To Discount or Not to Discount?

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Part IV

Values and Measures of Health

Discounting future health benefits when computing the global burden of disease has been highly debated. This chapter reviews some arguments in favor of discounting. The authors first propose a general theory of discounting for health benefits, based on a social welfare approach. They review two well-known arguments in favor of discounting: the infinite postponement paradox and the eradication paradox. They argue that these are invalid arguments. At the same time, they argue that the principle of weighting all life years equally, independently of time, is not plausible under assumptions of welfare growth. Health should be discounted, but at a rate that should not be related to market interest rates, or to the discount rate for regular consumption goods. The authors contend that the social welfare approach justifies a positive but very low discount rate for health.
discounting, Global Burden of Disease Study, social welfare, infinite postponement paradox, eradication paradox, measurement of inequality

Chapter 13

To Discount or Not to Discount?

Marc Fleurbaey and Stéphane Zuber

13.1. Introduction

The early measurements of the global burden of disease involved discounting disability-adjusted life years (DALYs) at an annual rate of 3%, a value that was “entirely arbitrary” but appeared to be a good compromise, because it is “the lower limit of acceptability for those economists who are persuaded by opportunity cost arguments and is at the upper limit for those who are willing to accept a positive discount rate for the reasons of excessive sacrifice"[1] (Murray and Acharya 1997, 722). The recent versions have eliminated the discount factor, on the ground that "a year of healthy life should be counted as equally important in terms of population health regardless of the year in which it is lived" (Murray et al. 2012, 16 of the supplementary appendix). This conclusion is in agreement with the criticism of discounting in the first generation of GBD put forth by Anand and Hanson (1997, 695), who saw "no justification for an estimation of the time lost to illness or death which depends on when the illness or the calculation occurs," except the uncertainty of existence of future generations (which would however justify a very small discount rate).

The literature contains many arguments in favor of discounting health, some of which push for discounting health benefits and money with the same discount rate (for a critical review of such arguments, see Nord 2011; for a discussion focusing on uncertainty about future health developments, see Cotton-Barratt in this volume). We will consider two such arguments, which seem to be the prominent ones in the discussion:

> *Infinite postponement paradox*: Suppose that a health program costing C would produce a health benefit B. The program can be implemented now or in the future. Suppose that the comparison of C and B when implemented now makes the program barely justified. If one postpones the program, then in the future one can do it again but obtain the extra benefit of the return on saving C for some time. Or, viewed from the present, if C is

[1] The meaning of "excessive sacrifice" in this quotation will appear clear later in this introduction when the eradication paradox is introduced.

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discounted at a greater rate than B, postponement diminishes the present discounted value of C more than the value of B, making the program appear more beneficial when done in the future. But since this argument will remain valid at any point in time, it seems to justify infinite postponement, which is absurd.

Eradication paradox: Suppose that one could invest in eradication and, with some finite but arbitrarily large delay, eliminate a particular disease completely. In absence of eradication efforts, the disease will continue to extract a toll of DALYs year after year. If health benefits are not discounted, the expected benefit of the eradication, even with a risk of failure, is infinite. Therefore one should put absolute priority for the use of current budgets on eradication, even if this raises the burden of disease now, because this burden is finite. The argument holds even if the burden is arbitrarily large when the delay with which the eradication efforts will bear fruit is long.

The eradication paradox is described by Murray and Acharya (1997, 719) as "the only strong argument for discounting." It is also prominent in Murray et al. (2012, 16), where it is argued that one should not seek to escape the paradox "by the artifact of discounting future health but rather explicitly recognize that social choices will be influenced by factors beyond minimizing DALYs, such as equity or fairness concerns." This statement recognizes that it is hard to address these issues without casting health policy in the broader context of social welfare (in contrast to Principle 2 in Murray and Acharya 1997, 709).

In this chapter, we first propose a general theory of discounting for health benefits, based on a social welfare approach. We argue that opportunity cost arguments are only relevant indirectly, not directly. But, although the infinite postponement paradox and the eradication paradox are in our view invalid arguments in favor of health discounting, we also argue that the principle of weighting life years equally, independently of time, is not plausible under assumptions of welfare growth. Health should be discounted, but at a rate that should not be related to market interest rates, or equal to the discount rate for regular consumption goods. We contend that the social welfare approach justifies a positive but very low discount rate for health.

For practical purposes, it appears to us that, in the GBD context, the move from a discount rate of 3% to a rate of 0% is probably a good move, although sensitivity checks with a small positive discount rate would appear worthwhile.

13.2. Theory of Discounting

Consider a policy maker whose objective is to maximize a certain objective that is a function of the situation of the members of the target population. A health policy changes the longevity and health status of the individuals in this population. It may change the composition of the future population, as people will live longer or differently, have more children or different children, and so on.

To make things simpler, we will ignore the change in composition of the population and only focus on a fixed population whose longevity can change under the chosen health policy. Health benefits take the form of added life years. We focus on life years, assuming that there is a way to make improved quality of life commensurable with additional life years.

As the paradoxes suggest, and reality confirms, policy makers are not exclusively interested in health benefits and they care about the cost of health programs. We claim that a concern for the cost must also derive from the underlying policy objective. This can indeed be done naturally: the cost implies a reduction in other goods consumed by the population.

This is not an innocuous step in the argument; therefore, let us pause here. We claim that one cannot talk about the cost and the comparison of discount rates for health benefits and money, without thinking in the framework of a social objective that incorporates consumption goods other than life years. Therefore, assessing whether health benefits should be discounted in Global Burden of Disease (GBD) measurement requires the definition of a comprehensive social objective. This is indeed explicitly acknowledged in the statement that “social choices will be influenced by factors beyond minimizing DALYs, such as equity or fairness concerns.” But this means that GBD measurement should not be conceived independently of a broad social objective covering the main dimensions of well-being, unlike common practice which treats GBD as a specific domain, measured separately from other aspects of well-being.

Note that this is not an argument against constructing a separate measure of population health. Even if one relies on a comprehensive social welfare objective, it is legitimate to seek to evaluate the contribution of particular domains, such as health, to this objective. Our point is only that the measurement of a domain indicator is better thought of within the context of the broader objective that the policy maker is ultimately pursuing.

To fix ideas, we will assume that the policy objective recognizes only two dimensions in people's situations: their longevity and their consumption (a shortcut for a comprehensive notion of standard of living other than health). For instance, we can assume that people's situations are assessed through a composite index (well-being measure) that depends on their longevity l and their consumption c, for instance $w(l,c) = l \times \; u(c)$, in which well-being is the product of longevity by an increasing concave utility of consumption. Consumption is here assumed to be constant over life for simplicity, and c measures yearly consumption.

Now, consider a choice between two policies. Policy I will make N people live an additional year now, and policy II will make N people live an additional year in t years. Which one is better?

A direct, principled, answer could declare that additional years are the same no matter when they are enjoyed. But this is not prima facie consistent with the objective mentioned earlier. In light of this objective, one should ask: what are the situations of the N individuals benefiting from either policy? If the N beneficiaries of policy I have a shorter life, or a lower consumption, than the N beneficiaries of policy B, we may want to give priority to the former and declare that policy I is preferable. One immediately sees that improved conditions of life in the future may provide a good reason for discounting future benefits (in health as well as consumption). Note that such priority for the worse off is not adopted by the GBD approach, though it has separately sought to assess health inequalities.

What discount rate follows from this reasoning? This derives from a comparison of social benefits produced by life years at different times. The marginal social benefit of an additional year of life to an individual i $(MSBAYL_i)$, i.e., the gain in social welfare produced by one additional year of life for i, can be decomposed as the product of two terms: (a) the marginal social value of i's well-being (MS_i), i.e., the gain in social welfare produced by one additional unit of i's well-being (not health); and (b) the benefit in well-being for i of one additional year of life ($BAYL_i$). This can be summarized by the equation

$$MSBAYL_i = MS_i \times BAYL_i \qquad (13.1)$$

Another useful decomposition of the same magnitude is the following: (a') the marginal social benefit of an additional unit of consumption for $(MSBAYL_i)$, i.e., the gain in social welfare produced by one additional unit of consumption for i; (b') the consumption equivalent of a life year ($CELY_i$), i.e., the increase in consumption that would produce the same well-being gain for i as an additional year of life.[2] This can be summarized by the equation

$$MSBAYL_i = MSBAC_i \times CELY_i \quad (13.2)$$

The advantage of the latter decomposition is purely practical and derives from the fact that consumption may be easier to measure with natural units (e.g., monetary units) than well-being. It also provides an easy way to compare discount rates for health and consumption, as we will see shortly.

Suppose that the social benefit of an additional life year for i is $MSBAYL_i$ whereas for j, who lives t years after i, it is $MSBAYL_j$, lower than $MSBAYL_i$. The reason why $MSBAYL_j$ is lower than $MSBAYL_i$ may have to do with j's greater well-being (due to higher consumption or longevity), reducing the term MS_j of the decomposition in

[2] For a formal analysis proving this decomposition, see the appendix.

equation (13.1), or it may be due to a lower marginal utility of health, reducing the term $BAYL_j$.

One can then write that $MSBAYL_j$ is equal to $MSBAYL_i$ divided by a term $(1 + r)^t$, which makes the relative weight of life years for j appear as a discounted value of the life years for i:

$$MSBAYL_j = \frac{MSBAYL_i}{(1+r)^t} \quad (13.3)$$

Obviously, this is just a convention, and time plays no essential role here. The discount rate r obtained in this way need not be the same when other individuals are considered, and need not be constant over time. It may also be negative if $MSBAYL_j$ is greater than $MSBAYL_i$. We claim, however, that this is *the only way in which discounting can be introduced and made consistent with a social welfare objective*.

Note that if one can write $MSBAYL_j$ as equal to $MSBAYL_i$ modified by a certain (possibly negative) growth rate g,

$$MSBAYL_j = MSBAYL_i \times \ (1+g)^t, \quad (13.4)$$

then the discount rate is approximately equal to minus this growth rate, because $(1 + g)^t$ is approximately equal to $\frac{1}{(1-g)^t}$.

It is convenient to remember this observation: the discount rate for any particular good is roughly the opposite of the growth rate of the marginal social value of this good.

Another useful observation is that the discount factor $1/(1 + r)^t$ is simply equal to the ratio of future over present marginal social benefits, as can be seen by rewriting equation (13.3) as

$$\frac{1}{(1+r)^t} = \frac{MSBAYL_j}{MSBAYL_i}. \qquad (13.5)$$

A more detailed and more formal exposition of this approach to discounting can be found in Fleurbaey and Zuber (2015), but it restricted to a single-good world. In this chapter, we extend the analysis to the multiple-good context.

13.3. Differential Discounting for Health

There is nothing special about health benefits in the reasoning of the last paragraphs and a similar reasoning can be done for consumption. But, in general, the ratio of marginal social benefits for *j* relative to *i* will not be the same for consumption as for health. This is very clear using the decomposition in equation (13.2).

For consumption, the ratio of future over present benefits will be equal to the ratio of the terms $MSBAC_i$ of that decomposition, whereas for health the ratio also involves the ratio of the terms $CELY_i$. If the consumption equivalent of health gains increases with time, for instance because wealthier populations are willing to pay more for their health, then the ratio of future over present benefits will be greater for health than for consumption, justifying a lower discount rate for health.

An extreme example can illustrate this point vividly. Suppose that the current population is so poor that it does not care about longevity (for instance, because consumption is so low that live is barely worth living) and only cares about consumption, whereas in the future, the affluent population will care about longevity. In such a case, one should give no weight to longevity now, making the ratio of future over present health benefits infinite, which means that the discount rate should be -1 and that the future population has full priority as far as health gains are concerned. But on the contrary, the poor population today has much greater priority than the future population for the allocation of consumption, which implies that the discount rate for consumption should be high, possibility close to infinity if the priority of the present population is close to being absolute. Insisting on equal discount rates for health and consumption in such a context would be absurd.

It is easy to conceive of a social objective that gives equal value to additional life years no matter when and where they fall. Suppose that the social objective has no aversion to inequality in well-being and is a simple sum of individual well-being levels, and is such that the contribution of longevity to well-being, for each individual, is a simple additive term, i.e., $w(l,c)=l+u(c)$. With such an objective, the implicit discount rate for life years is zero. Indeed, the gain in well-being produced by one year of life is then constant, and since the social priority of all individuals is the same (no inequality aversion), equation (13.1) implies that the marginal social benefit of an additional year of life is the same in all periods.

However, measuring well-being with an additive term for longevity is quite nonstandard. A more conventional form is multiplicative, longevity being multiplied by the utility of consumption on average over life as in the example introduced earlier: $w(l,c)=l\times\ u(c)$. With this more conventional well-being function, longevity has more value for the more affluent populations. Assuming no inequality aversion, and if standards of living continue to grow in the future, then one should have a negative discount rate for health and prioritize the future populations. Thanks to their greater consumption, future populations will derive more well-being from experiencing longer lives.

But this reasoning is valid only if one retains the utilitarian approach that simply sums well-being indices over the whole population under consideration. If one introduces a certain degree of inequality aversion, the greater benefits of longevity in the affluent future are valued less in the social objective. The balance of the two countervailing forces is discussed in the final section.

Before that, let us revisit classical arguments for discounting based on uncertainty and opportunity costs, and re-examine the paradoxes introduced in the beginning.

13.4. Uncertainty and Opportunity Rationales for Discounting

The approach previously presented and defended can encompass a well-known uncertainty rationale for discounting. Suppose that *j* is identical to *i* except for the fact that, living in the future, $j's$ existence is uncertain. Then the ratio of $MSBAYL_j$ to $MSBAYL_i$ is equal to the probability of *j*'s existence, if we assume that the social objective takes the form of an expected value of social welfare. If this probability is $(1-p)^t$, where p is the probability of extinction at every period, then one sees that, in first approximation, p is a good estimate for the discount rate r because $1-p \approx 1/(1+p)$.

As argued by many authors, although ethically sound, this rationale for health discounting only suggests discount rates close to zero (see for instance Anand and Hansson 1997, 696).

Our approach also shows why the standard opportunity cost arguments for discounting are flawed but contain a grain of truth. These arguments are based on the idea that money now cannot have the same value as money in the future, because it is possible to invest money now and obtain a return in the future, thereby proving that money now has greater value. But this sort of argument confuses objectives and constraints. The fact that money can be invested and yield a return is a constraint that shapes the budget of the decision maker, but need not correspond to her objective, unless she happens to be at the optimum already.

Let us explain this point in more detail. Suppose that the decision-maker has no pure time preference and values the consumption of two identical individuals equally, independently of when they live. When assessing the consumption of two identical individuals living in different periods, the correct discount rate for consumption is then zero, independently of the return on the market. But giving the same consumption to two such individuals cannot be the optimal policy, because a small reduction to the *present* consumption of one to the benefit of a greater gain (greater thanks to returns on savings) to the *future* consumption of the other is viewed as an improvement precisely because the discount rate between their consumptions is zero. The (zero-)discounted gain tomorrow is equal to one plus the rate of return times the cost today.

The optimal policy will then make sure that no such transfer can improve the social objective. When will that happen? It will happen when the benefit to the future individual is discounted at a rate that cancels the market returns on savings, i.e., when the discount rate is equal to the market rate. This equality is therefore obtained only at the optimum, when the greater consumption by the future individual justifies giving his gains in consumption a lower value than present consumption.

Holding only at the optimum, this equality cannot be assumed in other contexts. Therefore the market rate cannot be used as a guide for discounting when one is not at the optimum and seeks to reach it. Indeed, if one always discounts future consumption at the market rate, transferring any amount of consumption from the present to the future by investing in the market yields a zero net present benefit and provides no guidance whatsoever for finding the optimum allocation of consumption over time. The market rate, as a discount rate, cannot offer any guidance to the optimal amount of savings.

Using the market rate as the discount rate can also produce wrong recommendations when evaluating actions with rates of return that differ from the market rate. Indeed, any action with a greater monetary return than the market then appears preferable to any action with a lower rate of return than the market. But if the latter policy benefits the poor of the future whereas the former benefits the rich of the future, it is perfectly possible that the social benefits of the latter are much greater. Market rates implicitly represent a distribution of costs and benefits that may not be in any way related to the social value of a particular investment (imagine for instance that only rich people invest for their own sake in markets, whereas the poor are barred from credit markets: the discount rate for poor people' consumption would not play any role in shaping interest rates).

Importantly, there is little reason to assume that the allocation of resources over time and generations is socially optimal, and therefore relying on the market rate for discounting is a good recipe for misguided decisions. It is not surprising that economists trained with models that focus on optimal allocations get used to relying on market rates and opportunity costs as useful shortcuts to discounting. But "those economists who are persuaded by opportunity cost arguments" (Murray and Acharya 1997, 722) can also be persuaded that far from the optimal allocation, these shortcuts are no longer valid. In the very imperfect world in which we live, the opportunity cost rationale for discounting is not relevant from the social welfare point of view.

13.5. Revisiting the Paradoxes

We previously suggested that health benefits should be discounted at a *different* rate than the monetary costs. Suppose that, following our approach, one concludes that they should be discounted at a *lower* rate. In the next section we will suggest tentative arguments leaning in this direction. Doing so seems to give rise to the infinite postponement paradox and the eradication paradox recalled in the introduction. Let us now re-examine these paradoxes.

Consider a decision made now in order to determine when to implement a particular program. Assume for the sake of simplicity that cost C and life years gained L are the same, no matter when the program is implemented. The discount rate for C is, say, 3% and the discount rate for L is 1%, the difference being due to the increase in the value of health ($CELY_i$) for more affluent populations in the future.

The problem with the initial formulation of the infinite postponement paradox is that to assess the net social gain from the program and determine when it should best be implemented, one has to make C and L commensurate. Let us denote B the consumption equivalent of L , and for simplicity assume that at most one individual can be affected by the program, which eliminates considerations of inequality in the calculation of the consumption equivalent. The net value of the program, if implemented now, is $B–C$. Everything is now measured in consumption equivalent.

Now consider postponing the program. The consumption equivalent of L will then be $B' > B$, because by assumption the future populations value health more relatively to consumption. The net present value of the program will then be $B' - C$, discounted at the consumption discount rate. There are two counteracting forces here. On the one hand,

$B'-C$ is greater than *B*–*C*, but on the other hand, it is discounted at the 3% rate. Presumably, with time B' increases slowly, whereas discounting operates exponentially. It is therefore impossible that indefinite postponement can appear desirable.

Let us, however, check that B' increases slowly even if the discount rate for *L* is only 1%. We know that the marginal social value of consumption (*MSBAC*) decreases at the 3% rate, whereas the marginal social value of health (*MSBAYL*) decreases only at the 1% rate. This means that the consumption equivalent of health (*CELY* = *MSBAYL/MSBAV*) from equation (13.2) increases by about 2% per year. Therefore $B'-C$ increases by more than 2% per year, but its growth rate tends to 2% (when *C* becomes negligible compared to B'), while it is discounted at the 3% rate.

More generally, B' increases at a rate equal to the difference between the discount rate for consumption and the discount rate for health[3] (equation 13.2).[4] If one assumes that both rates are positive, the growth rate of *B'* should be lower than the discount rate for consumption.

The indefinite postponement paradox does occur, indeed, when health has a null or a negative discount rate, but then there is nothing paradoxical, because health benefits have at least as great a present discounted value when pushed in the future, whereas the postponed costs have an ever lower discounted present value.

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[3] In a prominent case developed in the appendix, this difference between the two discount rates is just equal to the difference between the growth rate of consumption and the growth rate of health.

[4] See Gollier (2010) for a similar reasoning involving the discount rate for consumption and the discount rate for environmental quality.

However, the paradox does not raise a practical dilemma. When more and more health programs are postponed into the future, the situation of the present population deteriorates and, relative to the future population, gets an ever increasing priority, which increases the discount rates, especially the discount rate of health because health becomes an ever greater concern now whereas its value in the future falls. At some point, it will no longer be optimal to postpone because the discount rate for health will be high enough. All in all, it can never happen that health programs are indefinitely postponed.

Do we obtain a result saying that at the optimum the discount rate for health should equal the discount rate for consumption, in similar fashion as the equality between the market rate and the discount rate discussed in the previous section? There is no reason to expect such equality, because the technology for transferring health across time is not the same as the technology for transferring consumption. Reducing consumption now means investing and obtaining a return based on the productivity of capital. Reducing health care now means investing an amount that will produce the same monetary return but then will be transformed into health at the technology available in the future. This technology may be more or less productive than the current technology, depending on technical progress in health care and depending on the health condition of the population (the healthier the future population, beyond a certain level, the most costly it may be to improve its health further).

What about the eradication paradox? With a consistent social objective, the benefits of investing in eradicating a disease will be weighed against the cost of doing less for the current and proximate victims of this disease. When does it occur that every dollar should be spent on the former option? An absolute priority for the future can occur when the future people are extremely badly off (as in Weitzman's 2009 "dismal theorem") or when they represent an infinite mass because of the infinite number of periods. It is the latter issue that underlies the paradox.

But the paradox is unrealistic in its formulation. The last dollar spent on eradication might be diverted to curing current patients without making the eradication operation unsuccessful, but only postponing its success or its implementation. Therefore, the optimal amount spent on eradication will be such that the value of making this operation successful a little earlier is equal to the value of assisting a few more patients before its success. Roughly speaking, we could say that the optimal amount will be such that the additional patients preserved by one more dollar spent on eradication should equal the number of additional patients cured by spending one more dollar on treatment (assuming for simplicity that they are equally affluent). No infinity appears in this trade-off.

Moreover, even if the problem were formulated in terms of a single package yes-or-no decision, the value of the future would not appear infinite in the context of a finitely lived planet. It is only if the horizon of humanity is truly infinite that the weight of the future becomes overwhelming. There is no fully satisfactory solution to the social welfare problem for an infinite horizon, but it is far from clear that we should wait for one in the context of measuring GBD.

The only remaining concern that the use of a very low discount rate for health may raise is that it would imply an "excessive sacrifice" on the present generation due to the recommendation of investing a lot of present resources for the sake of future health gains. This concern is unwarranted if the discount rate is derived from a social welfare objective that gives sufficient weight to the present generation. If the investment required of the present generation makes it suffer hardship, for instance through increasing poverty, this should dramatically raise the marginal social benefit of its consumption so much that discount rates for consumption and health become high and investment should stop. Therefore, it is true that a low discount rate, when the present generation struggles under the burden of investing for the future generations, may produce excessive sacrifice. The obvious solution is to rely on a comprehensive social welfare objective and allow the discount rate to reflect the perceived relative priorities of the various generations.

In the end, it does not seem to us that the two paradoxes raise serious objections against using a discount rate for health lower than the consumption discount rate, even close to zero, provided that it is connected to a comprehensive social welfare objective. We shall now argue that such a practice is indeed plausible from the social welfare point of view, and that a discount rate much lower than 3% (but positive) may, in the current context, be reasonable.

13.6. Whither GBD?

Let us consider a social objective with a certain degree of inequality aversion over individual well-being, and relying on an index of well-being, at the individual level, that is the product of longevity by a concave utility of consumption: $w(l,c) = l \times u(c)$, admittedly a simplistic form that ignores the multiple dimensions of both health and consumption.[5]

In a first step, let us ignore inequalities within generations and focus on the trade-offs between generations.

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[5] For a formal analysis, see the appendix.

With such an objective, the marginal social value of an additional year of life is equal to the utility of consumption, which increases over time if consumption continues to increase, multiplied by the social marginal value of well-being, which goes down if well-being goes up, due to inequality aversion. One can suspect that with sufficiently strong inequality aversion the latter will prevail, inducing a declining marginal social value of health, therefore a positive discount rate for health.

One can show that if the degree of inequality aversion is equal to 1 (meaning that the marginal social value of well-being is inversely proportional to well-being), then the discount rate for health is independent of consumption and is equal to the growth rate of longevity. At the world level, the annual growth rate of longevity over the last century, which has witnessed the most dramatic increase (from 34 years in 1913 to 70 in 2012),[6] is actually quite low, around 0.7%. Looking at a longer time period in the past, much lower growth rates have been observed. The relevant period for GBD measurement, however, is the future. One may expect that, barring a revolutionary innovation against aging, life expectancy will have a slower growth in the coming decades than in the last century—one already sees the longevity curve flatten in the last decades—therefore justifying a lower discount rate than 0.7%.

With a greater degree of inequality aversion, for instance such that the marginal social value of well-being is inversely proportional to the square of well-being, the contribution of longevity growth to the discount rate for health doubles, while the

[6] Source: http://ourworldindata.org/data/population-growth-vital-statistics/life-expectancy/#life-expectancy-at-birth-in-different-countries-around-the-world-1540-2011-max-roserref

contribution of the utility of consumption becomes positive. More precisely, the growth rate of the utility of consumption must then be added to the discount rate for health.[7] The growth rate of utility may however be low due to the concavity of the utility function.

In view of these computations, the choice of a zero discount rate in the computation of GBD may appear an improvement compared to 3%, but perhaps too radical a move. Viewed from the perspective of a social welfare objective, it reflects the choice of a low degree of inequality aversion, which is perhaps easier to accept for some policy-makers, but it may be worth keeping the option of a positive discount rate in view of future progress in well-being, for the policy makers who do want to grant the worse-off (who live mostly in the present time) a substantial priority.

When one takes account of inequalities within generations, the analysis becomes more complex because additional health for the future poor (poor in health and/or consumption) has more value than additional health for the (present and future) rich. The idea of taking account of inequalities has been on the radar of the GBD experts. What is interesting, in the context of this chapter, is that with a comprehensive social welfare objective, the issue of the discount rate over time cannot be analyzed independently of the issue of inequalities. Discounting over time derives from inequality aversion between people living at different periods. Conversely, introducing equity weights in favor of the poor is of the same essence as using a discount factor diminishing the value of benefits for the rich. As explained earlier, the discount factor is just the ratio of marginal social values of benefits for different populations. Whether they live at different times or not is of no importance, for a social objective that has no hard-wired time preference.

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[7] See the appendix for a detailed account of these computations.

Therefore, our recommendation is that if inequalities are taken into account in GBD measurement, this should also be directly reflected in the discount rate—which is not the case in current practice. Or conversely, if a positive discount rate is tested on grounds of inequality aversion, then inequalities within generations can no longer be neglected.

Recall that, if well-being is measured by $w(l,c) = l \times u(c)$ or a similar standard formula, and no inequality aversion is incorporated in the social objective, then the discount rate for health should be negative due to the greater utility $u(c)$ of future generations. Therefore, only some inequality aversion can justify a discount rate for health that is not negative. One can then argue that inequality aversion across generations is already implicitly present in GBD measurement and that it would be a matter of consistency to introduce equity weights in favor of the poor. With a degree of inequality aversion equal to one, which is consistent with a very low discount rate for health over time, the relative marginal social value of additional years for the poor, compared to the rich, is simply equal to the ratio of longevity of the rich over the poor. This provides a very simply way to compute weighted GBD.

In conclusion, coming back to the simple intergenerational trade-off, we believe that a low but positive discount rate, proportional to the expected future growth of health quality (or longevity), would be better than no discounting at all. At least, some variants of GBD including some discounting (say at a 1% discount rate) would be informative. This could be easily combined with equity weighting for populations of different levels of health. Ideally, testing variants of the discount rate should be consistent with variants of the equity weights (a higher discount rate being associated with greater equity weights for the poor).

One serious drawback of a rigid zero discount rate is indeed a variant of the indefinite postponement paradox in which postponing health benefits is not viewed as harmful whereas postponing costs is clearly beneficial. As explained in the previous section, this paradox disappears only when the discount rate is allowed to become positive after enough postponement has been implemented and the relative priority of the future has declined sufficiently.

Another way to justify the zero discount rate is simply to argue that the purpose of GBD measurement is tied to a pure health magnitude that has no intrinsic time preference and that is not related to any social welfare perspective. For instance, Murray and Acharya's (1997, 709) Principle 2 states that "the non-health characteristics of an individual affected by a health outcome that should be considered in calculating the associated burden of disease should be restricted to age and sex," suggesting that this is not part of a comprehensive measure of welfare. This means that when reading the results of GBD, one should not think of making allocation decisions on this basis, and one can therefore ignore the paradoxes that involve policy decisions over the timing of health programs or the relative spending on treatment and eradication. GBD measurement is then viewed as informative without recommending GBD minimization as a policy goal. This does not make GBD irrelevant. We routinely look at statistics that do not directly guide decision but are helpful in understanding the world in which we live—and die.

But our preferred recommendation is to jointly test variants of GBD that incorporate a health discount rate and equity weights both based on relative longevity—relative longevity of future and present generations and relative longevity of the rich (or long-lived) and the poor (or short-lived). Needless to say, longevity has been the focus of this stylized discussion of discounting, but a more comprehensive notion of health and quality of life if incorporated in the GBD. Whatever measure of health is used, our analysis is easily adapted.

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Appendix

Consider an additively separable social objective with a certain degree of inequality aversion $a > 0$ over individual well-being and involving an index of well-being, at the individual level, that is the product of longevity by a concave utility of consumption, $w(l,c) = l \times u(c)$:

$$W = \sum_i \frac{[w(l_i, c_i)]^{1-a}}{1-a} = \sum_i \frac{[l_i u(c_i)]^{1-a}}{1-a}$$

The individuals i may belong to different generations; this formula hence does not include "pure time preference," i.e., discounting on the sole basis that individuals live in different periods.

The marginal social benefit of an additional year of life for an individual i is

$$MSBAYL_i = \frac{\partial W}{\partial l_i} = l_i^{-a} \times \ [u(c_i)]^{1-a}.$$

This can be written as

$$MSBAYL_i = [l_i u(c_i)]^{-a} \times \ u(c_i) = MS_i \times \ BAYL_i,$$

which is the decomposition given in equation (13.1).

The marginal social benefit of additional consumption for an individual i is

$$MSBAC_i = \frac{\partial W}{\partial c_i} = l_i^{1-a} \times \ u'(c_i) \times \ [u(c_i)]^{-a}.$$

We thus have

$$MSBAYL_i = \frac{u(c_i)}{u'(c_i) \times \ l_i} \{l_i^{1-a} \times \ u'(c_i) \times \ [u(c_i)]^{-a}\} = CELY_i \times \ MSBAC_i,$$

which is the decomposition given in equation (13.2).

Consider two individuals, i and j, the latter living t years after i. The health discount rate is

$$\rho_t^h = \left(\frac{MSBAYL_i}{MSBAYL_j}\right)^{1/t} - 1 \approx \frac{1}{t} \times \ ln\left(\frac{MSBAYL_i}{MSBAYL_j}\right).$$

Using the expression of the marginal social benefit of an additional year of life, we obtain that

$$\rho_t^h \approx \frac{1}{t} \times \ ln(\frac{l_i^{-a} \times \ [u(c_i)]^{1-a}}{l_j^{-a} \times \ [u(c_i)]^{1-a}}) = a \times \ \frac{1}{t} \times \ ln\ (\frac{l_j}{l_i}) + (a-1) \times \ \frac{1}{t} \times \ ln(\frac{u(c_j)}{u(c_i)})$$
$$= a \times \ g_l + (a-1) \times \ g_u,$$

with g_l the growth rate of longevity and g_u the growth rate of the utility of consumption. This justifies the statements in the text that when $a = 1$, the discount rate is simply g_l, whereas when $a = 2$, it is equal to $2g_l + g_u$.

Using equation (2), we also have

$$\rho_t^h \approx \frac{1}{t} \times \ ln(\frac{u(c_i)/u'(c_i) \times \ l_i}{u(c_j)/u'(c_j) \times \ l_j}) + \frac{1}{t} \times \ ln(\frac{MSBAC_i}{MSBAC_j}) = \frac{1}{t} \times \ ln(\frac{u(c_i)/u'(c_i) \times \ l_i}{u(c_j)/u'(c_j) \times \ l_j}) + \rho_t^c,$$

with $\rho_t^c = (\frac{MSBAC_i}{MSBAC_j})^{1/t} - 1$ the consumption discount rate. In the case in which $u(c) = c^\gamma$, for $0 < \gamma < 1$, we have $\frac{u(c_i)i}{u'(c_i) \times \ l_i} = \frac{c_i}{\gamma^{l_i}}$. We thus obtain (with g_c the growth rate of consumption):

$$\rho_t^h \approx \rho_t^c + \frac{1}{t} \times \ (\frac{c_i}{c_j}) - \frac{1}{t} \times \ ln(\frac{l_i}{l_j}) = \rho_t^c - (g_c - g_l).$$

In the previous expression, $(g_c - g_l)$ is the growth rate of the consumption-equivalent of longevity. This formula justifies the statement, in footnote 3, that the difference in discount rates for consumption and health is equal, in a salient case, to the difference in growth rates.