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Natural Selection, Health Economics and Human Welfare

by
Alan Williams

DISCUSSION PAPER III

NATURAL SELECTION, HEALTH ECONOMICS AND HUMAN WELFARE

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The Author

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Acknowledgements

This essay had its origins in discussions I had with Tom Kirkwood at a meeting on ageing in Bethesda MD in 1987, which suggested to me that the theoretical models used by biologists to explain ageing bore a close resemblance to economists' models of resource allocation in health. This serendipitous encounter has led me to see my own work in a rather different light, aided and abetted (wittingly or unwittingly) by the many people who have responded (positively or negatively) to my ideas as I have struggled to organise them more coherently. The present paper indicates where I have got to in this process, and it has benefitted from (or perhaps I should say "been influenced by") the comments of Tony Culyer, Rhiannon Edwards, Victor Fuchs, Marlene Gyldmark, Peter Hogarth, Alan Maynard, Lesley McTurk, Wendy Morrison, Gavin Mooney, Cathy Staples and Adam Wagstaff.

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ABSTRACT

In evolutionary physiology the human body is viewed as a resource allocation mechanism working according to a predetermined set of priorities to maximise reproductive capacity. In health economics people are viewed as having a portfolio of assets (health; wealth; and wisdom) which they manage over their lifespan according to priorities that are intended to maximise the length and quality of that lifespan. This essay explores the similarities and dissimilarities between these two approaches to health (at both the individual and population levels), and concludes that, since natural selection is no longer a significant influence on human demography, we as societies have to adopt conscious resource allocation policies to fill the void. These individual or collective priorities need not be those bequeathed to us by our physiological evolution, but if they do differ we need to be aware of the tensions between them, and of their demographic consequences.

I INTRODUCTION

When I discovered that some biologists interested in evolutionary biology had found it convenient to conceptualise their central concerns using models borrowed from economics, I decided to try to find out in what ways they had had to adapt or develop "our" models in order to solve "their" problems, thinking that perhaps these innovations might prove useful to us if we borrowed them back! But in the event this proved less interesting than mulling over the analogies that their work suggested to me between (a) the autonomous homeostatic "rules" built into our individual physiological systems to maintain our fitness as organisms, and (b) the deliberately chosen "rules" we build in to our collective social systems to maintain our health as communities.

I shall argue that the biological model which underlies natural selection is no longer useful in explaining human demography. The economic model is more general and more useful in according a central role to the rules we adopt as societies regarding the production and distribution of health. But where these societal rules conflict with our evolutionary heritage as individuals, we are likely to have great difficulty in accepting them and acting upon them ..... our "instinct" or "intuition" may pull us in a different direction. Hence we may expect great social tensions to develop as we move from innate maximisation of reproductive capacity to a more deliberative and conscious concern to improve the general quality of our lives, in which rearing offspring will play a part, but only a part. Dramatic examples of such tensions are the fierce debates surrounding contraception and abortion.

The substance of the paper begins (in section II) with my understanding of those bits of evolutionary physiology which are both accessible to me and seem to be relevant to my main theme. Evolutionary physiology deals with all organic species, but I shall restrict myself to humans. It has also spawned a whole raft of mathematical models which might well repay closer attention by those more numerate than me. I can only rehearse their key features in more informal terms, running the inevitable risks of misunderstanding and unwitting misrepresentation. But these risks have to be run in the interests of interdisciplinary cross-fertilisation (in the hope that enriching our intellectual "gene pool" might have survival value both for our species and for us as individual members of it!).

Section III sets out the bits of health economics that bear most directly on my theme. Needless to say there is a lot more to the subject-matter of the sub-discipline than I shall draw upon here[1] so the uninitiated should not be misled into thinking that I am offering an exhaustive account of what health economics has to offer to struggling humanity.[2] Indeed this whole paper is essentially a **personal** essay, reflecting **my own** interests, and drawing heavily on **my own** earlier work. Not all health economists would agree with my views.

Section IV highlights the analogies I see between the biological and the economic approaches to the health of individuals, and, perhaps more significantly, the differences

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[1] For a more comprehensive view of the scope of the sub-discipline see Blades, C.A. et al, (editors) The International Bibliography of Health Economics, Parts One and Two, Wheatsheaf Books, Brighton (1986), and the contents of the Journal of Health Economics.

[2] I have done that in a more popular vein in "Health Economics - The Cheerful Face of the Dismal Science" in Williams, A. (editor), Health and Economics, Macmillan, London, 1987.

between them.

In Section V I go on to explore the differences between the two models as regards their respective implications for the health of whole populations.

In my concluding Section VI I will offer some broader observations about problems that I find of absorbing intellectual interest, and which also seem to be of some considerable significance for the welfare of humankind.

II EVOLUTIONARY PHYSIOLOGY[3]

Two basic concepts in this field are the **genotype** and the **phenotype**. The former is essentially a set of templates controlling the form and function of the latter (which is a complex organism – such as a human being). This set of templates (or genome) needs to include instructions to the phenotype that will maximise the probability that in the long term the individual (and thereby the species) will survive (and preferably even thrive) in whatever environment it finds itself. But errors in copying those instructions, and/or faulty execution of instructions, and/or damage to the phenotype from sources external to it (e.g. through disease, or accidental injury, or an impoverished or hostile environment) will generate a broad spectrum of differentiated phenotypes.[4] Natural selection will favour those

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[3] In this section I have drawn heavily on Sibley, R.M. and Calow, P., Physiological Ecology of Animals: An Evolutionary Approach, Blackwell Scientific Publications, Oxford, 1986. Page references at the end of quotations in the text are to that work unless otherwise indicated.

[4] Further differentiation may also occur through mutation of the genotype.

variants of the phenotype which prove well adapted to their environment, and select out the others. To the extent that these favoured variations are transmittable through differential fecundity, they will affect the gene pool, the genotypes, and hence the phenotypes in subsequent generations. Thus

> "The study of adaptation ..... asks why specific phenotype traits have evolved in association with specific ecological conditions ..... In particular we shall be concerned with physiological adaptations of resource acquisition and use because we will argue that this is not only the basis on which organisms function physiologically but also the basis of their form (allocation of resources between different structures) and behaviour (allocation of resources between different activities). Patterns of resource use are controlled by enzymes and hence ultimately by genes, so ..... those patterns of use will be favoured that best promote the spread of genes that code for them ..... Nevertheless, one physiological process has to operate within the context of others which constitute the phenotype, and this is particularly true given that the resources required for use are finite and limited ..... Hence there are constraints operating within organisms on what patterns of allocation and hence phenotypic traits can evolve. Genotypes determine phenotypes, but the physiology of phenotypes constrains what association of genes (i.e. genotypes) can evolve" (p.1)

> "The core neo-Darwinian hypothesis usually adopted is that successful phenotypic traits will be those which maximise fitness. In principle this means the ones that maximise survival (S) and fecundity (n) and minimise generation time (t) of organisms that carry the traits. However ..... it will not usually be possible in practice to maximise these components of fitness simultaneously. There will be trade-offs and constraints so that optimisation is often a more important element of the core hypothesis than maximisation per se. (pp. 5-6)

It is then suggested that the key strategic investment decisions an organism has to make are between **growth, defence** and **reproduction** (pp. 13-15), and that the contribution of each of these activities to "fitness" (which may be broadly interpreted to mean the capacity to produce viable and fertile offspring) will vary according to the age of the organism (i.e. according to its stage in the life-cycle) (pp. 19-21). For instance

> "To increase fitness, it is desirable to reproduce fast, but it is also desirable to grow fast so as to be bigger (and able to reproduce faster) in the future ..... Early in life, growth may be advantageous. As the end of reproductive life approaches, growth is less useful, because there will be little time to take advantage of increased size" (p.21)

Moreover, since resource inputs may vary between organisms, so will the optima (pp. 23–24), and since resources are neither homogeneous nor infinitely versatile it may be necessary in any optimisation model to specify the precise vector of resources available, and which particular resource constraints are binding in any particular situation (p. 25). But "the most generally suitable currency" to use as a standard measure of resources in the case of animals (including humans) is energy (p. 25).

At this point a note of caution "on the general validity of the economics approach" is considered appropriate:

> "An economics of metabolism with energy as currency emphasises the quantitative aspects of the genotype. However, the quality of behaviour and form will often be important in determining survival and reproductive success. for example, the organisation of a nervous system is probably as important to the way it works as its size. Size nevertheless puts important constraints on form and organisation even in nervous systems ..... An ..... organisation and form are generated by the differential allocation of resources between structures in space. Hence the economics of resource use can make important statements about form and organisation and then about the consequences of this form and organisation". (p. 25)

One aspect of the "form and organisation" of the human physiology that is of particular interest here is the capacity to repair damage (from whatever cause). The effective repair of damage requires accurate and prompt information about the nature and location of the damage, what the repair possibilities are, and an ability to mobilise the

necessary resources to carry out the repair before the damage proves irreversible. In general, local responses to local problems meet these requirements most efficiently, and this includes rapid defence mechanisms that minimise damage in the first place. To the extent that effective defence and repair activities reduce the mortality risk, this "lifts the pressure off the rate of replication and thereby permits a wider range of adaptation"[5] though only if reducing mortality increases fitness. This will depend on the costs of repair. This in turn raises the question "When is repair worthwhile, and which types of damage should be repaired before others?"[5]

Exponents of the "disposable soma theory"[5] argue that since an organism's life history is essentially a set of co-adapted traits that together determine its age-related patterns of growth, reproduction, senescence and death, and that this life history must have evolved because of its superior contribution to fitness, the priority rules for repair activity must themselves maximise fitness by optimising the distribution of resources between growth, defence and reproduction. Thus up to the stage of the life cycle when offspring are born and reared to maturity, a balanced programme of repair will maximise fitness. A "balanced" programme means one in which the marginal unit of any scarce resource (e.g. energy) devoted to each component of fitness makes the same contribution to overall fitness no matter how it is used.[6] For instance, to try to sustain a higher than optimal growth rate will lead to sub-optimal levels of defensive capability and reproductive capacity,

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[5] Kirkwood, T.B.L., "Repair and its Evolution: Survival versus Reproduction" in Townsend, C.R. and Calow, P. (editors) Physiological Ecology: An Evolutionary Approach to Resource Use, Blackwell Scientific Publications, Oxford, 1981.

[6] including holding back sufficient reserves to cope with future emergencies and routine maintenance.

because the energy needed to sustain them will not be available if it has gone into growth. And the consequence of giving priority (in an optimal way) to the activities which contribute to fitness is that low priority is given to all other activities, so that there are relatively sparse resources available for them. Damage which does not impair fitness is likely to go unrepaired.

When this last consideration is put together with the observation that internally generated "errors" and externally generated "damage" are both likely to cumulate (at an increasing rate?) with increasing longevity of a particular organism, the explanation offered by the "disposable soma" theory for senescence and finite life-spans is that the organism finds itself with too few resources available for repair activities in later life because it has behaved optimally with respect to fitness in its earlier life, and it is this trait which is selected for transmission to the next generation. So we are not exactly "programmed" to die at age 115 or whatever, but we are "programmed" with a set of priorities which has the effect of making it very unlikely that any of us will survive much longer than that, even when living in an ecological habitat which has been made incredibly productive, and in the protected environment of a peaceful "welfare state".

III HEALTH ECONOMICS

Health economists have found it important to distinguish sharply between the demand for health and the demand for health care. The demand for health may be met in many ways, of which seeking medical care is but one. Indeed it could be argued that in the richest countries of the world the marginal benefits from medical care are negligible (and

even possibly negative), whilst in the poorest countries of the world improving nutrition and hygiene will be far more cost-effective in improving health than investing in hospitals (even though such countries may have very few hospital beds per head of population). But it is not my immediate purpose to plunge into that territory, but simply to emphasise the importance of making a distinction which is still too rarely made..... the distinction between "health" and "health care".[7]

When thinking about health at the level of the individual, it is best seen, together with knowledge, as constituting that individual's human capital. Knowledge ranges from the basic skills required for everyday living (which can be quite demanding) to people's broad attitudes towards life, their worldly wisdom. In addition to these two intangible assets (health and knowledge), people also have tangible assets (such as houses, cars, personal belongings, and savings). So people's paths through life could be viewed as being essentially concerned with the management (or mismanagement) of these three types of asset - Health, Wealth and Wisdom.[8] Each can be seen as a capital stock yielding a flow of services over time. Each is subject to depreciation and capable of augmentation (within limits). The general situation is summarised in Table I.

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[7] It should be noted that by "health care" is meant not only medical and nursing and remedial and rehabilitative interventions as typically provided by health services or nursing homes, but also counselling and advisory services concerned with health that might be provided by other bodies. As will become evident shortly, the "health care" provided within the household by lay people constitutes an awkward borderline case, which it is sometimes advantageous to separate out, and sometimes not. In general I shall here distinguish "informal care" from "health care", reserving the latter term for care provided by "professionals".

[8] Here I am drawing heavily on an earlier excursion I made into this territory, namely: Williams, A., "..... Makes a Man Healthy, Wealthy and Wise! (or from folklore to system science)". In Duru, G. et al (eds) System Science in Health Care: Vol 2. Health Care System and Actors, Masson, Paris, 1988, pp. 57-60.

Table 1: Health, Wealth and Wisdom as Capital Stocks

Capital Stock	HEALTH	WEALTH	WISDOM
Measured as: The present value of the expected future stream of	Quality-adjusted life-years	Net real income	?
The associated current flow of services being	Quality-adjusted time and energy	Purchasing power and the use of consumer durables	Lifestyle possibilities, adaptive skills and valuations
Time-related depreciation due to	Ageing (Physiological)	Inflation (and retirement conventions)	Ageing and obolescence of knowledge/skills
Use-related depreciation due to	Hazardous lifestyles	Capital consumption	?
Augmentation possible by	Health promoting life-styles and medical care	Investment	Learning (from study or experience)

We are used to thinking about tangible (real and financial) assets as wealth, and to valuing them according to the present worth of the future flow of income (and capital gains) that we expect from them, using as the discount rate our own personal rate of time preference. We are familiar with the fact that our real assets (e.g. houses, cars and other consumer durables) are subject to both time- and use-related depreciation. Our financial assets may be subject to rather different forces affecting their value over time, and will not suffer "use-related" depreciation (unless we regard the costs of asset-switching in that light). It is through labour market participation that most people acquire the resources that enable them to augment their wealth. But there are strong societal norms, not to mention formal restrictions and requirements, which influence people's access to labour markets at different stages in their life-cycle (e.g. minimum school leaving ages or strict retirement rules). These constraints may prevent the building up of wealth, or force the running down of wealth, at particular times in our lives. We can "use up" our wealth by living above our means, or add to it by net savings. We may also inherit it, and give it away.

But suppose we now follow Grossman[9] and apply this same kind of thinking to health. Health too can be seen as an asset in the form of a capital stock, which has to be maintained above a certain minimum level to avoid death (just as with financial assets in the business world you must not get into so much debt that you get declared bankrupt). Our stock of health determines the maximum amount of quality-adjusted time and energy

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[9] Grossman, M., The Demand for Health, New York, National Bureau of Economic Research, 1972. This seminal work has led to other explorations of this way of thinking, for instance Muurinen, J.-M., "Demand for Health", J. of Health Economics, (1982), 1, 1-28; Wagstaff, A., "Demand for Health: theory and Application", J. of Epid. and Community Health, (1986), 40, 1-11. The whole field has recently been reviewed by van Doorslaer, E.K.A., Health, Knowledge and the Demand for Medical Care: An Econometric analysis, University of Limburg, Maastricht, 1987, especially pp. 5-25.

available to us in any specific period, though below this maximum there will be some smaller amount of time and energy which is the most we can draw on before we start experiencing use-related depreciation (due to "burning the candle at both ends"). The above-mentioned "quality-adjustment" refers to the extent to which the time and energy available to us during the period in question is compromised by pain, distress or disability. At any point in time our stock of health may be measured as our quality-adjusted life-expectancy. It is susceptible to time-related depreciation (senescence), which, as we have seen, is likely to increase noticeably in later life. But this decline may be accelerated by particular lifestyles and circumstances (e.g. by smoking, lack of exercise, poverty). Augmentation of the stock is possible (within limits) by health promoting life-styles and by health care. We can inherit good or bad health, and we can even "give it away" by sacrificing it for the sake of others.

Applying the same conceptual framework to Wisdom is rather more difficult, for we immediately run into difficulties over the valuation of this stock. Historically, in the economics of education such valuations have been sought by investigating the additional labour market rewards to be gained from enhanced knowledge and skills, but this seems too limited a view of the "rewards" from "wisdom". What to put in its place is not clear, however. And the problem is compounded by the likelihood that increased wisdom changes people's whole value system, and particularly their personal rate of time preference and the relative importance they attach to material wealth. If this is so it will have a direct and pervasive effect upon the valuation of the other two assets. Thus summarising the services provided by the asset Wisdom as "lifestyle possibilities, adaptive skills, and valuations" may be so wide ranging and complex as to defy measurement. But, measurable or not, our

stock of wisdom cannot be ignored. Our day–to–day living and adaptive skills have to be maintained above a certain minimum level, otherwise we cease to be viable as individuals (an increasingly common problem with the very elderly and with the mentally ill and handicapped). But our knowledge and skills may also be subject to time–related obsolescence (what good now is my investment in counting and calculating in £.s.d?). On the other hand, in the case of wisdom there seems to be no analogue to use–related depreciation, and the augmentation possibilities are enormous (until such time as senescence restricts them). Like love, knowledge is one of the few things you can give generously to others and still have as much as (or even more than) you started with!

But we now need to put this conceptual apparatus to work so as to generate a model of health related behaviour at an individual level. For this purpose it will be useful to refer to Figure 1.

I will start by tracing out the standard simplified economic model of individual/household behaviour.[10] The individual is supposed to start each period with some accumulated wealth[11] which itself generates spending power irrespective of current earnings (top left of Figure 1). If the individual participates in the labour market and thereby earns income, these earnings can be distributed between consumption activities and net saving[11] according to the (intertemporal) preferences of the individual. These preferences are derived from the individual's objectives (depicted at the top of Figure 1), which in turn

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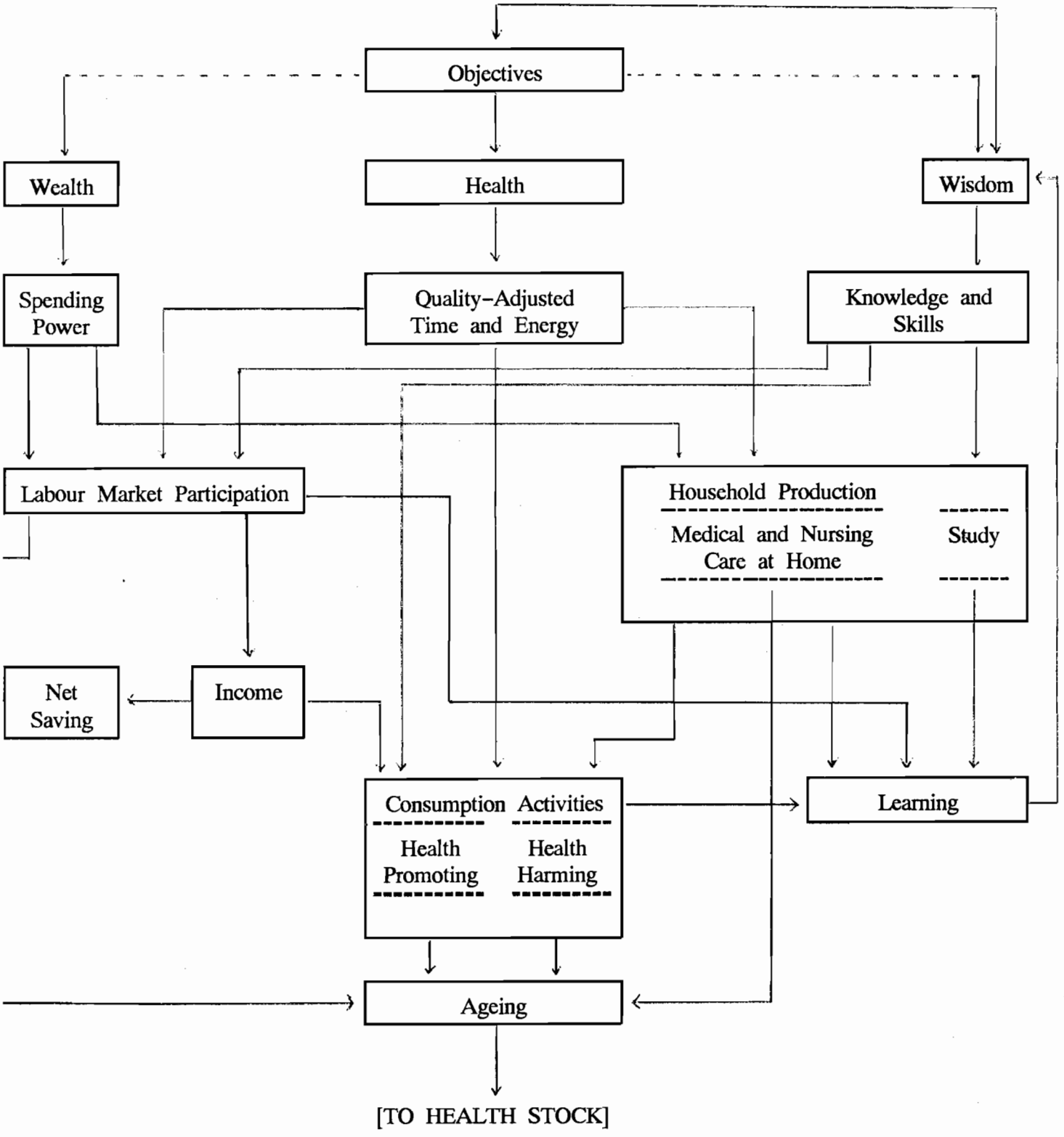
[10] already we are in some difficulties, because health is an individual attribute, but economic behaviour is likely to be best explained using the household as the unit.

[11] which does not have to be a positive amount.

Figure 1: The Grossman–Williams Model of Health Behaviour



derive from the individual's stock of wisdom. Obviously these objectives have a pervasive effect on all optimising decisions in the model. The cycle is then repeated, period after period, over the lifetime of the individual, so that it is possible in principle to trace out different (economic) life histories according to endowments, opportunities, and objectives.

A significant enrichment of this simple model (in which "firms" produce and "households" consume) occurs when the possibility of household production is introduced into it (see the centre right of Figure 1). Thus certain activities (e.g. domestic work) are seen as requiring both goods or services purchased in the market and the input of the household's own human resources (especially time and energy). For reasons already stated I shall not pursue this further at a general level, but restrict myself to its implications for health related behaviour.

To do this we need to introduce health explicitly into the model as a separate asset. Thus the health stock (top centre of Figure 1) generates the (quality-adjusted) time and energy whose availability is largely taken for granted in the simple economic model (where money is the key resource). This time and energy can be used for labour market participation (to earn money), for consumption activities (including sleeping!), and for household production (which, besides domestic work, includes child rearing and other informal care). The appropriate allocation of time and energy then becomes the central optimising task, and activities have to be appraised according to both their money prices and their time prices. Thus deciding within a household how to treat a sick member of it will involve weighing the relative costs and benefits of health care obtained in the market as against informal care produced at home. Within each of these broad options there may

be a variety of sub-options with different opportunity costs in terms of time, energy and money (and, in the context of a household, some variation in whose time, energy and money it will be!).

But we have to consider not only how sickness might be treated, but how it gets produced in the first place. We have already examined the mechanisms underlying physiological senescence, and in simple economic models the ageing process is usually taken as exogenous. But physiological ageing is not the same as chronological ageing, and physiological ageing can be retarded by the pursuit of a healthy lifestyle (which means working in a favoured occupation, living in a favoured environment, and adopting "good" eating, drinking and leisure habits). Ageing differs from other depletions of the health stock in that (like death) it is irreversible.[12] For that reason it has been shown separately, at the foot of Figure 1, as a "filter" through which all potential influences on the health stock have to pass before their actual effect on the health stock can be assessed,[13] recognising that the precise nature of this filter is itself partly determined by those same influences.

Ill health can of course be inherited, but it can also be acquired, and although there is undoubtedly a stochastic element in its incidence, it is abundantly clear that the risks are distributed unevenly across the population in a quite systematic way. Poverty puts you at

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[12] Though the effects of this irreversibility can in some cases be alleviated by organ transplantation and joint replacement and artificial support through intensive care.

[13] This allows economic activities to have different implications for people's health according to their degree of physiological maturity and senescence, for which we usually (but dangerously?) take their age as a rough proxy.

high risk, and so does smoking. Certain occupations are characterised by abnormally high (or low) incidence of particular kinds of injury or disease. So an individual's economic situation is a strong influence on that individual's health (and possibly on the health of the other members of the household too).[14] An individual's economic situation contains both voluntary and involuntary elements. A child does not choose the household it is born into, and many households have very restricted opportunities to acquire health, wealth or wisdom. People living in desperate straits need money badly, and have to optimise over short time horizons (they may literally live from hand to mouth), so they are likely to discount heavily the long term health risks from certain employments or consumption activities. If the only way to get through the day is to smoke a cigarette from time to time, why worry about what it is doing to your life expectancy, or might do to your current health in 20 years time?

It is also possible to affect your health through ignorance and foolishness, of course, and this brings us to the role of the third asset, our stock of Wisdom. The knowledge and skills which flow from that stock may also be distributed between labour market participation, consumption activities, and household production. Greater wisdom may widen our opportunity set, and make us more efficient at exploiting the opportunities that do come our way, in all three of these domains. Wisdom may be augmented by learning, which comes not only from "study" (which I have treated as household production)[15] but also from "experience" (which comes from all three domains of activity). This "learning" may

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[14] And conversely health is a strong influence on an individual's economic situation.

[15] In order not to clutter up the diagram too much, I have ignored formal on-the-job training provided by employers. I have also ignored occupational health care provided by employers.

contribute to wisdom not only in such a way as to increase earning or adaptive capacity, but also in such a way that the individual's objectives themselves get modified (as depicted at the top right of Figure 1).

Looking at the system as a whole, when managing this "portfolio" of assets, the trade–offs facing an individual at a mundane commonsense level include:

(a) how far to risk one's health to increase one's wealth or wisdom;

(b) how much wealth to sacrifice to reduce life's hazards or get the best information or advice;

(c) how seriously to set one's mind to work thinking through ways to improve one's lifestyle or to get more lucrative employment.

In these various ways each asset can be transformed into the others, and (within limits) the desired balance achieved, though with an attenuated and unbalanced portfolio at the beginning of the period it may well be that the best achievable balance at the end of the period is not very good. Later (on page 33) I will provide an illustration of how these transformation processes work.

IV A COMPARISON OF THE TWO MODELS AT INDIVIDUAL LEVEL

The heroic simplifications and sweeping generalisations made so far in this paper pale into insignificance beside those I am about to make in order to compare the main features of the two approaches to explaining the health of individuals and populations. To

make this forbidding task somewhat easier I shall conduct the comparison in two stages, the first (in this section) concerned with the modelling of individual behaviour, the second (in the next section) concerned with the implications for whole populations.

The situation as I see it is summarised in Table 2. It highlights five key features of the models: the assumed maximand, the key input, the control mechanism, the main priority at each life-stage, and the manner in which inter-generational transfers are effected. I will discuss each in turn.

The Biological Model (BM) takes "fitness" to be the maximand, which can be interpreted as reproductive capacity (success in rearing to maturity viable and fertile offspring). The Economic Model (EM) assumes that individuals are pursuing a rather broader aim, that of leading a long and rewarding life, which is encapsulated in the notion of maximising quality-adjusted life-years. The two maximands might broadly coincide if having sex and rearing children to adulthood[16] were by far the most rewarding experiences in people's lives, all subsequent activities being merely a self-indulgent afterglow. The BM suggests that this "afterglow" will occur only to the extent that there happens to be energy left over from the reproductive phase, and only if the control mechanism's energy-allocation-rules (which will still be operating in the same way as before) happen to be conducive to it. This is most likely to happen from the "instinct for survival" reflected in the rules governing the defence/repair mechanisms. The EM, on the other hand, suggests that people will consciously set aside resources for the "afterglow", even though they know

[16] It is of course now possible to separate these two sources of satisfaction and to pursue them independently.

Table 2: A Comparison of Models

FEATURE	BIOLOGICAL MODEL	ECONOMIC MODEL
ASSUMED MAXIMAND	FITNESS (REPRODUCTIVE CAPACITY)	QUALITY ADJUSTED LIFE-YEARS (LENGTH AND QUALITY OF LIFE)
KEY INPUT	NUTRIENTS	REAL INCOME
OBTAINED BY	FORAGING	WORKING
MEASURED IN TERMS OF	ENERGY	MONEY
ALLOCATED TO	STRUCTURES AND ACTIVITIES	INVESTMENT AND CONSUMPTION
CONTROL MECHANISM	GENOTYPE	STOCK OF WISDOM
DETERMINING PRIORITIES ACROSS	GROWTH REPRODUCTION DEFENCE/REPAIR	LEARNING SUSTAINING OWN LIVING STANDARD KEEPING HEALTHY
MAIN PRIORITY AT EACH LIFE STAGE		
PRE-ADULTHOOD	GROWTH	LEARNING
EARLY ADULTHOOD	REPRODUCTION	LIVING STANDARDS
LATE ADULTHOOD	DEFENCE/REPAIR	HEALTH
INTERGENERATIONAL TRANSFERS	GENOTYPE	LEGACIES (OF HEALTH, WEALTH AND WISDOM)
EFFECTED THROUGH		

it means reducing their net reproduction rate below 1, a decision encapsulated in the view that "we cannot afford to have any more children". There is, however, a possible influence working in the other direction, namely that the successful rearing of children may be the best investment that it is possible to make for the provision of informal care (and general sustenance) in later life. Investing in the health of others is then an alternative to investing in wealth for yourself. Again I am straying into the economics of the family and of household production, so I had better stop and move on.[17]

In the BM the key input for the organism is nutrient, which is generally obtained by foraging. It is measured in terms of energy, and may be allocated to sustaining either structures or activities. In the EM the key input is (real) income, generally obtained by working. It is measured in terms of money, and may be allocated to sustaining either investment or consumption. Here the two models are remarkably similar and further comment seems superfluous.

This is not so with respect to the next feature, however, which is the control mechanism and its instrumental variables. In the BM the control mechanism is the genotype, which (apart from the possibility of irreparable damage) is given and invariant

[17] There is one other comparative aspect of the rival maximands which is worth some attention, namely the representation of time preference. In the EM this is picked up by using a discount rate which has the effect of making benefits more valuable the sooner you get them, and costs less hurtful the longer you postpone them (other things being equal). In the BM similar effects are produced by the term in the fitness formula relating to the time interval between generations, which it is advantageous to shorten (other things being equal). Again the BM is more narrowly focused than the EM, in that it concentrates "time preference" wholly on reproduction, and adopts a unit of time that is very long (25 years?) by economist's standards, thereby excluding time preference within that period. As we have already noted, many people's subjective rate of time preference is so high that they do not pay much regard to things happening 3 months ahead!

from conception. There are no learning possibilities, so the necessary range of adaptive rules has to be there from the word go. In the EM it is a very different story. The control mechanism is the stock of Wisdom, and this can be added to (within limits) throughout life. Among these limits is the physiological capacity of the system, which is set ultimately by the genotype. So the EM could be seen as seeking to explain how the (predetermined?) physiological capabilities of individuals (which include their cerebral capabilities) are consciously optimised according to those individuals' own perceived objectives. And this raises the age-old question about the extent to which our "conscious" optimising behaviour unwittingly mimics the rules of behaviour embedded in our genotype! And if it does not, will natural selection eventually bring us to heel? More on this subject anon.

We must next turn to the instrumental variables that each model envisages the control mechanism working on in order to achieve the supposed objective. In the BM at each point in time priorities have to be established between growth, reproduction and defence/repair. In the EM priorities have to be established at each point in time between learning (wisdom), sustaining living standards (wealth), and keeping healthy (health). In both cases inter-temporal optimisation is called for, as well as inter-functional optimisation. The odd one out here is "learning" in the EM, which, as we have just seen, has no direct counterpart in the BM. The BM does require resources to be devoted to maintaining the structures responsible for information flows in the system, but this is as close as it gets to investing in "wisdom". Otherwise growth and reproduction can be seen as broadly analogous to the sustaining of living standards, and defence and repair is obviously about keeping healthy. Both the BM and the EM envisage trade-offs having to be made

between these rival claimants on scarce resources, with an implication that there is a key role for cost–effectiveness analysis in both models. In the BM the opportunity costs in any such calculations will be in terms of reductions in fitness (i.e. reproductive capacity),[18] whereas in the EM they will be in reductions in quality–adjusted life–expectancy.[19] In the BM the rules that reflect this cost–effectiveness analysis have been "learned" in the "school of hard knocks" through natural selection, and are incorporated in the genotype. In the economic model we are supposed each to do the calculations (albeit informally and intuitively) for ourselves (except where social norms effectively restrict our behaviour to what others have already decided is cost–effective for us).

This brings us to what seems to emerge as the main priority at each lifestage, distinguishing, for simplicity's sake, only three such life–stages: pre–adulthood, early adulthood, and late adulthood. The distinction between the last two is loosely based on the division of adulthood between the child–rearing phase and the post–child–rearing phase. In the BM the main priority in the first life stage seems to be growth, in the second reproduction, and in the third defence/repair. In the economic model the corresponding main priorities are learning, living standards, and health respectively. This is not to imply that the variables assigned lower priority are of no importance, but simply that they are not seen as the pre–eminent considerations at that particular life–stage. There are some paradoxes here. When asked "when is it most important to be healthy?", most people say

[18] See for instance the quotation in paragraph 8 above.

[19] See for instance the observations about smoking behaviour in paragraph 23 above.

"when bringing up young children",[20] which is in fact a period when nature has fitted us to be quite healthy, so we do not usually need to devote many additional resources to health maintenance as such at that stage. But we do need plenty of energy, which in the EM means we need plenty of money. In the richer countries we have prolonged the period of formal education (giving priority to "learning" in the pre-adult phase) and kept young people out of the labour market, so they will not have accumulated much wealth by the time they enter early adulthood. Thus it is in early adulthood that people typically get most heavily into debt, so that they can "live above their means" during this phase of their lives. Moreover, before the end of early adulthood they may come to see the need to make suitable provision for old age, when they will once more find themselves out of the labour market, voluntarily or involuntarily. Both of these factors put pressure on them to earn as much money as possible in early adulthood, sometimes at the expense of their health. But it is not until old age that they typically become large consumers of health care (see Figure 2), trying to counteract the senescence that natural selection has bequeathed to them as their physiological heritage.

This brings us to the last column of Table 2, which is connected with what it is that we can transfer directly from one person to another within each model. In the BM what is transferred is the genotype, the set of instructions telling us what to become physiologically and how to respond as a phenotype to the various circumstances we may encounter in life. In the EM a broader range of possibilities seems open to us, since we can endow our offspring with health, wealth and wisdom. But the differences may not be

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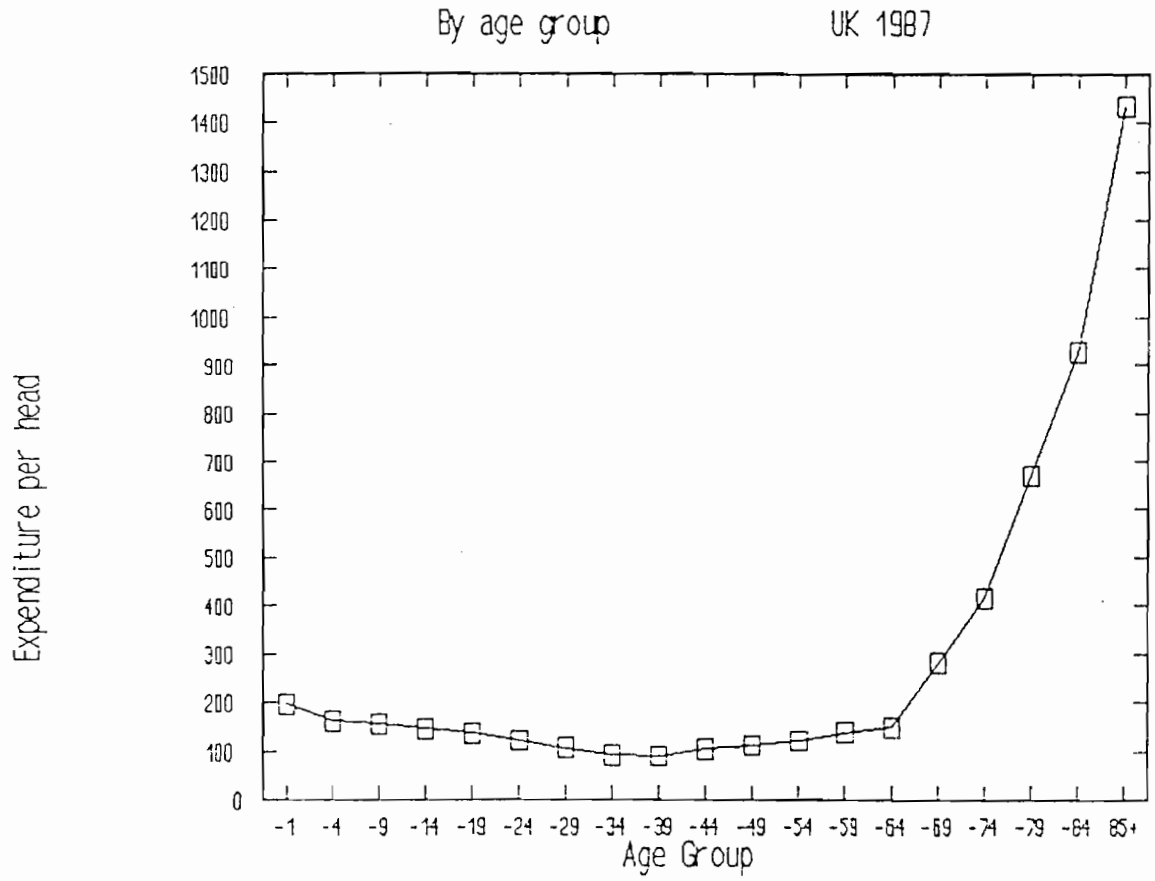
[20] See Williams, A, "Economics and the Rational Use of Medical Technology", in Rutten, F.F.H. and Resider, S.J. (eds.), The Economics of Medical Technology, Springer Verlag, Berlin, 1988, p. 117.

Figure 2: Annual NHS Expenditure per head (£)



so great as they appear at first sight, since the genotype may include "instructions" to parents to look after their offspring until they are viable, so that the EM is merely spelling out (at a conscious level) the way we respond to the sense of kinship that has been instilled in us from conception. But what instils in young people a sense of obligation for the welfare of their (ageing) parents? It is hard to see what value this could have in fitness terms.[21]Is this why it seems less strong than the obligations parents feel for their children? What it suggests to me is that not all of our conscious prioritising rules can be explained as unconscious reflections of (i.e mimicking) the rules embodied in our genotypes, and that some of our conscious rules may act counter to our biological inheritance. It is a conflict we must come back to.

V A COMPARISON OF THE TWO MODELS AT POPULATION LEVEL

When we compare these two approaches with regard to their implications for human beings as whole populations, a very sharp divergence becomes evident. The BM is emphatic in stressing that evolutionary physiology works through natural selection of

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[21] Peter Hogarth has observed (personal communication) that there are biological precedents for the care of aged parents e.g. in chimpanzees. The explanations given tend to be based on a total absence of supporting evidence, but include (1) the idea that it's always worthwhile, if you are likely to be chased by a leopard, to have a few individuals around who can run more slowly than you can ..... (2) that an elderly and infirm chimp may still have something to contribute in the non-genetic transmission of experience; (3) that to transmit to your offspring the trait that ensures they look after you, you must carry the trait that you look after your own parents - which could work, but only if an elderly chimp still has some chance of reproducing, however small; or (4) that what has evolved is a tendency to invest to some extent in close relatives for the enhancement of enhanced inclusive fitness, and the investment is not so great that it was worth evolving the ability to discriminate between one lot of close relatives (those still able to reproduce) and another (those no longer capable of reproducing). None of these arguments seems especially convincing, but it is at least possible that care of aged parents could enhance fitness. It would be hard to test any of these ideas rigorously.

individuals, which obviously has implications for populations, but the populations themselves are merely consequences of what is happening at individual level, they are not independent sources of influence upon the evolutionary process. The macro-relationship between population size and ecological habitat is obviously a determinant of demographic change, but it is mediated by the micro-responses of individuals in that habitat. Individuals are not seen as engaging in deliberative collective decisions to influence their situation. If they act in an apparently concerted way, it is because as individuals they are all programmed with similar instructions as to how to respond in that situation.

In the EM the story is quite different. The individual is not optimising in a social vacuum. Even the most atomistic models of well-functioning perfectly competitive markets require the institution of private property and the existence of collective agencies to enforce contracts based on that institution. Collective agencies (by which I mean any purposive and co-ordinated group of individual other than the family)[22] deliberately control the terms on which an individual can gain access to whatever resources the habitat offers to the population of which that individuals is a member.[23] They do this by establishing and regulating contracts of employment and of sale, by taxation and social security provisions, and by the provision of some benefits in kind (such as "free" health care or compulsory primary education). This involves establishing rules of entitlement, and operating according to some system of priorities. These entitlements and priorities may not be well articulated or consistent, or indeed be regarded as a "policy" at all, but simply as an "obligation".

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[22] I leave the family on one side partly because it is conceivable that effects of physiological evolution may still have a strong influence on family behaviour.

[23] The key population group in this context being the nation-state.

It will be convenient to consider the impact of a population's collective policies about health and health care at two levels[24]. Firstly we must consider the priorities that society brings to bear on an individual's encounters with the health care system. Secondly we must consider the priorities that society brings to bear on the higher level decisions that are made about providing health care facilities for the population at large. The higher level decisions obviously constrain the lower level decisions to some extent, but in a decentralised system they do not determine them.

Historically the greatest influences determining health care priorities at individual level must have been the wealth of the individual (which has determined access) and the attitudes and behaviour of the medical profession. The matter of access I will set aside for a while, and concentrate initially upon the key role of the medical profession in determining priorities once access has been established. Doctors play a dual role in the health care system ... they are both the mediators of "demand" (as agents of the patients) and the suppliers[25] of care. This creates various well-known tensions when what is in the patients' interests is not identical to what is in the doctors' interests. To help doctors to resist the temptation to exploit patients for their own ends, the medical profession has developed a code of ethics, the six main injunctions of which are:

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[24] The emphasis here will be upon health care rather than other contributors to health, because the problems of establishing priorities are particularly acute there. But similar arguments could be developed with respect to occupational hazards, road safety, consumer protection, health promotion, etc.

[25] Or in the more complex world of modern health care, they are the facilitators of the supply of care, much of which is supplied by other health care professionals.

1 Preserve life

2 Alleviate suffering

3 Do no harm

4 Tell the truth

5 Respect the patient's autonomy

6 Deal justly with patients

It is readily acknowledged that these principles frequently come into conflict with each other, but it is held by the medical profession that:

"resolving such conflicts is central to the art of medicine"[26]

thus it is seen as the role of doctors to establish priorities in the use of health care resources, bearing in mind (amongst other things) the views of patients (and, in practice, of their nearest and dearest).

It is interesting to note that doctors have tended to give strong priority to the preservation of life over all other considerations. Typically they regard the death of a patient as a defeat. They are encouraged to hold this view by the widespread use, in clinical trials, of mortality rates as the main criterion for choosing between treatments, and by the common belief that it is the duty of doctors to do everything possible for the patient in front of them, no matter what the costs. It is still very difficult for a doctor

[26] Taken from Ruark J E, Raffin T A and the Stanford University Medical Center Committee on Ethics – "Initiating and Withdrawing Life Support", New England J of Medicine 318(1) 1988 pp 25–30.

to say "we have done everything that it is reasonable to do in the circumstances, and we must now let nature take its course". In this context being "reasonable" should mean taking into account the suffering of patients (and of their nearest and dearest) [principle 2 above], and the costs (in terms of health care foregone) being imposed upon other potential patients [principle 6 above].

The health economics model anticipates that some broad-ranging cost-effectiveness analysis will be undertaken to determine what is "reasonable" in any specific context. To do this an estimate will be made of the benefits to be gained (in terms of quality adjusted life years) and the costs incurred (in terms of benefits foregone) of each of the alternative courses of action (including doing nothing), and the one with the best cost-effectiveness ration will be adopted provided the benefits are worth the costs. Since this entails placing a finite value on (quality-adjusted) human life it excites great emotional antagonism, both from members of the general public and from members of the medical profession[27]. As far as the concerns of the medical profession are concerned, nothing is being advocated that

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[27] For instance here is an extract from a particularly sharply worded protest along these lines:

> "Of late an increasing number of papers in this and other journals have been concerned with the 'cost-effectiveness' of diagnostic and therapeutic procedures. Inherent in these articles is the view that choices will be predicated not only on the basis of strictly clinical considerations but also on economic considerations ... It is my contention that such considerations are not germane to ethical medical practice ... A physician who changes his or her way of practising medicine because of cost rather than purely medical considerations has indeed embarked on the 'slippery slope' of compromised ethics and waffled priorities".

Loewy E H - "Cost should not be a factor in medical care", New England Journal of Medicine, 302 (1980) p 697.

is inconsistent with medical ethics[28], so I think resistance on those grounds is misguided. But this may simply be a cover for a different fear, namely a perceived threat to clinical freedom[29]. It is interesting to note that rallying the troops to the defence of this cause has met a very mixed response (in Britain at any rate)[30]. In the case of the general public, to the extent that the rejection of the cost-effectiveness approach is not a manifestation of romantic idealism and the denial of scarcity, I think it stems from a belief that EM embodies a ruthless Darwinistic approach to the survival of the fittest, in which the emphasis on reproductive fitness in the BM has simply been replaced by an emphasis on economic productivity in the EM. As will be obvious from the earlier analysis, this is quite false, for in the EM the maximand is QALYs, not GNP per head[31]. But the QALY maximand is itself ambivalent. At a very broad level it could be interpreted to include everything that we might consider to be an element in individual human welfare. But in health economics it is usually interpreted in a narrower way to mean "health-related quality of life", ie those aspects that depend on (and are affected by) the state of our health. The difference is illustrated by smoking behaviour, which is deleterious to health-related quality-of-life, but may improve other aspects of quality of life (simply by giving pleasure). Thus doctors (and health economists?) are likely to interpret the maximand in

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[28] See Williams A - "Cost Effectiveness Analysis: Is It Ethical?", J of Medical Ethics (forthcoming).

[29] Which I have analysed in greater depth elsewhere - see Williams A - "Health Economics: The End of Clinical Freedom?" Brit Med J 297 (1988) pp 1183-6.

[30] See for instance Hampton J R - "The End of Clinical Freedom", Brit Med J 287 (1983) pp 1237-8, and Hoffenberg R - Clinical Freedom, Nuffield Provincial Hospitals Trust, London, 1987.

[31] though the contribution of GNP per head (ie, real income) to QALYs (ie, health) cannot be ignored, just as the contribution of health care to health cannot be ignored.

the narrower sense, whilst patients (and welfare economists?) are more likely to interpret it in the broader sense.

Turning now from the level of the doctor–patient encounter, to the level of the health care system as a whole, we again encounter a complex of ethical considerations which have a pervasive, but not wholly determinate, effect on priorities at system level. But this time we are in a much broader realm than medical ethics, ... the realm of political ideology. We must here pick up the key issue of how access to health care is to be prioritised, in a situation in which even the richest countries in the world can no longer afford to provide all the health care that might conceivably do someone some good, ... somehow, ... sometime.

There are two general ideological stances which are of central importance in this context, the libertarian and the egalitarian[32]. Elsewhere[33] I have summarised their respective features, and their implications for health care, in the following terms:

> "In the libertarian view, access to health care is part of the society's reward system, and, at the margin at least, people should be able to use their income and wealth to get more or better health care than their fellow citizens should they so wish. In the egalitarian view, access to health care is every citizen's right (like access to the ballot box or to the courts of justice), and this ought not to be influenced by income or wealth ...

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[32] The arguments summarised here are developed at greater length in Williams A – Priority Setting in Public and Private Health Care: A guide through the Ideological Jungle", J of Health Economics 7 (1988) pp 173–83.

[33] Williams A – "Managing Care and Capacity in the Public Sector: The United Kingdom", in Gelijns A C (ed) Patients, Providers, Innovators and the Evolving Health Care Science (Provisional title), Washington DC, National Academy Press, January 1992 (in press).

> Each of these broad viewpoints would generate a distinctive health care system whose characteristics would be very different.
>
> In the libertarian system willingness and ability to pay would be the determinant of access, and this would best be accomplished in a market-orientated "private" system (provided such markets can be kept competitive). In the egalitarian system equal opportunity of access for those in equal need would be the determining rule, and because this requires the establishment of a social hierarchy of need which is independent of who is paying for the care, it would be best accomplished in a publicly provided system (provided that the system can be kept responsive to social values and changing economic circumstances) ..... Note that the success criterion to be applied to the egalitarian system is the level and distribution of health in the community.
>
> Needless to say, in practice neither system lives up to its ideals, and most of the problems stem from (i) the peculiar role of doctors in health care systems, (ii) the problems associated with market deficiencies on the supply side, and (iii) information problems on the demand side .....
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> In most countries health care is provided by a mixture of systems, with no common ideology. This may simply reflect the fact that we all live in pluralist societies which try to accommodate sub-groups with incompatible ideologies. A hypothesis suggested by this analysis is that the structure of the health care system in each country is likely to be systematically related to the nature of the equity concerns that have been dominant in the (recent ?) past, and is also likely to reflect the ideology which generated those concerns. An obvious instance is the balance between public and private provision, which differs markedly between countries".

One interesting feature of this discussion is again the strong emotional reaction engendered by the notion of "rationing" health care. If by rationing is meant deciding who shall and shall not get health care, what sort of health care they will get, and when they will get it, then rationing is, and always has been, pervasive in all societies. Instead of asking "should we ration health care?" we should ask "which method of rationing health care is best?". And in my preferred terminology the question would become "how should we determine priorities in health care?". One possibility is by willingness and ability to

pay, and another is by "need", an elusive concept[34] which I think can best be defined as "a person's capacity to benefit from something, as judged by some other party". Since needs outrun resources, some needs have consequently to remain unmet, so needs have to be prioritised according to some higher level criteria. So, in a "need-driven" system, when a doctor decides that I "need" an operation and organises things so that I get it, he has judged that my "need" is greater than that of those who are waiting or going without. This method of "rationing" should then be compared with one that works on the willingness and ability to pay of individuals (or, more frequently these days, on the willingness and ability to pay of the insurance carrier, where the reimbursement rules are the expression of the priorities of the system), to determine which produces the socially preferred outcome.

As explained earlier, the EM was based on the assumption that for the individual the maximand is quality-adjusted life expectancy.[35] For the society as a whole the analogous maximand would then be the aggregate quality-adjusted life-expectancy of the entire population.[36] But this aggregation process raises (at least) two further problems concerning distributive justice: what is to count equally between people, and are some

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[34] See Williams, A., "Need as a Demand Concept (with special reference to Health)", in Culyer, A.J. (ed), Economic Policies and Social Goals, Martin Robertson, London, 1974, pp. 60-74.

[35] I am here passing over a complex literature on interdependent utility functions and altruistic behaviour which represents an intermediate stage between the altruistic individual and the collective agencies of the society.

[36] and if one got really ambitious, of future generations too, thereby bringing us back closer to the biological maximand of reproductive capacity.

people to count for more than others?[37] The simple answer to the first question is that a quality-adjusted life-year is to be counted as of equal value no matter who gets it, an assumption that mimics the assumption behind the use of average life-expectancy as a measure of welfare, namely that an additional year of life (of whatever quality) is of equal value no matter who gets it. But this "simple" answer seems much less acceptable when QALYs are the maximand than when (unadjusted) life expectancy (i.e. life-years gained) is the maximand, though why this should be so I find puzzling. There are two common counter positions. The first is that the maximisation of QALYs (like the maximisation of life-years) discriminates against the elderly, because it is much more costly to provide them with an extra unit of "health" (however you measure it).[38] The second is that it discriminates against the poor (and those deprived in other ways) because their general health prospects are poor and also difficult to improve.[39] So the assertion is that, in interpersonal allocation of health care resources, either there should be positive discrimination in favour of these groups, or, more radically, access to health care should not be prioritised at all by "need" as capacity to benefit, but according to "entitlement" based on some notion

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[37] These issues are not avoided in a libertarian system, but they are not problematical in that system because, provided that spending power was acquired in a legitimate manner, each unit of spending power is regarded as of equal (ethical) value provided it is spent in a legitimate manner. The resulting interpersonal distribution of health (or use of health care) is whatever it is, and is of no further moral concern (unless it gives rises to external costs or benefits which need to be internalised in the pursuit of Pareto efficiency).

[38] See, for instance, Avorn, J., "Benefit and Cost Analysis in Geriatric Care: Turning Age Discrimination into Health Policy", New England Journal of Medicine, Vol. 310 (1984), pp. 1294-1301.

[39] See, for instance, Harris, J., "QALYfying the Value of Life", Journal of Medical Ethics, Vol. 13 (1987), pp. 117-123.

of desert.[40]

Such surveys as have been conducted[41] eliciting the views of the general public, and of health care professionals, as to who should be given priority if not everyone can be treated, indicate a strong consensus on two points: the young should have priority over the old,[42] and the parents of young children should have priority over their childless contemporaries. The interesting thing about the former finding is that it suggests that discrimination against the elderly is not regarded as **unfair** discrimination.[43] The interesting thing about the second finding is that it mimics perfectly the priorities of the EM, as, to some extent, does the first finding.[44]

The case of the poor and deprived is a more difficult one, because the EM suggested that using the health care system as a compensatory mechanism to offset deprivations **which are not caused by deficiencies in the health care system itself** may

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[40] For a very readable and lucid account of these rival ideological positions see Gillon, R., Philosophical Medical Ethics, Wiley, Chichester, 1985.

[41] See for instance, Charny, M.C. et al., "Choosing Who Shall Not be Treated in the NHS", Social Science and Medicine, 28 (12) (1989), pp. 1331–8; Brakenheim, C.R., "Vard pa lika villkor" (Care for similar conditions), in Calltorp, J. and Brakenheim, C.R. (eds.), Vardens Pris (The Price of Care), Verbum, Stockholm, 1990, pp. 35–54; and Williams, A., "Ethics and Efficiency in the Provision of Health Care", in Bell, J.M. and Mendus, S. (eds.), Philosophy and Medical Welfare, Cambridge University Press, 1988, pp. 111–26.

[42] a view shared by the old.

[43] A commonly cited justification for giving priority to the young is that it would be unfair to deprive them of the opportunities in life that the old have already had.

[44] The reason for the note of reservation here is that it appears that the very young (e.g. children under the age of 5) are given lower priority than older children, the reason usually given being that less has been invested in them and they are easier to replace.

be both inefficient and misguided. Suppose someone starts life in a poor family, with limited access to knowledge, but in good health. Nutrition is likely to be poor, knowledge about health and hygiene is likely to be poor, educational opportunities are likely to be poor, and getting money becomes the number one priority. So employment will be sought as early as possible (but may be harder to get than for the average person) and the individual will not be too fussy about occupational risks. As income rises the individual is likely to be in a culture in which smoking, heavy drinking and other hazardous pursuits will be the norm. Time off work on account of injury or sickness is costly in terms of foregone income (unless social security support is generous), and frequent visits to the health care system will be made to boost the overloaded repair system that evolutionary physiology has provided. But the potentially favourable effects of the health care system upon the individual's health stock will be dissipated by continuing to transform health into wealth (by earning money in a hazardous way) and into current living standards (by pursuing hazardous consumption activities). So even if such an individual started life with average health (which is unlikely), the subsequent time path of current health is likely to be poor, as a direct result of the individual's attempts to optimise (within rather severe constraints) his or her "portfolio" of health, wealth and wisdom. It therefore seems to me that it is likely to be both futile and inefficient to attempt to improve the health of the poor through special treatment within the health care system alone. The problem is much more pervasive, and needs a more radical approach if inequalities in quality-adjusted life-expectancy within a population are to be taken seriously as a public policy objective.

VI CONCLUSIONS

Anyone involved in public policy discussions about health and health care will be confronted almost daily with issues such as those outlined in Section V, and it is my belief that what we health economists are being called upon to do is to help our respective societies to come to terms with the consequences of the emasculation of natural selection. It is paradoxical that now that we are richer than we have ever been before, and have more potentially beneficial health care activities available to us than we have ever had before, we seem to face more excruciatingly difficult decisions about resource use than we have ever had to face before. I think the reason for this is that our success as a species has given us considerable scope for deciding our own destiny, and we are finding it too great a responsibility. We can now virtually choose our own demographic structure (within limits), either directly (and then seek to develop instrumental policies that will get us there) or indirectly (by choosing instrumental policies knowing the demographic structure they will lead to if successful).

Health economists are contributing to this discussion by stimulating a rather fierce debate about the objectives of health care (and especially about the efficiency/equity trade off), and the implications of these objectives for "traditional" medical decisionmaking. We are also helping the public and the health care professionals to compare alternative methods of "rationing" health care, so that we can all come to a more informed choice about priorities and their consequences for the demographic structure, and for the general welfare of the population.

But it is a mistake to confine the drama surrounding the question "who shall live?" (and still more that surrounding the question "who shall die?") to discussions about health and health care. As long ago as 1974 Victor Fuchs[45] observed that

> "At the root of most of our major health problems are value choices: What kind of people are we? What kind of life do we want to lead? What kind of society do we want to build for our children and grandchildren? How much weight do we want to give to individual freedom? how much to equality? how much to material progress? how much to the realm of spirit? How important is our own health to us? How important is our neighbours' health to us? The answers we give to these questions, as well as the guidance we get from economics, will and should shape health care policy" (op cit p. 148).

He could have gone on to say that the answers we give to his questions will and should shape **our destiny as humankind**, for the emasculation of natural selection with respect to human populations[46] requires us to think much more fundamentally, and on a global level, about our relationship with our habitat and our relationships with each other, in all realms of human activity, not just in health care.

I think the first part of the ambitious programme on which we have to embark is clarification of what is involved in determining an optimum population size and structure. This should lead to a systematic comparison of the priorities or trade-offs that seem to be

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[45] Victor Fuchs, Who Shall Live? Health, Economics and Social Choice, Basic Books, New York, 1974.

[46] It should be noted that there have been less than 100 generations of **Homo sapiens** since the advent of settled agriculture, less than 15 since the industrial revolution, and only about 5 since pre-maturity mortality rates dropped sharply in the richer nations of the world. This is but a fleeting moment in evolutionary terms, and we must expect that our physiological inheritance lags way behind the current demand (and opportunities) of our economic and social situation.

emerging with a view to determining whether they are compatible with each other, and what sort of population size and structure they are likely to lead to. It is too demanding an intellectual task for me personally, but, perhaps one of my readers will have the necessary talent and motivation to step into the breach.