Is it equitable to favor tomorrow's wealthier generations over today's poorer generations?

Discounting the Future

By Indur M. Goklany

One of the difficulties of analyzing climate change policies is that the costs of greenhouse gas emission reductions would be near-term while any benefits from those reductions would be delayed because of the inertia of the climate system. How should we compare costs and benefits that occur at different times? This, of course, isn't a new problem. It is inherent to any investment that provides less than instant gratification, but it becomes a critical issue if an investment — and its associated benefits — are spread out over several years. It is precisely to deal with such problems that economists developed discounting.

Discounting recognizes that both individuals and societies prefer to get benefits sooner and to postpone any costs until later. Discounting gives lesser weight to benefits and costs that occur in future years. Thus, for each year that either costs or benefits are delayed, their value is reduced by the annual discount rate.

Because this reduction is compounded, a benefit of $1 trillion obtained in the year 2100 would be valued much lower today. The higher the discount rate, the lower the present value of either costs or benefits occurring in the future. Thus a trillion-dollar benefit in the year 2100 would be valued today at only $1.2 billion if the annual discount rate is 7 percent, but at $52 billion if the discount rate is 3 percent.

Many people argue that if we value future generations' welfare, then we are ethically bound to employ a lower discount rate for future benefits that stem from global warming control policies enacted today. In contrast, use of a high discount rate for future benefits reduces the likelihood that carbon emission constraints today would pass a benefit-cost test, which, it is claimed, could put the welfare of future generations at risk. Some analysts such as Nicholas Stern, who conducted the *Stern Review on the Economics of Climate Change*, while emphasizing intergenerational equity, would use a near-zero discount rate (adjusted for the probability that a catastrophe might wipe out the human race and for the possibility that future generations may be wealthier than us). But the underlying premise behind using a low discount rate is that climate change, unless reduced sufficiently, could or would leave future generations worse off than current generations. This contrasts with the standard practice of using a market discount rate for both costs and benefits, so as to better consider the opportunity costs and avoid hurting both current and future generations by depriving them of the benefits flowing from current investments.

In this article, I address the threshold question of whether future generations would in fact be worse off than we are if climate change is allowed to occur and is uncontrolled. I compare current and future welfare per capita after accounting for the costs of climate change. To do this, I will reduce estimates of future welfare per capita in the absence of climate change by estimates of the welfare losses from climate change. For those downward adjustments, I use the *Stern Review*'s estimates of the costs of climate change from market effects, non-market (i.e., public health and environmental) effects, and the risk of catastrophe, even though several researchers have characterized the *Stern Review*'s estimates as excessive. I show that through 2200, at least, future generations will be much better off than present ones even after accounting for the costs of climate change.

COSTS AND BENEFITS

In Table 1, I show the average welfare per capita (as measured by gross domestic product per capita) in 1990 and 2100 for the four major scenarios constructed by the Intergovernmental Panel on Climate Change (IPCC). Each scenario is labeled using the IPCC's nomenclature. The GDP estimates used in this

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table are the ones incorporated into the IPCC's future emission and climate change scenarios. The projected temperature increase between 1990 and 2085 for each scenario is also shown in the table.

The table shows that in the absence of climate change, future GDP per capita for both developing and industrialized worlds would be much higher under each IPCC scenario. Under the warmest scenario A1FI, for instance, mean welfare per capita in the absence of climate change would increase 70-fold for developing countries, from $900 in 1990 to $66,500 in 2100. For industrialized countries, welfare per capita would increase sevenfold over the same period, from $13,700 to $107,300. (All figures are in real 1990 U.S. dollars.) For context, in 2006, GDP per capita for industrialized countries was $19,300; the United States, $30,100; and developing countries, $1,500.

Figure 1 shows, for 2050 through 2200, the *Stern Review*'s estimates of the annual undiscounted stream of losses in equivalent GDP per capita ("income") because of the temperature increases projected in the *Stern Review*'s "high climate change" scenario. This scenario is equivalent to the IPCC's A1FI scenario. The estimates include losses from market effects, non-market effects from environmental and public health impacts, and the risk of catastrophe. The mean loss in welfare from climate change rises from relatively small amounts in the early years to 2.9 percent in 2100; the 5th–95th percentile estimates of losses in 2100 range from 0.9 to 7.5 percent. By 2200, equivalent estimated losses range from 2.9 to 35.2 percent, with a mean loss of 13.8 percent.

In Table 2, I show net welfare per capita in 2100 and 2200, respectively, for both industrialized and developing countries, before and after adjusting for the costs of climate change. I use the *Stern Review*'s estimates of the costs of climate change shown in Figure 1, even though they are excessive for several reasons:

First, they do not account fully for future increases in adaptive capacity that should occur as nations become wealthier.

Second, Table 2 uses the *Stern Review*'s 95th percentile estimates of welfare losses resulting from climate change rather than the average estimate. Under the "high climate change" A1FI scenario, the welfare losses in 2100 and 2200 are equivalent to 7.5 and 35.2 percent of GDP, respectively (see Figure 1). Regarding the other three IPCC scenarios, the estimates assume that climate change losses would increase with the square of the average global temperature increase from 1990 to 2085 per Table 1. (Most, but not all, integrated assessment models assume that the effects of climate change increase linearly or with the square of global temperature increases.) The qualitative results and conclusions derived from Table 2 would be unchanged had I assumed that welfare losses from climate change for all IPCC scenarios would either be at the same level as for the warmest scenario or would vary with the cube of the temperature increase.

Third, the 2200 results shown in Table 2 also assume that in the absence of climate change, GDP per capita will double between 2100 and 2200, a conservative assumption. Notably, the *Stern Review* assumes a long-run (2100–2200) growth rate of 1.3 percent per year, whereas a doubling in 100 years

implies an annual rate of only 0.7 percent per year. In comparison, global GDP per capita quintupled between 1900 and 2000.

Fourth, the estimates in Table 2 assume that welfare is a function of consumption (GDP) per capita, but not of secular improvements in technology, which over the long term would advance welfare even if GDP per capita were unchanged. I have shown elsewhere that for any specified level of GDP per capita (in real dollars), the most important objective indicators of human well-being — life expectancy, infant mortality, educational attainment, food supplies per capita, access to safe water and sanitation, and so forth — have generally improved over time. Thus a society with a GDP per capita of $5,000 a year (in real dollars) today, for instance, is better off than a society that would have had the same GDP per capita in prior years. This phenomenon is illustrated for life expectancy in Figure 2, which shows an improvement in life expectancy of four years between 1977 and 2003 independent of GDP per capita. This improvement over time that is independent of advances in economic development can be ascribed to secular improvements in technology, broadly defined to include tangible objects such as machinery as well as intangibles such as knowledge and institutions (e.g., trade, rules of conduct, management systems). Based on historical experience over the past two centuries, it seems unlikely that secular technological change will be halted. Therefore, technology-driven welfare improvements should extend into the future, independent of economic development.

Fifth, the *Stern Review*'s methodology also ignores secular technological improvements in its projections of the effects of climate change. This compounds the underestimation of future adaptive capacity resulting from the increases in wealth projected in Table 2. This flawed approach, which is endemic to all climate change impact analyses that have been undertaken to date, substantially overstates the future costs of climate change and, therefore, the benefits associated with climate change mitigation.

Table 1

Life Without Global Warming

Mean welfare per capita in the absence of climate change in 1990 and 2100 for developing and industrialized countries, measured as GDP per capita (1990 U.S. dollars) per the IPCC scenarios.

	1990	2100			
Scenario	**Actual**	**A1FI**	**A2**	**B2**	**B1**
Developing countries	$900	$66,500	$11,000	$18,000	$40,200
Industrialized countries	$13,700	$107,300	$46,200	$54,400	$72,800
Global temperature increase, 1990–2085	N/A	4.0°C	3.3°C	2.4°C	2.1°C

SOURCES: *Arnell et al. (2004), IPCC (2000)*

Table 2

The Costs of Warming

Mean welfare per capita in 2100 and 2200 for developing and industrialized countries, adjusting for the costs of climate change from market effects, nonmarket (i.e., environmental and public health) effects, and the risk of catastrophe, per the *Stern Review*'s 95th percentile estimate of costs

A.

	1990	2100			
Scenario	**Actual**	**A1FI**	**A2**	**B2**	**B1**
DEVELOPING COUNTRIES					
GDP per capita, no climate change	$900	$66,500	$11,000	$18,000	$40,200
Maximum cost of climate change*	0	$5,000	$600	$500	$800
Net welfare per capita, with climate change	$900	$61,500	$10,400	$17,500	$39,400
INDUSTRIALIZED COUNTRIES					
GDP per capita, no climate change	$13,700	$107,300	$46,200	$54,400	$72,800
Maximum cost of climate change*	0	$8,000	$2,400	$1,500	$1,500
Net welfare per capita, with climate change	$13,700	$99,300	$43,800	$52,900	$71,300

B.

	1990	2200			
Scenario	**Actual**	**A1FI**	**A2**	**B2**	**B1**
DEVELOPING COUNTRIES					
GDP per capita, no climate change	$900	$133,000	$22,000	$36,000	$80,400
Maximum cost of climate change*	0	$46,800	$5,300	$4,500	$7,600
Net welfare per capita, with climate change	$900	$86,200	$16,700	$31,500	$72,800
INDUSTRIALIZED COUNTRIES					
GDP per capita, no climate change	$13,700	$214,600	$92,400	$108,800	$145,600
Maximum cost of climate change*	0	$75,500	$22,100	$13,700	$13,800
Net welfare per capita, climate change*	$13,700	$139,100	$70,300	$95,100	$131,800

SOURCE: *Author's calculations, based on Warren et al. (2006), Arnell et al. (2004),* Stern Review, *and World Bank data.*

Finally, no discount rate was used in the net welfare estimates in Tables 2.

Taken in combination, the above assumptions tend to severely underestimate future welfare per capita after accounting for climate change because they underestimate welfare in the absence of climate change while overestimating welfare losses from climate change.

IMPROVEMENT, REGARDLESS

Nevertheless, despite the series of "conservative" assumptions, net welfare per capita in 2100 and 2200 will be several-fold higher than in 1990 for both industrialized and developing countries under each of the IPCC scenarios, regardless of whether climate change is mitigated. This is shown in Figure 3, which summarizes information on net welfare from Table 2. In fact, in 2100 under both the B1 and A1FI scenarios, net welfare per capita of the inhabitants of the currently developing countries will exceed that for the United States in 2006 ($30,100), to be joined in 2200 by the B2 scenario. Thus the *Stern Review*'s own numbers do not support claims that unmitigated climate change will make future generations worse off than current ones. Such claims therefore cannot justify the use of a low discount rate in cost benefit analysis of climate change policies even if costs and benefits span different generations.

Figure 3 illustrates several other points:

Average welfare per capita in today's developing countries should be higher in 2200 than it was in industrialized countries in 1990 under all scenarios, even after accounting for the costs of climate change. That is, regardless of any climate change, populations living within the borders of today's developing countries in the future will be better off than people currently inhabiting today's industrialized countries. This is also true for 2100 for all but the poorest (A2) scenario.

Considering that future generations will be far better off than current generations even after accounting for climate change, it would be more equitable for today's industrialized world to help solve the real problems facing today's poorer developing world than to mitigate climate change now to help reduce the burden on future populations that would not only be wealthier but also technologically superior. Moreover, a finite probability exists that global warming may not be among the more urgent problems for future generations even if one accepts the results of climate change analyses upon which the *Stern Review* and the IPCC have relied.

In addition, the IPCC states, "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations." Since the IPCC defines "very likely" as greater than 90 percent, there may be as much as a 10 percent chance that the observed temperature increases are not due to anthropogenic greenhouse gas emissions, which would mean that there is a finite chance that the benefits of greenhouse gas reductions are substantially overstated under all of the IPCC scenarios. There is also a finite probability that efforts to reduce climate change may, because of their considerable cost, be catastrophic to human well-being.

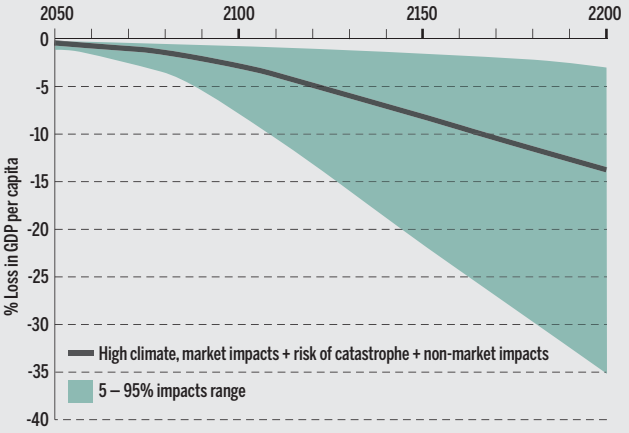
Under each scenario, for both developing and industrialized countries, net welfare should be higher in 2100 than it was in 1990, and higher in 2200 than in 2100. This suggests that Robert Solow's criterion for sustainable development — namely, that current generations should "endow [future generations] with whatever it takes to achieve a standard of living at least as good as our own" — would be easily met, despite any climate change.

Net welfare in both 2100 and 2200 is highest under the richest-but-warmest (A1FI) scenario, and lowest under the poor-

Figure 1

The Costs of Global Warming

Losses in welfare per capita from unmitigated climate change through 2200 under the "high climate change" scenario. The costs of climate change include costs from market effects, non-market (i.e., environmental and public health) effects, and the risk of catastrophe.

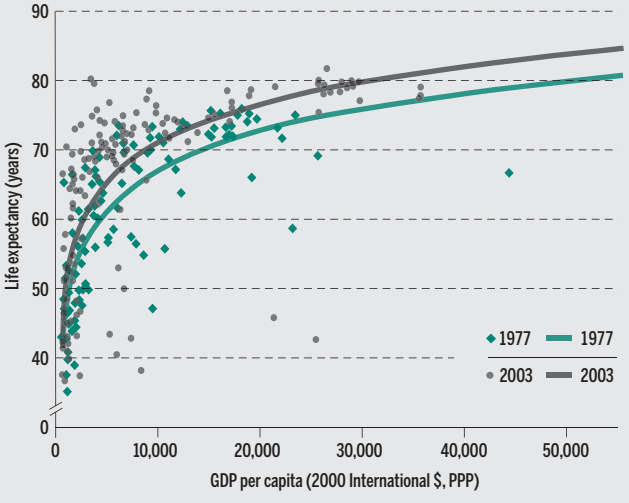


SOURCE: Stern Review

Figure 2

Secular Technological Improvement

Life expectancy in years across countries, 1977 and 2003

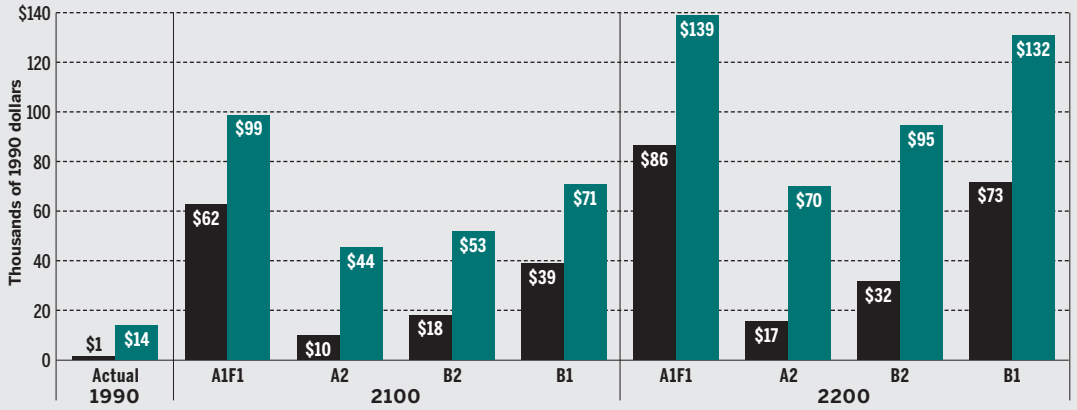


SOURCE: The Improving State of the World, *based on World Bank data.*

Figure 3

Improvement Despite Warming, With Zero Discounting

Net welfare per capita (in 1990 U.S. dollars) after accounting for losses from climate change per the *Stern Review*'s 95th percentile estimates of costs of climate change.



SOURCE: Stern Review

est (A2) scenario. Therefore, to the extent society wants to favor one scenario over another, it should favor the scenario that would result in the highest level of wealth rather than the one with the lowest carbon level.

Finally, proponents of using low discount rates in climate change analysis apparently overlook the fact that resources expended on behalf of current generations would directly or indirectly benefit not only current generations but future ones as well. The well-being of current generations stems from the wealth, technology, and institutions conceived and improved during past generations, despite the lack of any explicit consideration of future generations' welfare. Today we benefit from the resources expended by previous generations on the problems they faced, including low agricultural productivity, hunger, malnutrition, high infant and maternal mortality, insufficient usable energy, and water-related diseases such as malaria, cholera, typhoid, paratyphoid, and other gastrointestinal diseases. Had our forebears not devised methods to deal with those problems, we would be expending more of our current resources on them and we would be worse off — as would have been our much poorer ancestors. So by being "selfish" in focusing on their problems, our ancestors not only helped themselves, but also helped us without necessarily explicitly attempting to do so. Think of this as the "invisible hand" reaching across generations. In essence, today's wealth, technology, and human capital are based on yesterday's wealth, technology, and human capital. Reducing the latter would also have diminished the former. And so it will be for the future.

In conclusion, use of extremely conservative assumptions from the *Stern Review* indicates that future generations will be much better off than current ones, notwithstanding any climate change. Accordingly, there is no ethical rationale for using a lower discount rate for future generations than for current generations. In fact, doing so devalues the very real problems today's generations face in favor of future hypothetical problems that their wealthier and technologically more advanced descendants may or may not have to confront. R

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