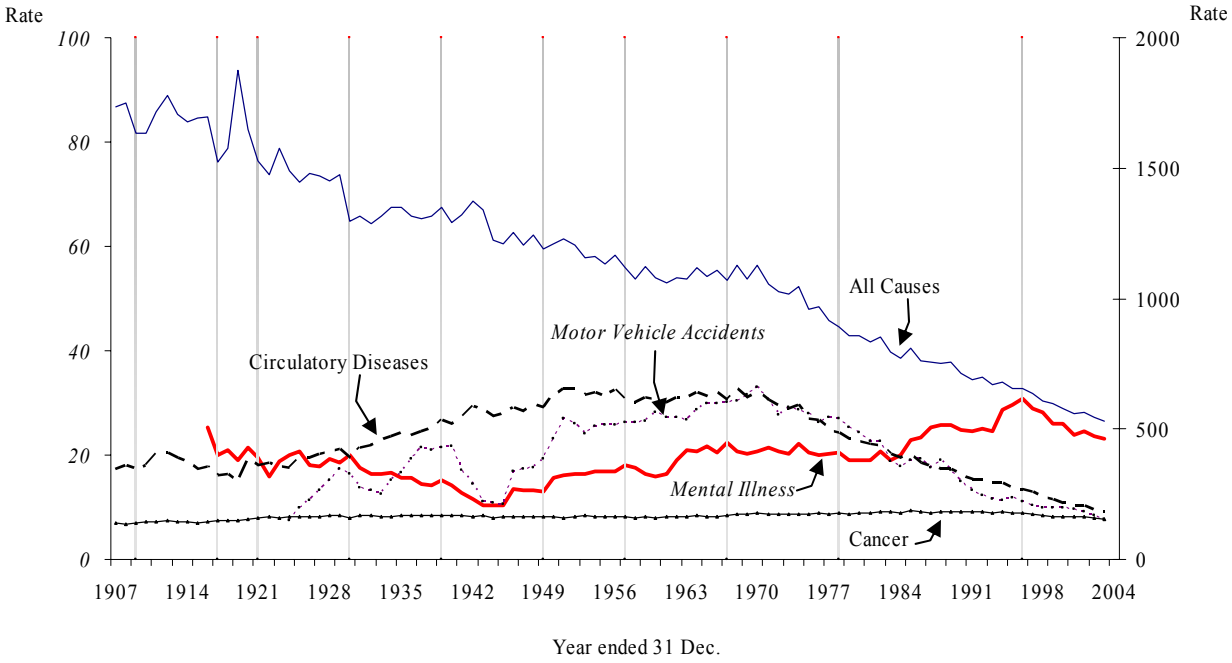
Period	GDP (A$'000m.) at constant (2000-01) prices	Total VSL (A$'000m.) at 2000-01 prices, Males and Females (Lower Bound)	Total VSL (A$'000m.) at 2000-01 prices, Males and Females (Upper Bound)	VSL Estimate as a Percent of GDP (%) (Lower Bound)	VSL Estimate as a Percent of GDP (%) (Upper Bound)
(1)	(2)	(3)	(4)	(5)	(6)
1907-1921	453.4	110.0	216.2	24.3%	47.7%
1922-1941	928.2	226.9	445.8	24.4%	48.0%
1942-1961	1,990.2	454.0	892.1	22.8%	44.8%
1962-1981	5,589.2	1,368.2	2,688.0	24.5%	48.1%
1982-2001	10,563.9	889.6	1,747.9	8.4%	16.6%
1907-2001	19,525.0	3048.8	5,990.0	15.6%	30.7

Sources: See text

Table 1. Gross Domestic Product, and upper and lower estimates of the Value of Statistical Lives saved, five sub-periods, and for 1907-2001, Australia

More specifically, the All Cause mortality rate has fallen from approximately 1,734 per 100,000 in 1907 to about 556 per 100,000 in the years since 2000. Such a decrease is quite remarkable. Figure 10 also depicts the relative magnitudes of four specific causes of death, *viz*. circulatory diseases (by far the largest single cause of

death), cancer (the second most numerous cause of death), and two relatively 'small' causes of death (motor vehicle accidents and the summation of mental disorders and



Sources: Australian Institute of Health and Welfare[97], Commonwealth Bureau of Census and Statistics[117-120]

Notes: (a) These rates have been standardised to the age distribution of the 1991 Australian population.

(b) The *left-hand Y-axis* is shown with *italics* and is relevant for the mortality rates for *Mental Illnesses* (Mental Disorders and Suicides) and *Motor Vehicle Accidents*, whereas the right-hand Y-axis indicates the scale for the mortality rates for Total Deaths (All Causes Combined), All Cancers and All Circulatory Diseases.

(c) 'Mental Illnesses' includes Suicides.

Figure 10. Age-standardised mortality rates for motor vehicle accidents, circulatory diseases, cancers, mental illness and all causes, Australia, persons, 1907–2004

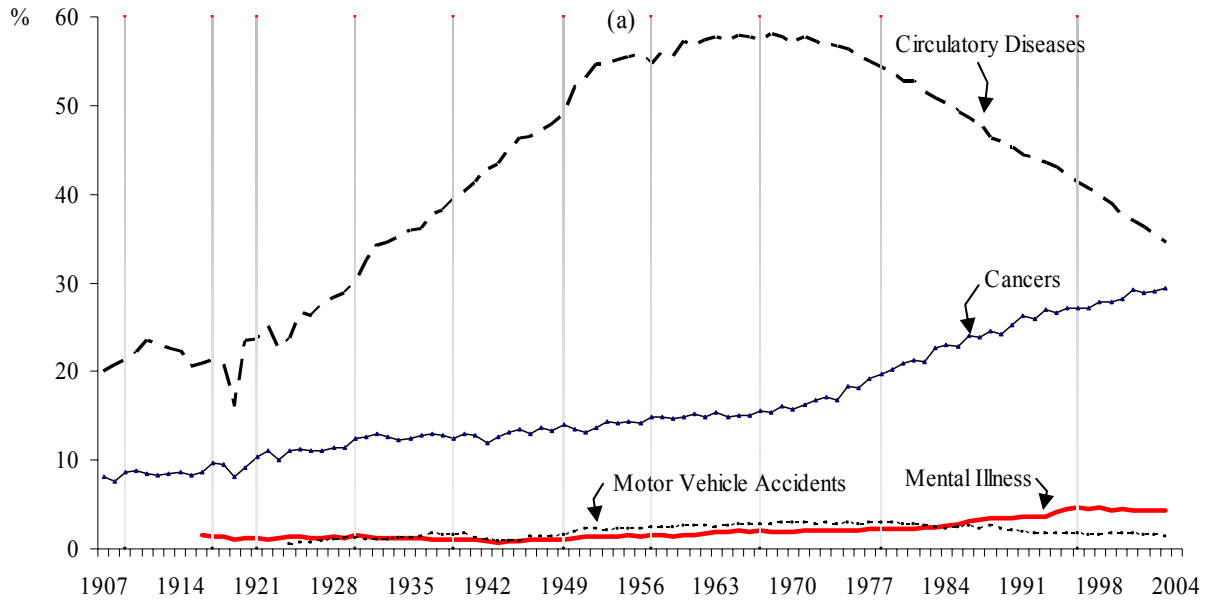
suicide). We will take the summation of these two causes of death as a rough approximation of the (mortality) size of the problem of mental illness. We have considered, elsewhere, the numerous conceptual and empirical problems associated with measurement of 'mental illness'.[100] The trends in these different rates vary in the sub-periods since 1907. The cancer mortality rate over the whole period is virtually constant, whereas the mortality rate for circulatory diseases initially rose, but has

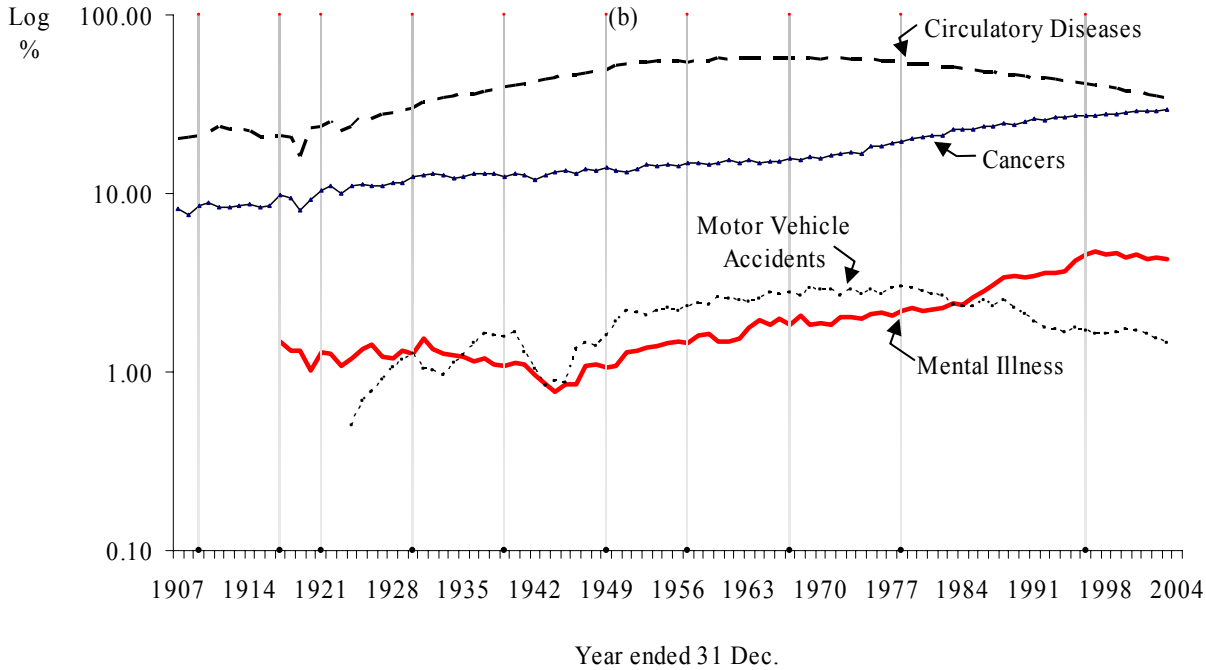
experienced a persistent and continuing secular decline from 1968. Mortality arising from motor vehicle accidents (data on which were first recorded in 1924) increased until 1978, and has declined since then.

The temporal trend associated with mental disorders and suicide combined (our aggregate measure of mental illness) is unique compared to the other three measures in Figure 10. From a relatively high level in the 1920s and early 1930s, there was a fall during the World War II period, and then began to increase again, reaching a local maximum in 1996. The period from the mid-1980s to 2004 has experienced a considerably higher level of mortality from mental illness (as defined) compared to the earlier post-WWII period. Note that the mortality rate from Motor Vehicle Accidents, which exceeds that for mental illness (as defined) from the 1930s to the 1980s (often by a substantial margin), has been less than the mental illness rate since 1983.

Figure 11, which is in two parts, indicates the proportionate 'shares' for each of these causes of death relative to All Causes through time. This is calculated as the ratio of each of the above four causes of death to All Causes, expressed as a percentage. The two-part structure of this figure is explained by the relatively large differences in the proportions for these specific causes. The scale of the Y-axis in Figure 11(a) is in levels whereas the scale in Figure 11(b) is logarithmic, so as to provide detail of the trends in the 'smaller' causes of death.

Figure 12(a) shows that, during the period from 1950 to the 1980s, circulatory diseases accounted for at least half the deaths but that, since then, the relative fall in this cause of death is quite marked, accounting for 35 per cent of deaths in 2004. The relative importance of cancer has increased: approximately 10 per cent of all deaths





Sources: As for Figure 10

Note: The Y-axis of Figure (b) has a logarithmic scale.

Figure 11. Shares of four causes of death to all causes, measured by counts, Australia, persons, 1907–2004

were due to cancer in the 1940s and almost 30 per cent by 2004. In Figure 11(a) it is quite difficult to interpret the data for motor vehicle and mental illness mortality: however Figure 11(b) clarifies matters. The relative importance of mental disorders and suicide reached a maximum of nearly 5 per cent in 1996.

The message from Figures 10 and 11 is clear: mental illness (measured by the summation of deaths from mental disorders and suicide) has contributed nothing to the aggregate increase in longevity that Australia has experienced in recent decades.

It is interesting to note that mental disorders and suicide are not classified as being 'avoidable' in recent publications that classify causes of death into 'avoidable' and 'non-avoidable'. The concept of 'avoidable mortality' or 'amenable mortality' (meaning mortality amenable to health interventions) builds on the early work of Rutstein *et al.*,[101] after which numerous scholars developed lists of diseases/conditions for which medical or societal interventions are efficacious. The key characteristic of being 'avoidable' is that mortality does not arise for particular diseases/conditions if appropriate health care interventions (in terms of timing and efficacy) are undertaken.[102,103] See Nolte and McKee for a comprehensive review.[102] In the context of empirical work, the European studies under Holland are notable.[104, 105] Nolte and McKee's listing of 'avoidable' conditions has recently been empirically applied.[105]

The relevance of avoidable mortality is this: mental disorders and suicide are **not** included in **any** list of 'avoidable deaths'. **Mortality from these mental illnesses has implicitly become classified in a 'non-'avoidable 'box'.**

Various factors have affected the trends observed in Figures 10 and 11. Regarding the rise of motor vehicle transport from the early decades of the twentieth century, at first the rise resulted in a rise in accident mortality through time, but numerous government interventions (seat-belt legislation, crash helmets, safety-

designed roads, drink-driving legislation etc.) were developed. Some such interventions have been shown to be efficacious.[107] In like manner, efficacious interventions for ischaemic heart disease and related conditions have been developed.[108]

The data of Figures 10 and 11 present a partial picture of Australia's mortality experience in the twentieth century. Not shown are some of the major causes of death in the in the early years of the twentieth century: big 'killers' were various diarrhoeal diseases, infectious diseases (whooping cough, scarlet fever, diphtheria and measles), meningitis and polio and maternal mortality (puerperal fever, haemorrhages, toxaemias and infections). These causes of death have experienced very large decreases since the 1900s.[109] However, it should not be thought that these declines have occurred in the latter part of the century. For example, Wilcocks and Lancaster[110] reported in 1951 that in the period to 1948, the maternal mortality rate decreased from 6.1 to 1.5 (per 1000 confinements) at ages <20. In the 1910s diarrhoeal diseases accounted for 7-8 per cent of all deaths, and by the mid-1940s their relative importance had fallen to about 0.5 per cent of all deaths.[109] Tuberculosis had a similar temporal pattern: in the 1910s it accounted for approximately 7 per cent of all deaths yet by 1945 it was also approximately 0.5 per cent of all deaths.[111, 112] A similar trend has occurred for infectious diseases.[113] It is not our purpose here to debate the factors that caused these sharp declines. However in this context it should be noted that public health measures of one kind or another were implemented,[114] public investments in reticulated and waste water systems were undertaken, as well as rising standards of living, better nutrition, the use of chemotherapy etc.[109]

7. Conclusion

For various reasons there has been a re-awakened interest in the economic significance of longevity, an issue first analysed by Usher in 1973.[8] The theoretical framework for imputing a value for the length of life involves the same critique of national accounting procedures with respect to pollution, a topic first addressed by Nordhaus and Tobin[3,4] at much the same time (the early 1970s) as Usher outlined how to bring longevity into focus by applying the Pigovian 'measuring rod of money'. By way of contrast, environmental issues have since received enormous attention (by academics and the general public) whereas, until very recently, longevity has been neglected.

This paper has been concerned with the place of mental illness in this longevity literature that commenced with Usher's work. It should be noted (in passing) that the literature with which this paper is concerned is not in the *genre* of work on health and longevity (e.g., van Zon and Muysken[115], Aísa and Pueyo[116]) that has emerged within the endogenous growth framework.

The present study has been concerned with several contributions in health economics that have in common the characteristic of re-thinking a 'conventional wisdom' in the health sector, i.e. a 're-appraisal'. That conventional wisdom relates to the proposition that rising (absolute and relative) aggregate health expenditures constitute a problem, the usual policy prescription being that cost-containment should be the objective.

It is commonly argued by scholars of this re-appraisal perspective (which has been taken up also by several groups of economists) that a focus on rising health expenditures, without considering the improvements in health status brought about by those expenditures, is unbalanced: the health gains must be considered alongside the

expenditures. An important dimension, leaving aside morbidity changes, of rising health status, is longevity.

The valuation of longevity improvements involves applying concepts from a number of different strands of work, not simply in health economics, but in economics *per se*. In addition, it should be recognised that the analysis also involves considerable input from demography. The valuation of longevity may seem eclectic to some readers, but all the pieces are necessary to solve the puzzle.

We have applied the procedure developed in this literature to impute values for longevity to Australian data, and the results are in line with international studies. Given our focus on mental health, we have determined the role of mental illness (defined by the ICD codes for mental disorders and suicide) in the improvements in Australian longevity: in short, our results reveal that there have been **no** improvements in mortality arising from mental disorders and suicide. In other words, the goods and services provided to the mentally ill have contributed nothing to the improvements in Australian longevity. Such a sobering conclusion leads us to the importance of research: it is from a heightened research effort that efficacious therapies for mental illness will be developed.

Finally, it would be judicious to keep in mind a qualification alongside the above result: the arguments presented here do not negate the common criticisms that are routinely levelled at the health sector (poor access, inappropriate treatment, rent seeking etc.). As argued cogently by Karen Davis *et al.*,[71] those shortcomings of the health system still apply, despite this 'reappraisal' literature.

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