Regarding Optimum Population*

by

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** I am grateful to the editors for offering me the opportunity to write for moral philosophers and political theorists on a topic that has intrigued me ever since I was a graduate student. Their comments on an earlier draft of the paper has helped me to understand the subject a good deal better. The topic is so hard that until recently I was unable to arrive at a formulation of the concept of optimum population about which I felt confident. Over the years I have fumbled around to find ways to express my ideas; and am all too aware that readers may conclude I am still fumbling. The present essay is a consolidation of Dasgupta (1969, 1988, 1994, 1998, 2004 [2001]). My greatest debt is to Kenneth Arrow and the late James Meade, conversations with whom over the years have greatly influenced my thinking on the subject of optimum population. I have also been much stimulated by the criticisms of my earlier writings on the subject by John Broome (Broome, 1996; 1999: ch.15).

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1 Introduction

Population is a controversial subject. Many are persuaded that the sheer size of today's world population is a prime cause of human misery and environmental degradation. There are also those who infer over-population from evidence of wide-spread poverty in many parts of the globe. But there are others who do not see the world's population size as a problem at all. Some believe that poverty and high fertility are distributional failures, while others think that human inventiveness and ingenuity are capable of enhancing Earth's capacity to support our species indefinitely; and to support it at a high standard of living. There is a tension here between protagonists, arising from diverse readings of evidence. Unhappily, there is little sign that the tension will ease in the foreseeable future.

1.1 Policies and Ethics

However, few people regard population an unimportant matter. Government policies on schooling, family planning and reproductive health, old-age pension, and family allowances have impacts on the number of children people choose to have. There is now an extensive literature with quantitative estimates of those impacts.[1] Recently, reproductive behaviour has been studied with an eye on a number of *externalities* with which the behaviour is likely to be associated (Dasgupta, 2000, 2003), where, by externalities we mean the effects that transactions have on people who have not been a party to the negotiations that led to the transactions.

There are several types of externalities associated with reproductive behaviour. They arise because human reproduction is a paradigm of non-market activity, meaning that reproductive activities have effects that ripple across households along many of the non-market channels that co-habit with market and government channels. Externalities reflect institutional failure, be they failure of markets, the State, households, or communities. The presence of externalities is a reason for the State to institute policy reforms. Contrary to what is sometimes assumed in popular writings, reproductive decisions are not entirely a private matter. But policies should be evaluated before they are put into effect. Moreover, we need a normative theory to guide us if we are to do the evaluation. You might therefore think there must be an extensive literature on the ethical foundations of population policy. In fact there is little to appeal to, despite the fact that notable thinkers have periodically expressed views on the matter.

Economic demographers recognise that children are both ends and means. The mix of the two motivations underlying reproductive behaviour depends on the institutional structure of society and the personal circumstances of the parents. Children substitute for capital assets in economies where markets are underdeveloped. The thought that children serve as old-age security is an acknowledgment of that fact. Moreover, poor households in the world's poorest regions possess few labour saving devices (such as electricity, tap water). Therefore children there are also a source of labour for daily chores. Children mind their siblings, graze cattle, collect firewood and potable water, help with the cooking, and provide

[1] See in particular the essays in Rosenzweig and Stark (1997).

old-age security for their parents. They begin work from as early an age as six. Children are an economic necessity in households that are impoverished. A considerable body of anthropological and demographic literature has revealed that parents in such households don't expect the lives of the children they bring into the world to be any better than their own; rather, they see children as being desirable, necessary, and in keeping with the customs and norms of their society.[2] Caldwell (1981, 1982) has offered evidence for the suggestion that the intergenerational transfer of resources is from children to their parents in societies experiencing high fertility and high mortality rates (they are typically poor countries), but that it is from parents to their children where fertility and mortality rates are low (they are typically rich countries).

Although children substitute for capital assets and offer labour services at home in poor households in the world's poorest regions, child-bearing and child-rearing are everywhere a paradigm of non-market activities. The externalities associated with such complex patterns of reproductive motivation as I am alluding to go some way to explain the pro-natalist attitudes prevailing in the poor regions of the world, in marked contrast to reproductive attitudes in the world's rich nations. However, as this essay is on the ethical foundations of population policies, it is as well to purge from consideration the myriad of institutional failures and economic stresses with which households typically have to cope. The way they cope must, of course, be taken into account when policy reforms are evaluated in actual, imperfect economies. But the normative basis of the theory of policy evaluation is independent of the particular imperfections from which economies suffer.

1.2 Old Views on Ideal Population Size

Interest in the question of desirable numbers dates back well into the past. Plato concluded that the number of citizens in the ideal city-state is 5,040, arguing that it is divisible by every number up to ten (it is, in fact, the product of the first seven integers) and have as many as 59 divisors, which would allow for the population to "... suffice for purposes of war and every peacetime activity, all contracts for dealings, and for taxes and grants" (Plato, 1970).

Rousseau (1946: 356-7) also admitted no difficulty with the idea of desirable population size. By a different route, he arrived at a concept akin to that of the mercantalists. For he wrote:

"I am always amazed that one obvious mark should be consistently misconstrued, and that men should be of such faith as not to agree about it. What is the goal set by all political organizations? - Surely it is the maintenance and prosperity of their members. And what is the most certain sign that a people is being maintained and rendered prosperous? - the size of the population. There is no need to go further in our search. Other things being equal, the government under which ... the citizens do most increase and multiply is infallibly the best."

[2] For elaboration and an extensive set of references to the original literature, see Dasgupta (1993, 2003).

Today Rousseau's sentiments would appear quaint to some, wild to many. However, there is the well-known thought that any curtailment in the birth-rate may deprive the world of a Bach. One problem with the thought is that if they are to flower, potential geniuses, like everyone else, require resources, such as potable water, food, clothing, health care, and education. So it would seem that we cannot get very far with the notion of an ideal, or even a desirable, population size without considering resource constraints. This leads to modern formulations.

1.3 Plan of the Paper

In Sections 2 and 3, I review two modern theories of population ethics: Average and Classical Utilitarianism. They have been much discussed in the literature. We shall see that each suffers from serious weaknesses. Additional weaknesses of Classical Utilitarianism are then uncovered (Section 4) in the context of a pair of examples that capture certain considerations that are involved in reproductive decisions, but which have been neglected in recent normative theories of population. The morals I take away from the examples lead me in Section 5 to outline a theory of optimum population that is based on an especially strong conception of personhood. The theory, which appears to perform well when put to work in a world facing environmental constraints, distinguishes present and future people, on the one hand, and potential people, on the other. Although the theory reflects a form of *generation-relative ethics*, unlike the neo-utilitarianism of Narveson (1967) it does not award zero weight to potential lives.

In order to demonstrate the implications of the three ethical theories in believable worlds, I put each through its paces in the context of a formal model. The implications of Classical Utilitarianism and the theory advanced in Section 5 are derived, respectively, in two mathematical appendices. I apologise for the intrusion of the calculus in what is otherwise a philosophical paper, but the subject is inherently quantitative; so formal modelling is unavoidable if we are to understand the implications of the theories. Those familiar with the philosopher Derek Parfit's influential articles on normative population theory will recall that he too deployed mathematics; but of a geometric kind, involving imagined rectangles to describe alternative worlds (Parfit, 1976, 1982, 1984, 1990). The model I develop in this essay is based on an explicit resource allocation problem, involving the services provided by an aggregate capital asset, which may be thought of as being Nature. Alternative worlds in the model I present involve the sharing of Nature's services among different numbers of people. As this essay has been written for moral and political philosophers, I hope the resource allocation problem posed here serves also to illustrate the way we economists construct models so as to investigate problems in applied ethics.

Despite its well-known weaknesses as the basis of population ethics, Classical Utilitarianism continues to have a powerful hold on our sensibilities. In order therefore to compare the implications of Classical Utilitarianism and the generation-relative ethics advanced here, I adapt the latter theory to be mathematically as close to Classical Utilitarianism as possible, meaning that I formulate the theory in such a way that Classical Utilitarianism appears as an extreme special case. The version I present in Section 5.1 may be called *generation-relative utilitarianism*. In fact there are wider interpretations that

could be offered for generation-relative ethics. Toward that end, in Section 6 I extend the discussion in Section 5 of the worth of potential lives by appealing to a class of teleological considerations that have been advanced by a number of social thinkers.

2 Average Utilitarianism

The economists Edwin Cannan and Knut Wicksell are credited with having initiated the modern literature on optimum population.[3] Their idea was to identify the population size of that stationary economy at which average well-being per person is maximized.

Consider a closed economy, the natural illustration of which is the world as a whole. At any date there is a given stock of capital assets and a set of institutions the economy has inherited from the past. These comprise the economy's productive base. As this base is a datum in the theory, it is an input to the analysis.

Capital is assumed not to deteriorate. Nor are institutions assumed to change. It follows that in a stationary economy consumption would equal output. If consumption is the sole determinant of well-being, the population size at which average well-being per person is maximised is also the population size at which output per head is maximised. Let F(N) denote output if population size is N. The existing productive base is an implicit parameter of F. One may imagine that, if the base were larger, F(N) would be shifted upward. But we are interested in the way F varies with N. Cannan and Wicksell assumed that F(N) has the shape given in Figure 1, by which is meant that F increases with N at an increasing rate when N is small, but increases at a decreasing rate when N is large. This implies that average output, F(N)/N, is bell-shaped, as in Figure 1. The assumption that average output is bell-shaped is instructive. It captures the idea that at low population sizes additional people have instrumental worth (they add to average output), but that when population is large, that particular worth is not only absent, additional population in fact reduce output per head.

It is now a simple matter to confirm that output per head attains a maximum when population size satisfies the equation

$$F'(N) = F(N)/N, \qquad (1)$$

or, in other words, where *marginal output equals average output*.[4] In Figure 1 the solution of equation (1) has been denoted by N_R.

The sticking point in the above argument is that we have restricted ourselves not only to stationary economies, but more particularly, to stationary economies associated with the productive base inherited from the past. The latter restriction is not only arbitrary, it is questionable. Investment in capital transforms the stock of assets. If England in the mid-eighteenth century had taken equation (1)

[3] Gottlieb (1945) has an early survey of the history of optimum population theory.

[4] $F'(N)$ is the differential coefficient of F. In deriving equation (1) we are imagining that optimum N is large enough, so that N can be regarded as a continuous variable.

seriously, its optimal policy would not have allowed for capital accumulation of any form. There would have been no Industrial Revolution and no scientific endeavour, since the latter helps to transform our knowledge base. The amount that ought to be invested today depends on future population size, and the desirable level of population in the future depends upon the future productive base, which in turn is affected by the amount invested today. A theory that would accommodate the above considerations would require that investment and population be jointly determined.

Explorations into the twin problems within what may broadly be called Average Utilitarianism have been made by a number of authors. Ohlin (1967) sought to discover the rate of capital investment and population growth that would together maximise the rate of growth of national income per head, but he offered no ethical justification for his theory. I don't know how one justifies a social purpose where earlier generations are seen as mere tools for preparing the productive base of the future. How else would one arrive at the idea of maximizing the rate of growth of national income per head? So we look elsewhere.

The problem is that it is not obvious what Average Utilitarianism amounts to in a non-stationary setting. One interpretation would have it that the objective should be to choose the population size and the investment rate at each date so as to maximize the intertemporal sum of each generation's average level of well-being.[5] Since this interpretation has been explored by Pitchford (1974), we know theoretically what it implies in the way of policy. However, the objective lacks ethical foundations: it is *ad hoc*. Furthermore, as the criterion regards each generation as a unit of account, it is insensitive to differences in the numbers comprising the generations. If the average well-being of two generations were to be the same, the criterion would regard the two on a par with each other even if they differed greatly in numbers.

A more reasonable version of Average Utilitarianism would be to seek the population size and the investment rate at each date that would maximize the ratio of the intertemporal sum of each generation's aggregate well-being to the total number of all who are ever born.[6] This objective can be given a rationale: Which island would you choose among islands that differed in their population size and levels of individual well-being, if you were not to know which person's shoes you would occupy in any island, and were to attribute "equi-probability" to each such position?[7]

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[5] Letting U_t denote the well-being of the representative person of generation t, this criterion takes the form $\Sigma_0^{\infty}\beta^t U_t$; where β $(0 < \beta \leq 1)$ is the per-period discount factor, reflecting, say, a constant conditional probability of the type of extinction over which no one has any control.

[6] Letting N_t denote the size of generation t and U_t be the generation's average well-being, the criterion takes the form $\Sigma_0^{\infty}(\beta^t N_t U_t)/\Sigma_0^{\infty}(\beta^t N_t)$, where β is the per-period discount factor.

[7] See Harsanyi (1955). I have qualified equi-probability in the text because it makes no sense when the future has no termination. To give it sense, we must suppose that the probability of extinction over the indefinite future is unity. We may then talk of equi-probability of the conditionals. See Dasgupta and

But there is a problem even with this formulation. It is questionable whether the thought-experiment of choosing among islands can be the foundation for thinking about the problem in hand, which involves determining the desirable size of future population. When we reflect upon the ethical foundations of population policies, Average Utilitarianism, whichever way we define "average", would seem to have fundamental problems.[8]

3 Classical Utilitarianism

Unlike the average view, the total view is not so vulnerable to scrutiny. It has in any case an impeccable pedigree, namely, what Rawls (1972) called Classical Utilitarianism.

3.1 Raw Materials for the Theory

Here is Sidgwick's formulation:

"For if we take Utilitarianism to prescribe, as the ultimate end of action, happiness as a whole, and not any individual's happiness, unless considered as an element of the whole, it would follow that, if the additional population enjoy on the whole positive happiness, we ought to weigh the amount of happiness gained by the extra number against the amount lost by the remainder. So that, strictly conceived, the point up to which, on Utilitarian principles, population ought to be encouraged to increase, is not that at which average happiness is the greatest possible ... but that at which the product formed by multiplying the number of persons living into the amount of average happiness reaches its maximum." (Sidgwick, 1907: 415-16)

Sidgwick's formulation was revived in the important work of Meade (1955) and was subsequently developed for a non-stationary economy by others (Dasgupta, 1969; Lane, 1977; Gigliotti, 1983). Let us put the idea through its paces to see what it involves. In doing so I will deliberately misuse established classification schemes and regard Classical Utilitarianism to mean any theory that regards social well-being to be the sum of individual well-beings, whether or not well-being is interpreted as "happiness".

It is simplest to consider a timeless economy with a fixed resource base (Nature), eschew production, and imagine that the base is an all-purpose consumption good (ecological services). Let the stock of the resource be K. If C is a person's consumption level (his standard of living), his well-being is U(C). I follow the Classical Utilitarians by assuming that U is an increasing function of C ($U'(C) > 0$), but that it increases at a diminishing rate ($U''(C) < 0$).[9] If C is large, life is good, which is to say that the person experiences positive well-being. The Classical Utilitarian judges it to be a better state of affairs

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Heal (1979: ch. 9).

[8] See especially Hammond (1988) for a critique of Average Utilitarianism in the context of optimum population theory.

[9] See, especially, Edgeworth (1881).

where a life of positive well-being is lived than one where it is not; other things being the same. On the other hand, if C is small, life is not good, which is to say that well-being is negative. The Classical Utilitarian judges it to be a worse state of affairs where a life of negative well-being is lived than one where it is not; other things being the same. By continuity, this means that there is a standard of living, call it C_s, at which well-being is zero; that is, $U(C_s) = 0$. In what follows, I refer to C_s as *well-being subsistence*. Figure 2 depicts a typical shape of U(C).

Well-being subsistence is the living standard at which life is neither positively good nor positively bad. We may be tempted to think that it can be estimated by comparing different qualities of life with non-existence and identifying the quality of life that is on a par with non-existence; but it would be a mistake to try that route. Comparison with non-existence is conceptually more than merely problematic. The unborn are not a class of people, nor is non-existence a state of being. It makes no sense to attribute a degree of well-being, low or high or nil, to the "state of not being born". Non-existence is like nothing for us, not even a very long night, because there is no *us* to imagine upon. One cannot be asked what it would be like to experience one's own non-existence, for there is no subject of experience in non-existence.

We would no doubt understand someone if he were to say that he prefers suicide to continued life. But that would be a preference over *acts* at a moment in time at which the person still exists; it isn't an evaluation by him of alternative states, excepting in the sense that *anything* that would relieve the misery is preferable to him.[10] Nevertheless, it could be thought that the level of well-being at which someone is suicidal is the zero the Classical Utilitarian would seek to identify in order to calibrate the well-being function U(C). But that too would be a wrong move. The suffering a suicidal experiences is so acute as to be unendurable. If we were to interpret $U(C_s)$ to be the quality of life at which someone is suicidal, we would conclude that all who choose not to commit suicide must have lives that are not only not bad, but are positively good. And that would be an odd point of view. If C_s is to denote well-being subsistence, it must be that it is *higher* than the living standard below which someone who is alive judges his life not to be worth living. This is a point to which I return below (Section 3.3).

So well-being subsistence has to be tracked elsewhere. I can think of no other way to arrive at the calibration than through reflections on good and bad states of affair for the person. The recognition that someone's level of well-being is positive or negative involves no more (and no less!) than comparison with the worst state such that it is not a positively bad thing that a person should live in such a state. That this is an immensely difficult judgement only goes to show that normative population theory is an immensely difficult subject, it does not offer a reason for avoiding such comparisons.

Well-being subsistence offers a way of defining *carrying capacity*. Given the resource base, C_s yields the population size at which the best that can be achieved is a life for all that is neither positively

[10] I am grateful to Robert Goodin for discussions on this point.

bad nor positively good. If N_s solves $K/N = C_s$, then N_s is carrying capacity.[11]

3.2 The Genesis Problem

Classical Utilitarianism poses the problem of optimum population as a Genesis Problem. We are to suppose that there are no people to begin with. Let N denote the number of people to be created. For simplicity, continue to assume that people will all be identical. Since marginal well-being declines as the standard of living C increases (i.e., U"(C) is negative), Classical Utilitarianism tells us that an equal distribution of K among all who are created is the ideal distribution. If N people are created, each should receive K/N units of the consumption good. Total well-being would then be NU(K/N). We search for the value of N that maximizes this.

Routine arguments show that optimum N satisfies the condition,

$$(K/N)U'(K/N) = U(K/N).^{12} \qquad (2)$$

Write $C \equiv K/N$. Since we know K, identifying optimum N is the same as identifying optimum C. The condition that yields optimum C is therefore a re-write of equation (2) as

$$U'(C) = U(C)/C, \qquad (3)$$

that is, *the value of C at which marginal well-being of consumption equals average well-being per unit of consumption*.

Equation (3) is fundamental to Classical Utilitarianism.[13] I shall call it the Sidgwick-Meade Rule here. Its intuitive basis is simple. Notice first that at the optimum, neither a small increase in population nor a small decrease should alter total well-being. Suppose now that we consider a marginal increase. (The argument associated with a marginal decrease is analogous.) Then this additional person would share K equally with the population originally contemplated. The gain in introducing this additional person is her well-being, which is U(C). But there is also a loss, which is that each of the others being considered has slightly less consumption. The loss in well-being is $CU'(C)$. At the optimum this gain and loss must equal. The Sidgwick-Meade Rule asserts this. Figure 2 shows how we may locate the optimum standard of living with the help of the Sidgwick-Meade Rule. I denote the solution as C*. The corresponding population size is denoted by N*.

3.3 Overpopulation Under Classical Utilitarianism

There is, however, a seeming problem with Classical Utilitarianism. It can recommend what could be regarded as overly large populations. Under Classical Utilitarianism, aggregate well-being is

[11] Cohen (1995) contains a wide-ranging discussion of Earth's carrying capacity and offers accounts of various estimates that have been made of it.

[12] To arrive at equation (2), differentiate NU(K/N) with respect to N, which yields the derivative U(K/N) - (K/N)U′(K/N). Equate this to zero to obtain the condition. As with equation (1), I am supposing that K is sufficiently large, so that N can be regarded as a continuous variable.

[13] See Meade (1955) and Dasgupta (1969) for successive generalizations of this.

the product of average well-being and the number of people who are born. The product gives us the trade-off between average well-being and the number of people who enjoy that average. Imagine now a world where average well-being declines slowly to zero when numbers increase. Classical Utilitarianism encourages numbers to increase indefinitely no matter how low the average has fallen, so long as it is positive (Dasgupta, 1969: 307; Rawls, 1972: 162-3).[14] But this means that the optimum standard of living, C*, can be close to well-being subsistence C_s, which is a way of saying that the theory can recommend overly large populations. Parfit (1984) found this conclusion of Classical Utilitarianism repugnant. So he has a term for it: The Repugnant Conclusion.[15]

One can argue that while the Conclusion is unappealing, it isn't "repugnant". Parfit found it repugnant because he interpreted well-being subsistence to be the standard of living below which it isn't worth living. In justifying his feelings, he described the Conclusion in the following terms:

"For any possible population of at least ten billion people, all with a very high quality of life, there must be some much larger imaginable population whose existence, if other things are equal, would be better, even though its members have lives that are barely worth living." (Parfit, 1984: 388)

One would not contest that this is repugnant, but one would be forgiven for suggesting that the phrasing is more than a bit rigged. We are first tempted with a figure for world population that will most probably be reached in the second half of this century, a figure that many think can *in principle* be sustained at reasonable material comfort. This is followed at once by a picture of an overcrowded Earth, where people scramble for resources so as to eke out an existence, leading lives "barely worth living".

But as argued earlier, the underlying logic in well-being subsistence is a far cry from this. Someone whose life is barely worth living has a low, *negative* level of well-being; their standard of living is below well-being subsistence. They are among the wretched of the Earth; and there are over a half billion such people today, malnourished and prone to illness and diseases, but surviving and tenaciously displaying that their lives are worth living by the fact that they persist in wishing to live. If you were to say that you would not wish the circumstances those people endure on anyone, I would not take you to mean that their lives aren't worth living; I would take you to be saying that their circumstances are so bad that you wouldn't wish them on even your worst enemy, that something ought to be done to improve their lives.

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[14] The example developed in Appendix 1 reveals this feature explicitly.

[15] The Repugnant Conclusion has been the source of a number of further seeming paradoxes, much discussed in the recent philosophical literature. Parfit (1976, 1982, 1984, 1990) are the sources. Parfitian paradoxes have been discussed and added to by, among others, McMahan (1981), Hurka (1983), Sterba (1987), Temkin (1987), Cowen (1989), and Broome (1996).

When the Conclusion is stated in the form Parfit adopts, it *is* repugnant. But it isn't repugnant if well-being subsistence is interpreted in the way it should be for the Genesis Problem. There is nothing repugnant about a very large imaginable population, all enjoying positive well-being. Their lives may not be very good, but as well-being is positive, their lives are good, in fact a good deal better than just worth living. There is nothing repugnant about numbers compensating for living standards so long as well-being is positive; that is, so long as lives are good. In Appendix 1, I offer a simple model that illustrates Classical Utilitarianism's formulation of the value of potential lives and the numbers that ought to be born.

But there is a problem with Classical Utilitarianism. It doesn't lie where Parfit looked; it lies elsewhere. We turn to this.

4 Actual versus Potential Lives

As an exploration into a deep and difficult set of issues, Classical Utilitarianism has something to commend it, but it has only that to commend it. The theory's weakness is that it insists on developing normative population in the context of the Genesis Problem, not as an actual problem. In this Section, I first argue that the Genesis Problem is the wrong problem to study. I then develop a theory that extends Classical Utilitarianism so that it is able to address an actual problem. I have deliberately shaped the theory on the back of Classical Utilitarianism in order that the latter appears as an extreme special case; which in the present context means that the Genesis Problem appears as an extreme special case of an actual problem. This is demonstrated in Appendix 2.

4.1 Why the Genesis Problem is the Wrong Problem for Us

In the Genesis Problem there are no people actually present. All are potential. In its purest form, the Genesis Problem asks how many lives there ought ideally to be, enjoying what living standards (Sidgwick, 1907; Meade, 1955; Dasgupta, 1969; Parfit, 1984). This is the way ideas of optimum population were presented in Sections 2 and 3. However, the Genesis Problem may have been God's problem, but it is not the problem *we* face. We are here. In contrast, the unconceived are not a class of people. The impossibility of imagining the unconceived (and thereby our own non-existence) gives spurious credence to the view that non-existence must be a long dismal night from which we must try to rescue people. We may feel grateful to the persons who created us for doing just that, not because they rescued us from anything, but because they are responsible for all this experience. As noted earlier, to say that someone has a wretched life, for example a dismally low standard of living, isn't to say that the person would have been "better off unconceived". It is only to say that it is *bad* that her standard of living is what it is. No doubt it is enormously difficult to make such an assessment (where are we to draw the line separating positive and negative levels of well-being?), but that doesn't mean we can avoid making it, nor that we ought to even if we could.

It is useful then to distinguish *present* and *future* people from *potential* people.[16] Present people are alive now. Future people aren't alive now, but will be alive in the future. (For simplicity I am ignoring uncertainty in demographic forecasts.) In contrast, potential people are people who will be alive *only if* someone chooses to create them. Demographers refer to present people when informing us, say, that a country's population has passed the billion mark. They include future people in their reckoning when issuing a forecast that the world's population will be 9.5 billion in 2050, meaning that people can be expected to reproduce in a manner that will lead to 9.5 billion people in 2050. Demographers are, of course, unable to offer us the identities of future people, but they don't need to: future people will be here and will have needs when they are here.

Living people have feelings, aspirations, needs, claims, projects, and a sense of justice. And they have rights. Future people will have feelings, aspirations, needs, claims, projects, and a sense of justice, once they are here. As they will have claim rights once they are here (most especially, perhaps, on those who were responsible for their births), those claims have to be accommodated now; otherwise future people would be in danger of inheriting a barren Earth. When, in formulating the theory of optimum saving, Ramsey (1928) insisted that discounting future utilities is "... ethically indefensible and arises merely from the weakness of the imagination", he was assuming that future numbers are given, that they are not subject to choice. Ramsey's conceptual world contained only present and future people. In contrast, a theory of optimum population must presume that future numbers, at least upto a point, are a matter of choice. That is why we have to consider potential people; thereby potential lives.

Potential people are not present or future people, any more than clay by the banks of a river is pottery. It is hard to know what it even means to say that potential people have rights or claims. To illustrate, notice that when we revere the memory of deceased persons, it is to persons, now deceased, that we show reverence. When we debate at what stage in the development of a foetus we ought to regard it as a person, we recognize that there is something akin to a discontinuity in the process of each person's creation. The debate no doubt shows the notion to be fuzzy - even more than, and intrinsically a good deal more important than, the notion of a heap of stones (how many stones are needed to form a heap?) - but this doesn't mean the notion is spurious, nor that it depends upon mere convention. Social convention, possibly backed by formal legislation, dictates how in fact we resolve the issue of when a foetus becomes a person. This only means that we think there is something to resolve; it doesn't mean that the resolution is right. But in so thinking, we *are* right, for it offers room for the idea that a person's life has sanctity.

So there is a difference between present and future persons on the one hand and potential persons on the other. Classical Utilitarianism would appear to conflate the two categories. I argue below that this is a mistaken move and a reason why it should be rejected.

[16] I am using Parfit's (1982) classification.

4.2 Actual Problems

In an actual problem there are real persons, whom for convenience I shall continue to refer to as present people. The adults among them deliberate over future population sizes and future living standards. Thoughtful parents grapple with actual problems, not with the Genesis Problem. This leads us to a study of fertility decisions. The number of present people is given; it is a datum.

Consider the following problem (taken from Parfit, 1982). A woman suffers from a medical condition. There is a large chance that, if she were to conceive now, the child would suffer from a disability, but would otherwise enjoy a good life. However, a minor medical treatment would cure the woman within a month. Once cured, any child she bears will be free of the disability and enjoy a life of high quality. The woman is somewhat impatient to conceive. Ought she to wait a month, or would it be reasonable to conceive now?

One can argue that it is reasonable she conceives now. After all, or so the argument could go, the woman's feelings matter and the child she conceives now can't complain later that she was unfair to him, that she should have waited and undertaken the medical treatment, that he would then have had a better life. The reason he would not have grounds for complaint is that, had she waited, the child she would have conceived wouldn't have been him. Nor, or so the argument may continue, can some unconceived child complain that the woman prevented him from being born by being hasty.

Nonetheless, there is a strong intuition that the woman should wait. And the intuition is built not only on the thought that good lives are an intrinsic good, but also that better lives are intrinsically even better. I invoke this intuition presently.

Consider now another problem. A couple have a newly-born daughter (their only child to date), whose lifetime well-being is firmly expected to be nil unless additional resources are diverted to her needs (e.g., additional health-care and education in her early years). Option A_1 is to make available such resources as will raise her level of lifetime well-being to U* (> 0). Option A_2 is for the couple to create an additional child, with the understanding that sufficient resources will be diverted to this new child to enable him to enjoy lifetime well-being equal to U*. However, under A_2 the little girl's lifetime well-being will be nil. Assume that in all other respects A_1 and A_2 have the same consequences. What should the couple do?

If, as Sidgwick would have it, pleasure or agreeable consciousness is the sole good, and if the fact that something good would be the result of one's action is the basic reason for doing anything (the ground of binding reasons), the couple in question should be indifferent between A_1 and A_2.[17] But there are a number of additional considerations the parents can legitimately bring to bear in choosing between A_1 and A_2: Would they *like* to have another child? Is a single child congruent with their notion of a family? What is the source of the additional resources under the two options? What is their motivation

[17] I am assuming implicitly at this point that well-being is a measure of agreeable consciousness.

for having children? What about the claims their daughter may have on them? What about her rights as an individual? And so on.

I now consider two reasons why A_1 would be viewed as the right option, other things being the same.

Obligation to One's Children

A_1 would be the right option because the couple have an obligation toward their daughter, an obligation they don't have toward a potential child. They have an obligation toward their daughter because they were responsible for bringing her into the world. People do not have an obligation to become parents, of course, but they acquire one toward their children if they choose to become parents.[18] Moreover, parents have an obligation toward their offspring that no others have. By the same token, children have a claim on their parents no one else has.

This particular type of obligation, and the responsibility that goes with it, would seem to be acknowledged widely among known cultures. The obligation the couple have toward their daughter also has a wider implication, which is that parents ought to attach a greater weight to the well-being of the children they already have than to the potential well-being of an additional child (one they could choose *not* to have). In the case of the couple, the special claim provides an argument for choosing A_1 over A_2. The reason does not of course in general settle the matter: Their daughter is their only child; this may be the last opportunity to have another child; one child may not conform to the couple's conception of a family; and so forth. Such considerations should matter, but not in the case we are hypothesising, because in order to have a sharp problem to analyse, they have been assumed away.

Claim Rights of Actual and Future Persons

Another, not unrelated reason A_1 would be the correct choice has to do with the *claim rights* of the new-born girl. She is a person; it is *her* well-being that is under consideration. She has a right to demand that she be acknowledged; she has a right to be heard. Future people will have such claim rights, of course; a right that has to be respected by present people when latter take decisions. It is potential people who cannot be said to have a corresponding right.

Consider someone who has a miserable life. Her well-being is negative. Her life nevertheless has value. If nothing else, it is *her* life. More generally, the judgment, "Better if you had not existed than suffer such pain" is different from the judgment, "Better if a life that would suffer such pain were not created". Such asymmetry implies that the little girl's claims would lead A_1 to beat A_2.[19]

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[18] I am ignoring the obligation people may have to procreate in special cases, such as a dwindling population.

[19] Neo-Utilitarians too have reached this conclusion of asymmetric treatment between actual and potential people. The pioneering paper on what we are calling "actual problems" is Narveson (1967), but he arrived at the asymmetry by a different route: "We are in favour of making people happy, but neutral about making happy people". Narveson labelled the version of Utilitarianism that accommodates this

This isn't to argue that good lives do not have intrinsic value, it is only to say that actual lives (that is, present and future lives) have a weight that potential lives do not. To say that A_1 is the better alternative is not to say that, other things being the same, having a new child under A_2 isn't a good thing. Good lives are part of the intrinsic good; but, other things being the same, an improvement in the quality of life of the couple's daughter, from zero to U*, is better still.

One may put the matter more generally:

There are two reasons for benefiting a present or future person. One is that her well-being is *good in itself*. (This was the strong intuition that was referred to in the case of the woman with a medical problem.) The other reason is that it is *good for her*. (I am including in the former indirect effects, such as the well-being others may enjoy from the well-being of a given person.) However, there is only one reason for creating a person, which is that her life would be good in itself. (I am including in this the indirect effects of her conception, such as that the couple would like a child and that their desires count.)

To give an analogy, consider a different sort of problem: choice over product quality. Imagine a commodity possessing a single characteristic, G; and another that possesses an additional characteristic, H. We imagine that both G and H are desirable characteristics, but that the two commodities are identical in terms of characteristic G. Clearly, we would value both commodities. Presumably though, we would value the latter commodity more, because it possesses an additional, desirable, characteristic, H. If, on the other hand, the first commodity were superior in terms of characteristic G, we would face a trade-off problem. And so forth.

Now return to the problem facing the couple. Suppose they were to subscribe to any ethical theory that (a) regards good lives to be part of the intrinsic good and (b) insists that only present and future people have claims, rights, and interests. The couple could reasonably impute a positive weight to creating lives, even while awarding a lower weight to potential well-being than to the well-being of their little daughter. But such a move would give the couple a reason for choosing A_1.[20]

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asymmetry "person-affecting utilitarianism". For a far-reaching critique of Classical Utilitarianism when applied to reproductive decisions, see Heyd (1992).

[20] In a move to avoid Parfit's Repugnant Conclusion, Blackorby and Donaldson (1985) have explored a modified version of Classical Utilitarianism. In their theory, potential lives have the same value as actual or future lives and, so, personhood has no special role to play in what is a Different Numbers Problem. But the authors posit that, other things remaining the same, the creation of an additional person is good only if her lifetime utility exceeds some positive, "critical" level, say w (> 0). Blackorby and Donaldson call their theory "critical-level utilitarianism". The language they use to motivate their condition suggests that they have in mind an actual problem, but they invoke it in order to avoid the seeming paradoxes of the Genesis Problem. The conflation of the two quite different settings puzzles me. For, suppose that each one of all existing people is firmly expected to enjoy a quality of life equal to, say, 2w/3. This is a positive level, meaning that each person will enjoy a good life, and good lives are an intrinsic good. But, as I understand it, critical-level utilitarianism asks us to believe that, other things remaining the same, adding an extra person who would enjoy a quality of life equal to 2w/3 would be a bad thing. I don't see why it would not be a good thing.

5 Generation-Relative Ethics

The above arguments would seem to be at odds with the idea that ethical considerations must be impartial. But the notion of impartiality in social ethics, the idea that we should seek to peer at matters from no particular person's viewpoint (as in the notion of "impartial preferences" in Harsanyi, 1955; and in the reasoning behind the "veil of ignorance" in Rawls, 1972), has force when future numbers are not subject to choice. In those situations we, the present people, can deliberate over options affecting ourselves and future people. We can look at the world not only from our own perspective, but also from the perspective of future people as and when they appear. The veil of ignorance, for example, provides us with a reason for doing so.

The problem facing the couple is different. Future numbers are a matter of decision. Neither Harsanyi's nor Rawls's construct gets a grip on the matter being considered here. It isn't possible to assume the "perspective" of potential people. The veil can be worn for a pure savings problem, in which future numbers are given, as in Ramsey's (1928) exercise. It can do no work for the combined saving and population problem. In the combined problem, an overall ethical ordering over alternatives can be conceived only for each generation of actual people. The ethical viewpoint is thereby *generation-relative*. As generations change with the appearance of newer and newer people, the ethical point of view inevitably changes.

Of course, the couple's problem in our example is a mere example. We would want to generalise from there, to consider the situation where each generation chooses the size of the next generation and the amount of output to be set aside for investment. The latter choice determines the next generation's productive base. The problem is then to tie the ethical viewpoints of succeeding generations as and when they come into being. This involves an intergenerational game.

How should the generations play the game? In what follows I presume that no generation can bind any subsequent generation to do one thing rather than another, excepting in the simple sense that a generation's bequests influence the sets of options that will be available to its descendents. This inability to "bind the future" may be interpreted not only as an empirical constraint, but also as an ethical requirement, that each generation that comes into existence has the right to choose how much to save and how many immediate descendents to create.

As the theory of games has shown, the solution of the intergenerational game involves the concept of a Nash equilibrium. Along an intergenerational equilibrium each generation chooses the size of the next generation and the amount it bequeaths to it on the basis of reasoned expectations about the consequences of its choice. When choosing the size of the next generation, however, each generation awards a smaller weight to potential well-being than to their own well-being, subject however to the requirement that at each date resources will be shared on the basis of a procedure that gives equal

weight to all who are then currently alive.[21] Along an equilibrium each generation's reasoned expectations are fulfilled, in that no generation has an ethical reason to choose other than what was expected of them by their ancestors when they themselves chose how many to create and how much to save for those they created.

5.1 Two Examples

For ease of comparison with Classical Utilitarianism, we restrict generation-relative ethics in the rest of this section and in Appendix 2 to generation-relative utilitarianism.

Two questions arise: Does an intergenerational equilibrium exist? If an equilibrium does exist, is it unique?

The answer to the first question can be shown to be, "yes"; but the answer to the latter question is, generally speaking, "no". One way to interpret the answers is that generation-relative utilitarianism is coherent, but is not sharp enough to identify a unique population optimum.

Fortunately, in simple economies the answer even to the latter question is, "yes". That said, I have not been able to obtain an explicit characterization of optimum population that generation-relative utilitarianism would recommend in models with durable capital. As in other areas of applied ethics, the possibility of accumulating capital makes for computational difficulties. But there are two very special worlds where the theory can be put through its paces easily.

World 1

The first example is a world that captures the ethics of the theory in an impeccable manner, but is empirically audacious because it denies the possibility of capital accumulation and postulates an utterly simple life-cycle. Let time be divided into discrete periods (t = 0, 1, 2, ...), where a period is the length of a generation. In each period the economy is provided, rather like manna from heaven, with K units of a non-storable, all-purpose consumption good. Imagine that people live for two periods. In the first period of their lives they are young; in their second period they are adults. Each pair of successive generations therefore overlap for a period. Adults choose the number of children to have and the way the consumption good of amount K is to be shared among themselves and their young. The young consume what they are given to consume by the adults. This means that there is no production activity in the economy, imlying in turn that there is no possibility of investment or disinvestment. With some stretching of the imagination, one could think of K as the flow of ecological services Nature provides in each period. However, the "stretching" lies only in the thought that Nature cannot be destroyed. In other respects the model is sensible. For example, in not permiting capital accumulation for the purpose of increasing the productive base, the model draws attention to the constraints set by Nature: the parameter K captures environmental constraints.

[21] For simplicity of exposition I am assuming that all future numbers are subject to choice. That means we need to consider only present and potential people.

Children are desired not only as ends in themselves. As we noted earlier, in poor countries they are also a help with household actvities and security and comfort in old age. Average Utilitarianism, in the way the theory was formulated by its founders (Figure 1), stresses the instrumental worth of children: if the contribution of the next person to be born is expected to exceed average output now, the theory recommends an expansion of population, but not otherwise. The model I construct here to illustrate generation-relative ethics purges the instrumental worth of children so as to concentrate on their intrinsic worth. Even in this regard there are two aspects of potential children to be considered. One aspect is that of children as determinants of their parents' well-being, the other is that good lives are an intrinsic good. The model that follows picks up the latter feature only. That way we are able to capture the essentil tension between present people's desires and needs, and their "prescribed" reproductive behaviour.

For simplicity of exposition, I assume that an individual's well-being function is the same in both periods of their life.[22] If someone's consumption level is C, her well-being is U(C). I continue to suppose that $U'(C) > 0$ and $U''(C) < 0$. As the adults award the same weight to their own well-being as they do to the well-being of the young they have produced, K is shared equally in every period among all who are present.

We begin by considering the decision problem faced by the current generation, who are now in their adulthood. The moment is the beginning of period t = 0. The adults are the only people present. Their number is $\mathbf{N}_0$. Present people are to choose the size of the next generation. They know that if they were to conceive, say, N_1 children, those children would be awarded the same weight as themselves for the purposes of food allocation, implying that K would be shared equally among $(\mathbf{N}_0 + N_1)$ people during period t = 0. So the $\mathbf{N}_0$ adults recognize that a consequence of their choice would be that each person would consume $K/(\mathbf{N}_0 + N_1)$ units of the consumption good during t = 0. They also know that at the beginning of period t = 1 they themselves will have died and that the N_1 young they produce will be the adults, facing a reproductive and distributive problem similar to the one they themselves face. Moreover, they know that not only would their N_1 young but every generation that comes into being will deliberate in the same way as they themselves are deliberating.

It makes for tidy analysis not to assume that Earth will cease to exist at some known future period. On the other hand, to imagine that Earth will exist forever is against all evidence. The simplest compromise to make is that, conditional on Earth not having ceased to exist until any given period, there is a constant rate of risk that Earth will cease to exist in that period. Let $1/(1 + \delta)$ be that constant rate,

[22] This assumption can be relaxed easily. If the well-being functions of adults and the young differ, we may rescale the well-being function of a young person (alternatively, an adult) in terms of the well-being function of an adult (alternatively, a young person). The idea of "adult-equivalent scale", much used in estimating nutrition requirements of a population, involves rescaling well-being functions of different types of people.

where $\delta > 0$. Now write $\beta = 1/(1 + \delta)$. This means that $1 > \beta > 0$. Imagine now that $\{N_1, N_2, ..., N_t, ...\}$ is a *potential* demographic profile from t = 1. If the adults at the beginning of period t = 0 were to consider this potential profile, they would regard social well-being to be

$$\mathbf{N}_0U(K/(\mathbf{N}_0 + N_1)) + \gamma[N_1U(K/(\mathbf{N}_0 + N_1)) + {}_1\Sigma^{\infty}\{\beta^t(N_t + N_{t+1})U(K/(N_t + N_{t+1})\}].^{23} \quad (4)$$

Imagine that their choice is $\mathbf{N}_1$. They would then know in advance that their children, when they in turn become adults by the beginning of period t = 1, will regard social well-being to be

$$\mathbf{N}_1U(K/(\mathbf{N}_1 + N_2)) + \gamma[N_2U(K/(\mathbf{N}_1 + N_2)) + {}_2\Sigma^{\infty}\{\beta^t(N_t + N_{t+1})U(K/(N_t + N_{t+1})\}]. \quad (5)$$

Repeating the above argument generates a recursive relation among the social well-being functions of all generations that come into being. In other words, if $\mathbf{N}_t$ were to be the number of adults at the beginning of period t (≥ 0), they would regard social well-being to be

$$\mathbf{N}_tU(K/(\mathbf{N}_t + N_{t+1})) + \gamma[N_{t+1}U(K/(\mathbf{N}_t + N_{t+1})) + {}_{t+1}\Sigma^{\infty}\{\beta^{\tau}(N_{\tau} + N_{\tau+1})U(K/(N_{\tau} + N_{\tau+1})\}]. \quad (6)$$

An intergenerational equilibrium is a demographic profile $\{\mathbf{N}_0, \mathbf{N}_1, \mathbf{N}_2, ..., \mathbf{N}_t, ...\}$, such that each generation t (≥ 0), of size $\mathbf{N}_t$, judges $\mathbf{N}_{t+1}$ to be the optimum size of the next generation.

I have found even this simple recursive structure impossible to dissect analytically, but I have been able to discover the stationary demographic profile it gives rise to. An optimum stationary profile is a sequence {**N**, **N**, ...} such that the **N** adults in every period choose to create **N** children. Although tractable, identifying the optimum stationary profile involves mathematical steps. So the calculations are undertaken in Appendix 2. Among other things, I show there that generation-relative utilitarianism prescribes a smaller population than Classical Utilitarianism. I also show there that the Genesis Problem in Classical Utilitarianism is an extreme special case of generation-relative utilitarianism.

World 2

The other special world where the implications of generation-relative ethics are relatively easy to describe is ethically very dubious. It involves the thought that *no* weight should be awarded to potential well-being. The viewpoint was explored by Enke (1966) in his study of social cost-benefit analysis of family planning programmes in poor countries. Enke sought ways of measuring the economic value of prevented births, which he took to be the discounted sum of the differences between an additional person's consumption and that person's output over their lifetime. This means that children, in Enke's theory, have value only if they pay their way. The weakness of the theory is that it does not accept that good lives have intrinsic value.

But Enke's is an extreme point of view, as is Classical Utilitarianism: one awards no weight to potential well-being, while the other awards the same weight to them as it does to the well-being of present or future people. The arguments I have offered imply that both points of view are questionable.

[23] This formulation is identical to the one in Phelps and Pollak (1968), who had considered a pure saving problem. They justified their formulation on the basis of what would be called "agent-relative utilitarianism". The formulation being discussed in the text is a pure population problem. The justification I offered in Section 4.3 is not based on that class of theories.

Within the broad class of utilitarian theories generation-relative utilitarianism is attractive because it lies between two extremes and reflects the strength of each without giving in to the weaknesses of either. It prescribes neither a very large population nor a very small population. Instead, it offers a wide space in between, within which more detailed ethical considerations can be embedded. We should not expect an ethical theory to do more.

6 Rational Ends

Population ethics has for long been an underdeveloped branch of moral philosophy and welfare economics. That it has remained backward has much to do, I believe, with the insistence on the part of philosophers writing on the subject to ignore the ethical relevance of parental desires, and the related question of what in our own lives gives meaning to us. That my neighbour is not as close to me as are my daughters and son is a genetic fact, but that is not quite the point here. Closer to the mark is the fact that my children provide me with a means of self-transcendence, the widest avenue open to me of living *through* time. Mortality threatens to render the achievements of our life transitory, and this threat is removed by procreation. The ability to leave descendants enables us to invest in projects that will not cease to have value once we are gone, projects that justify life rather than merely serve it. These projects include not only the creation of ideas and artefacts; more pervasively, they include the formation of personal values. Thus the questions, "what kind of person ought I try to be? what should I value?" do not presume the questioner to own a specific set of talents, abilities, and resources (anyone can, and should, ask such questions); they presume only that they play a role in any reasoned answer.

Procreation is a means of making one's values durable. We imbue our children with values we cherish not merely because we think it is good for them, but also because we desire to see our values survive. It seems to me that our descendants do something supremely important for us here: they add a certain value to our lives which our mortality would otherwise deprive them of. Alexander Herzen's remark, that human development is a kind of chronological unfairness, since those who live later profit from the labour of their predecessors without paying the same price, and Kant's view, that it is disconcerting that earlier generations should carry their burdens only for the sake of the later ones, and that only the last should have the good fortune to dwell in the completed building, or in other words, that we can do something for posterity but it can do nothing for us (Rawls, 1972: 291), are a reflection of an extreme form of alienation: alienation from one's own life.

This viewpoint, of seeing ourselves as part of a delegation of generations, has roots reaching far back, in many cultures, and in recent years it has found its deepest expression in Schell (1982) and Heyd (1992). We act upon this perspective most often with no explicit verbalization to accompany it. We assume parenthood quite naturally; we do not make a big intellectual meal of it. It is the sort of thing we take responsibility for in the normal course of events. Of course, special circumstances may deflect us; we may have more urgent projects and purposes. Here, the fact of a general assumption of parenthood is of importance. An artist may regard his work as far more important than parenting, but he is helped in

this by the fact that there will be a next generation to bestow durability to the value of his work. The springs that motivate the general run of humankind to assume parenthood are deep and abiding. The genetic basis of the matter merely explains the existence of this motivation; it does not justify it. Justification has to be sought elsewhere, and any reasonable answer must come allied to the viewpoint that every generation is a trustee of the wide range of capital stocks (be it cultural or moral, manufactured or natural) it has inherited from the past. Looking backward, it acknowledges an implicit contract with the previous generation, of receiving the capital in return for its transmission, modified suitably in the light of changing circumstances and increasing knowledge. Looking forward, it offers an implicit contract to the next generation, of bequeathing its stocks of capital that they in turn may be modified suitably by it and then passed on to the following generation. The idea of intergenerational exchange is embedded in the perspective of eternity. But the intellectual source of such exchange is a far cry from the conception that balked Herzen in his effort to locate mutually beneficial terms of trade.

Recent attempts by social thinkers in Western industrial countries at creating an environmental ethic draw their strength from something like this conception (Schell, 1982). But it does not provide enough of an apparatus to do so. Finally, there is no avoiding the question, "what should I value?" if we are to see ourselves living through time, rather than in time. It is a mistake to try to justify the protection of the giant redwoods, or the seemingly so trivial a species as the hawksbill turtles, or, more widely, the preservation of ecological diversity, solely on instrumental grounds, on grounds that we know they are useful to us, or may prove useful to our descendants. Such arguments have a role, but they are not sufficient. Nor can the argument rely on the welfare of the members of such species (it does not account for the special role that species preservation plays in the argument), or on the "rights" of animals. A full justification must base itself as well on how *we* see ourselves, on what kind of people we ought to try to be, on what our rational desires are. In examining our values, and thus our lives, we need to ask if the destruction of an entire species-habitat for some immediate gratification is something we can live with comfortably. The mistake is to see procreation and ecological preservation as matters of personal and political morality. It is at least as much a matter of personal and political ethics.

Appendix 1

Numbers and Well-Being Under Classical Utilitarianism

Classical Utilitarianism can recommend what many would regard as overly large populations. I illustrate this by studying an example that is so simple that we are able to obtain an explicit solution.[24]

As in Section 3, I assume that all who are born are treated equally. Let C be the representative person's consumption level (his standard of living). Consider the following class of well-being functions:

$U(C) = B - C^{-\sigma}$, where B and σ are positive constants. (A.1)

The functional form (A.1) is useful because it is defined by two parameters, B and σ. Ramsey (1928) called B "bliss", since B, the least upper bound of U, can be approached, but never attained. $(1 + \sigma)$ is the elasticity of marginal well-being. It can be shown that the larger is σ, the more equity-conscious is Classical Utilitarianism, a fact that I return to at the end of the Appendix.

It is easy to check from expression (A.1) that well-being subsistence is given by the expression:

$C_s = (1/B)^{1/\sigma}$. (A.2)

As in Section 3, I consider a timeless world. There is a fixed stock of resources, of size K. The idea is to determine the number of people who should be created. To identify the optimum population, use (A.2) in the Sidgwick-Meade Rule (equation (3)) to obtain optimum consumption per head as

$C^* = [(1 + \sigma)/B]^{1/\sigma}$. (A.3)

Notice that C* is a function only of B and σ; C* is independent of K.[25] This is unexpected, because unaided intuition could suggest that the larger is the resource base, the higher would the optimum living standard be. Classical Utilitarianism says instead that population size should exactly match the larger resource base, meaning that the optimum standard of living is invariant to the resource base that Humanity inherits.

Use (A.2) in (A.1) to re-express (A.3) as

$C^*/C_s = (1 + \sigma)^{1/\sigma}$. (A.4)

Equation (A.4) is useful because it relates the optimum standard of living to well-being subsistence. For ecologists and demographers, however, it would prove more natural to recast the equation in terms of population size. So, define $N^* = K/C^*$ and $N_s = K/C_s$. N* is optimum population for Classical Utilitarianism, and N_s is the economy's carrying capacity. We may then re-express equation

[24] The example is a stripped-down version of a model of capital accumulation that was constructed and analysed in Dasgupta (1969). It transpires that, for our purposes, nothing is lost by assuming that capital cannot be accumulated.

[25] I am grateful to Kenneth Arrow for this observation. He and are currently engaged in a research project that builds on the utilitarian calculus to provide a unified account of the value of new births and the value of extending the lifespan of existing people.

(A.4) as

$$N_s/N^* = (1 + \sigma)^{1/\sigma}. \quad (A.5)$$

σ is a positive number, and it is a well-known mathematical fact that when σ is positive, $(1 + \sigma)^{1/\sigma}$ is less than e (the base of natural logarithms), which in turn is approximately 2.74. I conclude that

$$C^*/C_s = N_s/N^* = (1 + \sigma)^{1/\sigma} < e \approx 2.74. \quad (A.6)$$

Inequality (A.6) is interesting. It says that Classical Utilitarianism favours a large population: *the optimum standard of living is less than only 2.74 times the well-being subsistence rate*. To put it another way, *carrying capacity is less than only 2.74 times the optimum population size*.

It is instructive to work with stylized numbers. Suppose $\sigma = 1$.[26] Then $C^*/C_s = N_s/N^* = 2$, which is to say that the optimum standard of living is only twice as large as well-being subsistence. Optimum population is therefore half the carrying capacity. If carrying capacity were, say, 10 billion people, optimum population would be 5 billion.

Notice, however, that the larger is σ, the closer is C^*/C_s (= N_s/N^*) to unity, which is a way of saying that Classical Utilitarianism can advocate very large populations. If, for example, carrying capacity were 10 billion people, and if σ were large, optimum population would be nearly 10 billion. I have known this result for a long time, but still find it puzzling that the idea of *equality* should play such an influential role in normative population theory. Admittedly, the theory I have invoked here instructs that all who are born are to be treated equally. Even so, it isn't obvious why an attitude toward equality influences the optimum number of lives.

Appendix 2

Generation-Relative Utilitarianism and Classical Utilitarianism: A Comparison

In Section 4 arguments were advanced in favour of a generation-relative ethics when future numbers are a matter of choice. In Section 5 a model of over-lapping generations was presented that formalised a particular species of generation-relative ethics, namely, generation-relative utilitarianism. Here I derive the recursive equations that sequential maximization of expression (6) gives rise to and solve for the unique stationary solution. In order to do the calculation, we may as well work with the social well-being function of the adults at the beginning of t = 0 (equation (4)). For convenience, I re-write it here as

$$\mathbf{N}_0U(K/(\mathbf{N}_0 + N_1)) + \gamma[N_1U(K/(\mathbf{N}_0 + N_1)) + {}_1\Sigma^{\infty}\{\beta^t(N_t + N_{t+1})U(K/(N_t + N_{t+1})\}]. \quad (A.7)$$

Assume that $\mathbf{N}_0$ is not so large that the optimum value of N_1 is zero. If this assumption doesn't hold, further ethical considerations arise, for example that the continuation of the human enterprise has intrinsic ethical value (Section 6). Let C_t denote consumption per head at t. To determine the optimum value of N_1, we differentiate expression (A.7) partially with respect to N_1 and set the derivative equal to

[26] This choice is not ad hoc. Empirical studies of choice under uncertainty have consistently revealed that σ is only a little in excess of unity.

zero, which is the first-order condition. This yields the equation

$$\gamma U(C_0) + \gamma\beta U(C_1) = K(\mathbf{N}_0 + \gamma N_1)U'(C_0)/(\mathbf{N}_0 + N_1)^2 + \gamma\beta KU'(C_1)/(N_1 + N_2). \quad \text{(A.8)}$$

Let $\mathbf{N}_1$ be the solution of equation (A.8). At t = 1 those $\mathbf{N}_1$ persons will choose the value of N_2 using an identical type of reasoning. The first-order condition for them would be

$$\gamma U(C_1) + \gamma\beta U(C_2) = K(\mathbf{N}_1 + \gamma N_2)U'(C_1)/(\mathbf{N}_1 + N_2)^2 + \gamma\beta KU'(C_2)/(N_2 + N_3), \quad \text{(A.9)}$$

and so on, for subsequent generations. A demographic profile $\{\mathbf{N}_0, \mathbf{N}_1, \mathbf{N}_2, ..., \mathbf{N}_t, ...\}$ is an inergenerational equilibrium if it is a solution of the sequence of first-order conditions.

In order to obtain concrete, analytical results, let us identify a the stationary state that is associated with a repeated use of the first-order conditions. The assumption of stationarity enables us to solve the recursive equations (A.8), (A.9), ... explicitly. We therefore imagine that past choices have converged to the point where, at t = 0, the size of the population is such that equilibrium behaviour involves replication in every period. Being stationary, the demographic profile will be sustainable. So we may drop the time subscript from the population and consumption variables. If the solution is unique, there is a unique stationary state.[27]

Let **N** be the size of a generation and **C** be per capita consumption in the stationary state. Thus, **C** = K/2**N**. Simple manipulation of equation (A.8) then implies that **C** is the solution of

$$U'(C) = [2\gamma(1 + \beta)/((1 - \gamma) + 2\gamma(1 + \beta))]U(C)/C. \quad \text{(A.10)}$$

Notice that if $\gamma = 1$, equation (A.10) reduces to the stationary optimum under Classical Utilitarianism. (Compare equation (2) with equation (A.10).) Notice also that $U'(\mathbf{C}) < U(\mathbf{C})/\mathbf{C}$ if $\gamma < 1$. This means that stationary consumption per head under Generation-Relative Utilitarianism is greater than under Classical Utilitarianism. Correspondingly, population is smaller (Figure 3).

By how much? To investigate this, consider once again the laboratory,

$U(C) = B - C^{-\sigma}$, where B and σ are positive constants.

Well-being subsistence is $C_s = B^{-1/\sigma}$. Since two generations are alive in any given period, we should write carrying capacity as $2N_s$. Equation (A.10) then yields

$$(\mathbf{C}/C_s)^{\sigma} = (N_s/\mathbf{N})^{\sigma} = (\sigma + P)/P > 1,$$

where $P = 2\gamma(1 + \beta)/[(1 - \gamma) + 2\gamma(1 + \beta)]$. (A.11)

To obtain explicit numbers, let $\sigma = 1$, $\beta \approx 1$, and $\gamma = 1/9$. Equation (A.11) then implies,

$$\mathbf{C}/C_s = N_s/\mathbf{N} = 4,$$

which means that optimum population size is a quarter of carrying capacity. Thus, if carrying capacity is 10 billion people, optimum population is 2.5 billion. Recall from Appendix 1 that Classical Utilitarianism, however, would advocate a population of 5 billion. (One can confirm this also from equation (A.11) by setting $\beta = \sigma = \gamma = 1$.) With the parameter values being assumed here, Classical

[27] Interested readers can test for the stability of the stationary state by studying equations (A.8), (A.9), and so on.

Utilitarianism advocates twice the population size recommended by Generation-Relative Utilitarianism.

It is informative too to consider the extreme values assumed in Enke's theory, which was described in Section 5. Enke (1966) assumed $\gamma = 0$. Equation (A.11) implies that, if $\gamma \to 0$, then $\mathbf{C}/C_s \to \infty$ and, therefore, $N_s/\mathbf{N} \to \infty$. This is another way of saying that the lower is the weight awarded to potential lives, the smaller is optimum population. This too is consistent with intuition. In the limit, if no weight were to be awarded to potential lives, optimum population would be vanishingly small in a world that involves sharing, but no production.

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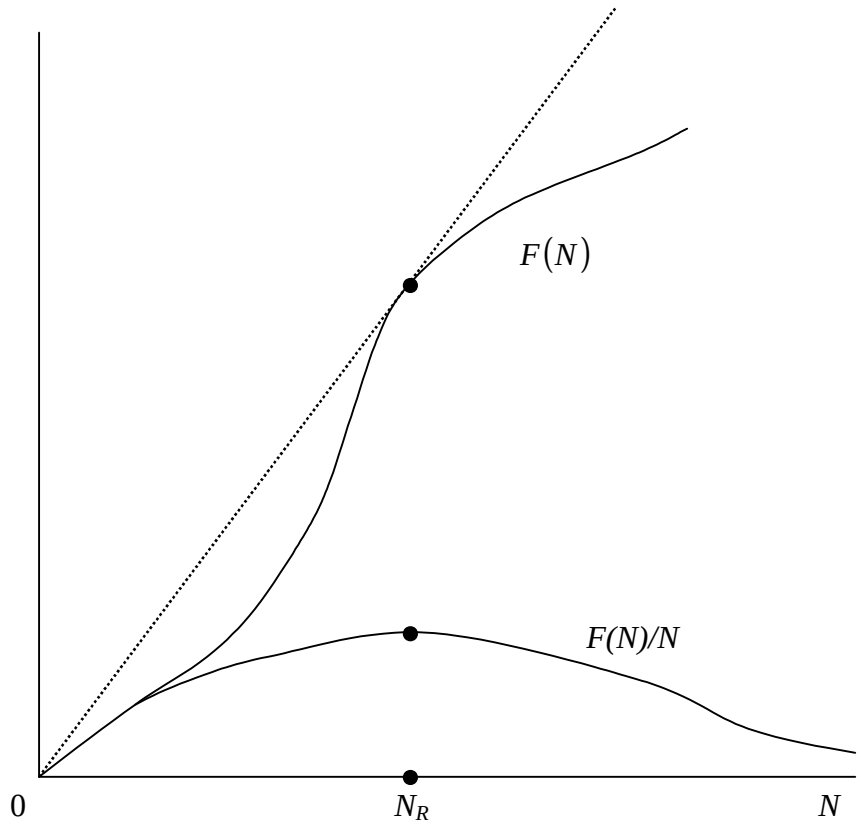

Figure 1. *Average Utilitarianism and productivity curves*

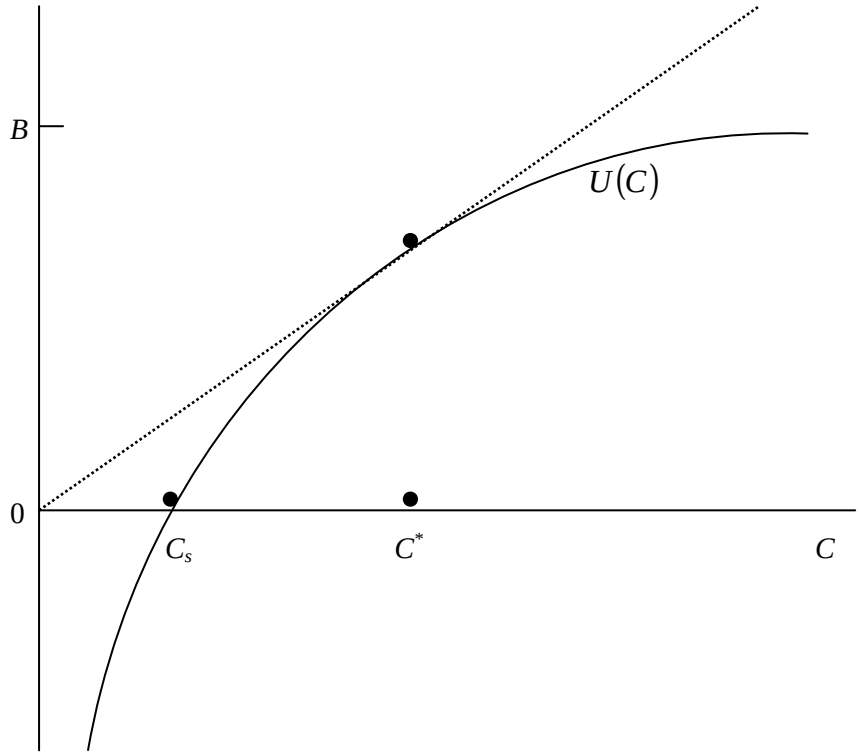

Figure 2. *Classical-Utilitarian optimum, C^**

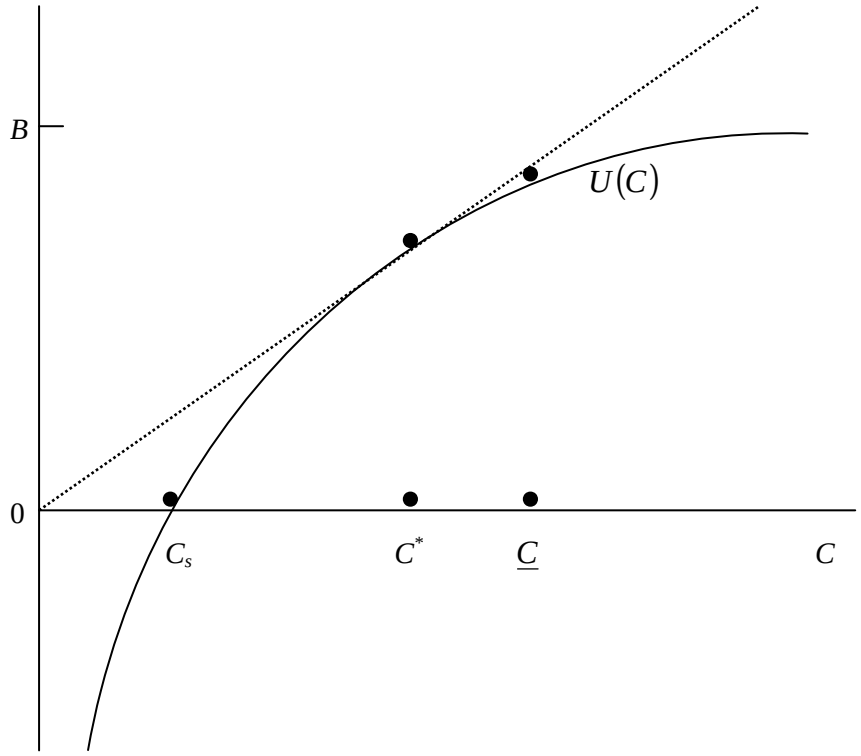

Figure 3. *Generation-relative Utilitarian optimum consumption:* $\underline{C}$