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Economics and Climate Change

William Nordhaus is an economics professor at Yale who won a Nobel Prize in 2018 "for integrating climate change into long-run macroeconomic analysis."[1] He has been researching the economics of climate change for forty years and his book, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World* is widely regarded as the best summary presentation of climate change from an economic perspective. The book is divided into three parts: the first deals with the science of climate change, the second analyzes various solutions, and the third deals with the political and social obstacles to implementing any solution.

Even before reading Nordhaus's judicious appraisal of the scientific data and theories regarding climate change, I was sufficiently convinced of the magnitude of the problem that I was perfectly willing to agree with his ultimate conclusion:

> A fair verdict would find that there is clear and convincing evidence that the planet is warming; that unless strong steps are taken, the earth will experience a warming greater than it has seen for more than a half million years; that the consequences of the changes will be costly for human societies and grave for many unmanaged earth systems; and that the balance of risks indicates that immediate action should be taken to slow and eventually halt emissions of CO_2 and other greenhouse gases. These basic findings must be qualified and constantly updated because of the uncertainties involved at all stages of the link from economic growth through emissions and climate change to impacts and policies. But the basic findings have stood the test of time, rebuttal, and multiple assessments by hundreds of natural and social scientists. There are no grounds for objective parties simply to ignore the basic results, to call them a hoax, or to argue that we need another half century before we act. Humans are putting the planet in peril. But humans can undo what they are doing.[2]

The obstacles to implementing appropriate policies that he discusses in the last section of the book are largely the political polarization and the manipulation of public opinion that are all too evident in many areas of public life. He makes an interesting comparison to the way the tobacco industry attempted to create doubt about the scientific evidence linking smoking and cancer, and he seems hopeful that the public can be educated about climate change in time to take action, even though he does acknowledge that the fossil fuel industry has much more at stake than the tobacco industry did. His book was published in 2013, and I have to wonder if he has been able to preserve his optimism even during the Trump administration. In any event, it is his analysis of the economics of climate change that interests me most.

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[1] https://www.nobelprize.org/prizes/economic-sciences/2018/nordhaus/facts/

[2] Nordhaus, William. *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*. New Haven: Yale, 2013. p. 235

How does an economist view climate change? On January 17, 2019 the Wall Street Journal published an op-ed piece entitled "The Economists' Statement on Carbon Dividends."[3] (It is worth noting that Nordhaus is not one of the 27 Nobel laureate economists who were among the original 45 co-signers of the proposal nor is he among the 3,500+ other economists who have subsequently endorsed it, even though a significant portion of the statement is clearly in line with Nordhaus's own policy recommendations.)

ECONOMISTS' STATEMENT ON CARBON DIVIDENDS

Global climate change is a serious problem calling for immediate national action. Guided by sound economic principles, we are united in the following policy recommendations.

I. A carbon tax offers the most cost-effective lever to reduce carbon emissions at the scale and speed that is necessary. By correcting a well-known market failure, a carbon tax will send a powerful price signal that harnesses the invisible hand of the marketplace to steer economic actors towards a low-carbon future.

II. A carbon tax should increase every year until emissions reductions goals are met and be revenue neutral to avoid debates over the size of government. A consistently rising carbon price will encourage technological innovation and large-scale infrastructure development. It will also accelerate the diffusion of carbon-efficient goods and services.

III. A sufficiently robust and gradually rising carbon tax will replace the need for various carbon regulations that are less efficient. Substituting a price signal for cumbersome regulations will promote economic growth and provide the regulatory certainty companies need for long-term investment in clean-energy alternatives.

IV. To prevent carbon leakage and to protect U.S. competitiveness, a border carbon adjustment system should be established. This system would enhance the competitiveness of American firms that are more energy-efficient than their global competitors. It would also create an incentive for other nations to adopt similar carbon pricing.

V. To maximize the fairness and political viability of a rising carbon tax, all the revenue should be returned directly to U.S. citizens through equal lump-sum rebates. The majority of American families, including the most vulnerable, will benefit financially by receiving more in "carbon dividends" than they pay in increased energy prices.

The first thing that grabs my attention in the statement is that climate change is seen as the result of a "market failure." Nordhaus describes this market failure in terms of "externalities:"

> The economics of climate change is straightforward. When we burn fossil fuels, we inadvertently emit CO_2 into the atmosphere, and this leads to many potentially harmful

3 https://www.econstatement.org/

> impacts. Such a process is an "externality," which occurs because those who produce the emissions do not pay for that privilege, and those who are harmed are not compensated. One major lesson from economics is that unregulated markets cannot efficiently deal with harmful externalities. Here, unregulated markets will produce too much CO_2 because there is a zero price on the external damages of CO_2 emissions.[4]

Just to be clear: excessive CO_2 emission is a form of pollution. The harmful effects of this type of pollution are not as immediately noticeable as the effects of smog or water pollution. Our eyes don't burn; dead fish don't come floating to the surface of a river; but the harm is real and potentially catastrophic. An unregulated market designed to satisfy consumer demand and maximize profits does nothing to prevent pollution. The effect is somehow "external" with regard to the market, so some form of intervention is required to prevent it. The intervention required is described as compensating those who are harmed. Some economists are fond of describing market transactions as win-win transactions in which each party benefits, but here we are dealing with a transaction in which people uninvolved in the transaction are harmed. "Collateral damage" might be a better term for this. Perhaps I should not quibble, but eventually I shall want to know how or why one can refer to the freedom to pollute the environment as a "privilege." To my mind this is an indication that economics may be forcing global warming into a framework where it does not fit or viewing it through a prism that distorts our vision. Am I paying for the privilege of endangering others when I get a speeding ticket?

Since global warming is largely caused by CO_2 emissions and CO_2 emission are largely a result of burning fossil fuels in the production of energy or goods for the marketplace, it makes sense to ask whether an intervention in the market can reduce the CO_2 emissions. Apparently economists believe that the intervention is one that enables "the invisible hand of the marketplace to steer economic actors towards a low-carbon future."[5] Nordhaus knows better than to just invoke a shared belief in this invisible hand and instead invokes the economist's assumption that human behavior is largely governed by incentives – at least in dealing with the marketplace:

> A central lesson of economic history is the power of incentives. To slow climate change, the incentive must be for everyone — millions of firms and billions of people spending trillions of dollars — to increasingly replace their current fossil-fuel-driven consumption with low-carbon activities. The most effective incentive is a high price for carbon.[6]

Nordhaus arrives at this conclusion after considering four different approaches to reducing CO_2 emissions:

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[4] Nordhaus p. 6

[5] https://www.econstatement.org/

[6] Nordhaus p. 6

> The previous chapter concluded that limiting climate change requires focusing primarily on reducing concentrations of CO_2 and other greenhouse gases (GHGs). We saw that there are four basic ways to accomplish this. The first, which is really not in contention, would reduce our living standards by slowing economic growth. The other three are worth serious consideration. We might change our lifestyle by curbing our carbon - intensive activities, such as deciding not to fly around the world. Additionally, we might produce our goods and services with low-carbon or no-carbon technologies or fuels, such as substituting natural gas or wind for coal in our electricity generation. And finally, we might burn fossil fuels but remove the CO_2 after combustion.[7]

Some may balk at the seemingly out of hand dismissal of policies designed to slow economic growth, and I shall explore that issue eventually, but apparently no serious economist would entertain such a notion. Perhaps the key is an assumption that it would mean slowing global economic growth and not just slowing growth in the richest nations. I think the living standards Nordhaus has in mind are some global averages.

The fourth alternative which Nordhaus describes primarily in terms of capturing CO_2 and then storing it indefinitely in some way was new to me, and I was surprised that he seems to consider it an area worthy of research and development. I had hoped that captured CO_2 could be converted to some other benign or useful compound and was disappointed to see that the proposals Nordhaus was considering involved storing the CO_2 underground or even at the bottom of the ocean. It now appears that some kind of catalytic conversion of CO_2 into a liquid fuel may become feasible, and I gather that is a technological breakthrough unexpected when Nordhaus wrote his book.[8] The other two alternatives of reducing the carbon footprint of our consumption or of replacing fossil fuel use with low-carbon or no-carbon technologies or fuels are obviously the approaches that Nordhaus views as compatible with market interventions in the form of some kind of "price" for carbon. The need for a "price" for carbon is based on one of the most fundamental principles of economics: an inverse relationship between price and demand. If energy or products with a larger "carbon footprint" cost more, there will be an incentive to use less and perhaps find alternatives.

"Economic actors" apparently decide what to do based on some kind of cost-benefit analysis even if it is subliminal or unconscious. The way they can be steered toward a low-carbon future is by making them pay more for carbon use. The question then becomes how you put a price on CO_2 emissions. You can tack an excise tax onto retail sales like gasoline taxes designed to discourage gasoline use and pay for smog

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[7] Nordhaus p. 169

[8] "New catalytic reactor turns CO2 into liquid fuel" https://www.upi.com/Science_News/2019/09/03/New-catalytic-reactor-turns-CO2-into-liquid-fuel/4111567524104/ see also https://www.advancedsciencenews.com/race-for-a-co2-to-fuel-technology/

abatement, but I am inclined to agree with economists who say it is much more effective to tax CO_2 emissions at the source, i.e. the coal mine or a coal-burning power station.

Nordhaus considers the two main proposals for putting a price on CO_2 emissions: a carbon tax and cap-and-trade. He will take either but prefers a carbon tax. Everyone agrees that the main difference between the two is that carbon tax directly sets the "price" for CO_2 emissions, while cap-and-trade sets a limit on the amount of CO_2 emissions and lets a market set the price. With a carbon tax the amount of reduction in CO_2 emissions depends on how the market reacts to the price. Both require monitoring the amount of CO_2 emissions by the designated sources. and both are based on projections for the impact of varying amounts of CO_2 emissions on climate change. Most of the first part of Nordhaus's book is devoted to exploring the extent to which it is possible to model climate change and the impact of different levels of CO_2 emissions in order to make reasonable projections. I am perfectly willing to accept his assessment of the science and math involved in such projections, and he makes it clear that there is a fair amount of uncertainty involved. The title of his book derives from his conclusion that given the uncertainties the large risks involved in pursuing the wrong policies only underline the urgency of doing as much as we can as soon as we can. He goes on to analyze how much we can do by means of a cost-benefit analysis of varying degrees of intervention. The costs include both an estimate of the cost of the impact of climate change in the long run and an estimate of the economic cost of varying degrees of intervention.

If I accept the economic framework within which Nordhaus presents his case, I agree with his conclusions. There are some places, however, that I balk because I want to question the underlying assumptions in the framework. One is how you determine the cost of the impact of climate change. Another is the confidence that price increases will in fact "steer economic actors" towards a low-carbon future.

If climate change increases the risk of severe hurricanes by a certain percentage, perhaps it is possible to estimate the dollar cost of this aspect of climate change. We have data about the dollar amounts of damage done by recent severe hurricanes. I am not enough of a mathematician to know how one incorporates probability into projections based on the kind of models scientists use for estimating the future impact of climate change, but I am willing to accept what the experts say is their best guess. Using the modeling for all aspects of climate change you can estimate the amount of damage if there is no intervention and the amount of damage with varying amounts of intervention. So you have dollar amounts for the benefit of different levels of intervention. You can then estimate the long term cost of various degrees of intervention and find the amount of intervention that satisfies the economist's goal of maximum efficiency in the current use of resources.

Setting aside the question of how reliable these extremely complex calculations may be, given the vast number of variables and uncertainty involved, is this the best approach to deciding how much to do now to reduce CO_2 emissions? Can there really be a cost-benefit analysis if part of what is at risk is the sustainability of civilization or even the survival of the human race? Surely the most efficient use of current resources is whatever it takes to save the planet. Perhaps this is just alarmist thinking that does not help determine what we should really do, but for Nordhaus there is clearly a point beyond which it is simply too costly to do more to reduce CO_2 emissions:

> Sensible global warming policies will require some balancing of costs and benefits. This means that an economically desirable policy is one that reduces emissions in an optimal fashion — to a level beyond which further reductions in damages are not worth the additional abatement costs. This point is actually quite intuitive if we look at the extreme options. We could stop global warming in its tracks by banning all fossil fuels today. No one advocates this policy because it would be extraordinarily expensive (the "wreck the economy" approach). At the other pole, we could do nothing at all, forever, or at least for a long time. Some people actually do take this position, but that proposal appears to me to be a reckless gamble (the "wreck the world" approach).[9]

The Copenhagen Accord of 2009 adopted a temperature target of 2º C above pre-industrial levels as the goal for policies to combat global warming. Nordhaus says the science behind this particular goal was "thin," but in the end he seems to regard it as a reasonable compromise.

> A balanced approach suggests that the 2° C target is both too low and too high. It is too low given the identified damages analyzed above and the high costs of attaining such an objective discussed in Part III. But it is too high a target if we believe, along with many earth scientists, that the earth has already crossed the thresholds of some of the dangerous tipping points. How can we resolve this dilemma of whether policies are aiming too high or too low? The answer lies in the realm of costs. Faced with the dilemma of deciding between too high and too low, we need to consider the costs of slowing climate change and of attaining different targets, to which I turn next. When that is completed, we can compare costs and benefits and propose a solution going forward — one that balances the twin objectives of preserving our environment for the future while economizing on losses in living standards along the way.[10]

Later he spells out the nature of this balance a little more explicitly:

> If the costs are small, then we would surely want to keep climate change and increases in CO_2 concentrations to the bare minimum. Why risk any damages to coastlines, ecosystems, and small islands if we can avoid them at a small cost? On the other hand, if aiming for a very low temperature increase involves cutting back drastically on central human priorities such as food, shelter, education, health, and safety, then we would need

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[9] Nordhaus p. 76

[10] Nordhaus p. 146

> to take a careful look at the trade-offs. We might be willing to run some risks on wheat yields or sea-level rise rather than spend a fortune limiting warming to the lowest feasible level. After all, we might be able to spend that money more fruitfully on improving seeds, water management, and infrastructure. Moreover, we might find inexpensive technologies for carbon removal — the carbon capture and carbon-eating trees that technologists are designing — so that we can drive down CO_2 concentrations quickly in a few decades. So short of catastrophic impacts, we should look at the price tag before committing to any specific target. The implication is that we cannot realistically set climate-change targets without considering both the costs of slowing climate change and benefits of avoiding the damages. This is where economics comes back into the picture.[11]

Note that he couches the critical trade-offs in terms of "central human priorities." It remains to be seen how these priorities are factored into calculations of the costs of a particular policy. More importantly note that time is a critical factor in the cost-benefit analysis and not just in terms of how soon we can expect important technological breakthroughs:

> Here is the issue in a nutshell: When we make investments to reduce emissions, these costs are paid largely in the near term. The benefits in the form of reduced damages from climate change come far in the future. As an example, suppose that we replace a coal - fired power plant with a wind farm. If we follow the chain of effects from building the wind farm to reduced CO2 emissions and concentrations to temperature change to reduced damages, there is a delay of many decades from building the wind farm emissions to the reduction in damages.[12]

The relationship between time and money is one of the central tenets of economics and Nordhaus devotes a chapter to explaining the basics of "Discounting and the Value of Time." There are several places in this chapter where I trip over terms and want to dig into them in order to understand their implications. Some of them may be so basic that any economist assumes their import is obvious, but they are not to me, and even Nordhaus indicates that some of what he is saying may not be universally accepted.

> Any consideration of the costs of meeting climate objectives requires confronting one of the thorniest issues in all of climate-change economics: How should we compare present and future costs and benefits? This is a moderately complex issue and extends to the frontier of current economic theory. However, it is also of central importance for understanding the temporal trade-offs involved. These are trade-offs between the costs of emissions reductions today and the societal value of reduced damages in the future. So a full appreciation of the economics of climate change cannot proceed without dealing with discounting.[13]

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[11] Nordhaus p. 204

[12] Nordhaus p.182

[13] Nordhaus p. 182

What gives me pause here is the contrast between "costs" and "societal value." Cost implies to me something that can be given a numerical value. Societal value sounds more like something that cannot be quantified and assigned a number signifying its cost. Perhaps the same is true for the "value of time." I can be all too aware of the value of time, but it would never occur to me to assign a number to it. The same is true of the idea of "units of consumption" when Nordhaus emphasizes that "consumption" must be understood broadly enough to include a swim in the ocean.[14] His point is that preventing pollution of the ocean especially near our beaches has a value to consumers and the cost of pollution abatement can be offset by the enjoyment of beaches in some kind of final accounting for consumption. But how do you assign any kind of numerical value to a "unit" of ocean swimming? Presumably it is whatever we are willing to pay to prevent or reduce the pollution of the water and maintain the beaches. Here we wander into the quicksand of political realities. If well-funded interests block any attempt to clean up the bay, that obviously does not mean that swimming in the ocean has no societal value.

Another "non-market item" that Nordhaus wants us to include in consumption is a home-cooked meal, presumably in contrast to eating raw food or a meal at a restaurant. Surely the "value" of a home-cooked meal depends on who is cooking it, but perhaps my behavior in restaurants could add societal value to my eating at home. The idea that we can have a reasonable metric for consumption defined this broadly strikes me as a fantasy that only an economist could have. Generally what we have is a number for the Gross National Product as an indication of how much we buy and sell. Nonetheless Nordhaus implies that "discounting" enables us to compare consumption now with consumption in the future:

> The major trade-off in climate-change policy involves trading off consumption today for consumption in the future. When we reduce CO_2 emissions today, that requires sacrificing current consumption. The return for our investment is reduced climate-change damages and therefore higher consumption in the future. If we reduce consumption by taking fewer airline trips today, thereby reducing CO_2 emissions, this will help preserve national parks and wildlife for vacations in the future. Now we see why discounting becomes so important. Suppose that a climate investment sacrificing 100 units of consumption today increases consumption by 200 units in the future. How can we put these into comparable units to determine whether that is a good investment ? We do this by discounting.[15]

Discounting is what permits economists to do a cost-benefit analysis involving near term costs and long term benefits. Nordhaus uses three examples or analogies to explain discounting. The first is a home mortgage, with which he assumes the reader

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[14] Nordhaus p. 186

[15] Nordhaus p. 186

will be familiar. We borrow money now with a provision that over time we shall pay the lender more than we borrowed. This enables us to "buy" the house and move into it now when we do not have all the money to pay for it. That we are willing to do this indicates not just that we want to be a homeowner rather than a renter, but also that as he puts it, "Money is more valuable today than tomorrow, and that is why people and businesses are willing to pay interest on borrowed money."[16] All it really illustrates to me is that from an average reader's point of view, interest-bearing loans are part of the real world which must be accepted if I want to "own" a home and don't have sufficient financial reserves to pay the full market price. The only thing it tells us about "money" is that those who have more than they need can make still more by "lending" some to others and charging rent for the use of it. From the point of view of the would-be homeowner, the real price of the house is the total of what he will pay for it over time regardless of what the real estate agent says. For they buyer the cost of financing is part of the cost of the house.

The second example Nordhaus uses is a hypothetical bond that will be redeemable at $1,000 in 50 years. He makes it clear that he is talking about inflation adjusted dollars, and then he asks how one can know what to pay now for such a bond in order for it to be a good investment. The solution of course is a reverse calculation of compound interest based on what one assumes the going market rate is or will be over the next 50 years. He postulates an annual rate of 4% and calculates the appropriate price as $141. The bond does not have coupons or issue checks periodically for the interest. The interest simply accumulates as part of the principal, hence there is compound interest on the initial principal. This is not a conventional bond, but it makes it easier to use as an illustration of discounting. The real point is that the current cost must be evaluated in terms of "opportunity costs," i.e. how much could be made with an alternative and comparably risky investment. The 4% rate that Nordhaus uses is based on an average for returns on for relatively conservative investments. Presumably Nordhaus assumes that his reader will be familiar with the decision process involved in long-term investing and will see how discounting is implicit in it so that a $1,000 benefit 50 years from now is the equivalent of a $141 investment today. (If instead of a check for $1,000 one could get $10,000 worth of increased "consumption goods" due to the mitigation of climate change resulting from a $141 investment today, clearly that would be a better investment.)

The third illustration Nordhaus uses for discounting is the phenomenon of perspective in visual perception. Things further away appear smaller.

> Interest reflects the fact that investments are productive. In other words, if the economy puts resources into investment projects, the projects yield more resources in the future.

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[16] Nordhaus p. 183

> This applies to building a factory, sending children to school, investing in energy-saving appliances, or writing better software. Typically, an investment of $100 in new capital would yield between 4 and 20 percent per year in more goods in the future. If the return is 4 percent, this means that to get $1 next year requires only $1 / $1.04 = $0.96 today
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> Because dollars are less valuable in the future than today, they are reduced or " discounted " in the future. We can use the analogy of visual perspective to show the impact of the future on values. If you look down a railroad track, distant objects look smaller… This is the way distant economic dollars should look as well because goods received in the future have lower economic value than goods received today.[17]

This strikes me as an unfortunate analogy, since the inevitable response is surely, "Yes, they look smaller, but in reality they are the same size as they are when they are right in front of you. $1,000 is $1,000 no matter how far into the future you are expecting it." I might also balk at the idea that putting resources into investment projects always results in more resources in the future. He seems to me to be sliding between ideas pertinent to capital investments in a production process and those pertinent to investments in other types of projects whose yield are much more difficult to quantify. How can anyone determine that an investment in a child's education will yield between 4 and 20 percent per year in more goods in the future? This just makes no sense to me. Writing better software may just enable you to keep your head above water for a few more years. You may build a beautiful ballpark, but there is no guarantee the fans will come. The reasoning seems somehow circular to me. The way we know the value of educating children is by the fact that we invest a certain amount in it that might have otherwise been invested in something that resulted in a measurable increase in goods in the future. By this reasoning the empty ballpark has a similar value even though it continues to drain resources required for its maintenance. Perhaps it is an historic monument.

Nordhaus makes a point of emphasizing that the Office of Management and Budget has to do cost-benefit analysis with discounting for investment decisions regarding things likes "roads, dams, levees, and environmental regulations," although he is quick to point out that the way in which the OMB arrives at those discount rates is totally confused. Maybe it is possible to model the impact of building the interstate highway system or installing fibre optic cable everywhere as well as economists can model the impact of policies designed to reduce CO_2 emissions, but is that really how we decide (or even should decide) what to do with our scarce resources? Did we put a man on the moon because we knew that we would get returns on our investment as a result of the technology developed in the process? I wonder if we also do cost-benefit analysis for defense spending. In addition a cost-benefit analysis provides no guidance when two

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[17] Nordhaus p. 184f

projects have the same prospects. Obviously there is something else that persuades us to invest in one rather than the other.

The use of cost-benefit analysis in evaluating climate change policies is also based on an assumption that the global economy will continue to grow at more or less the same rate.

> The opportunity-cost approach assumes that the United States and other economies will continue to grow over the next century in a manner roughly similar to that of the last century. As a result, living standards are assumed to rise rapidly in the coming decades. Is this really a good assumption ? Or will technological change dry up ?
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> Of course, there is no way to answer these questions definitively. However, most research on long-term economic growth suggests that continued growth is a good bet. After all, the information and biotechnology revolutions have just begun. Moreover, other countries can grow significantly just by catching up with best practices around the world. The forces of globalization are bringing major productivity gains to low-income regions.
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> But remember that, if this projection is wrong, then the economic projections underlying the climate models' projections are also wrong. The models projecting rapid warming over the next century also assume rapid growth in living standards and therefore in CO_2 emissions. A look back at Figure 13 indicates that slow economic growth would lead to a very different future compared to standard projections — both economically and climatically.
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> People look at the slow growth in the United States and other countries since 2007 and worry about economic stagnation. However, the slow growth was caused by inadequate demand, not by declining productivity. Moreover, poor countries have performed much better than rich countries. Per capita GDP in the developing countries of East Asia grew at 8.5 percent per year over the last decade, and the developing countries of sub-Saharan Africa grew at 2.5 percent per year during this period.
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> This is not necessarily a picture of future wine and roses for the world. But it reminds us that the climate-change problem results from strong economic growth without adequate climate-change policies — it is not consistent with a pattern of economic stagnation and slow growth in living standards.[18]

Nordhaus has already dismissed policies designed to slow growth by describing them as policies that would "reduce our living standards." His goal is to steer growth in directions that reduce CO_2 emissions while still allowing improvement in living standards. It is not immediately obvious to me that slowing growth would ***reduce*** our living standards rather than just slowing the pace at which those standards improve. I

[18] Nordhaus p. 189f

am also not sure how living standards relate to gross national product. Do more "goods" necessarily imply better living?[19]

Standard of living may not be a rigorously defined term in economics, although it is distinguished from quality of life and is generally regarded as quantifiable as per capita income, especially in relationship to the level of income deemed to indicate poverty. Presumably it is in factoring in consideration of the poverty level that economists distinguish the "central human priorities such as food, shelter, education, health, and safety" from other categories of consumption. It is unclear to me whether the goal of maximizing growth focuses in any way on these central priorities or whether it just lumps all consumption together in one abstract parameter.

Needless to say there are many people who now believe that maximizing growth is no longer a viable goal for economic policy. They are more interested in sustainability or some other priority and are willing to accept slower growth, especially in more developed nations.

Whether or how discounting should be used in projections for evaluating policies to mitigate climate change is a matter of debate among economists, environmentalists and political scientists. Nordhaus acknowledges that some make an ethical argument against discounting the benefits of climate change mitigation for future generations. He makes a distinction between a prescriptive and descriptive approach to discounting and cites the English economist Nicholas Stern as perhaps the most forceful advocate of a prescriptive approach.

> Along with others, Stern argued that it is unethical to discount the welfare of future generations. They believe that we should therefore apply a very low discount rate on goods to calculate the present value of future climate damages. Advocates of the normative view often advocate discount rates on goods around 1 percent per year. An alternative approach based on sustainability has been developed by Yale political scientist John Roemer.
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> While this is an appealing argument, there are important qualifications. In analyzing the issues, we need to distinguish the discount rate on goods, which applies to things like houses or energy spending, from the discount rate on welfare, which applies to the treatment of people in different times or generations. We might treat all generations equally but still discount future goods. If people in the future are richer than people today, we might count their consumption as less valuable than the consumption of the

[19] The generally accepted measure of the standard of living is GDP per capita. This is a nation's gross domestic product divided by its population. The GDP is the total output of goods and services produced in a year by everyone within the country's borders. – https://www.thebalance.com/standard-of-living-3305758

> present generation (i.e., discount it). So putting different values on goods is not the same as putting different values on people.[20]

This distinction seems a bit unconvincing to me. How do you quantify welfare or the treatment of people? Surely it will boil down to the goods that they have at their disposal. He adds that

> Most philosophers and economists hold that rich generations have a lower ethical claim on resources than poor generations. This would imply that we would discount the value of future consumption relative to today's consumption because we think that future generations will be richer than present generations.[21]

Earlier when Nordhaus calculated how much better off people will be in 50 years will be given the current growth rate of the economy, he came up with 500% to 1000% GDP growth in poor and middle-income countries and with per capita income in India and China of $50,000. He also said that most of the people would be working in services and few would be left in rural farming. This lead to the conclusion that, "The vulnerability of today's poor countries to climate-change impacts is likely to decline significantly by the end of the twenty-first century."[22] He says this as part of making the point that "managed systems are surprisingly resilient to climate changes if they have the time and resources to adapt. This finding applies especially to high-income market economies with small agricultural sectors."[23] Perhaps in 50 years large scale agriculture will be completely automated and located in massive climate-controlled geodesic domes. Needless to say it is the unmanaged systems like the ocean and the atmosphere that are Nordhaus's primary concern. In any event I feel as though the discussion of how much richer future generations will be and how much their consumption can be discounted is somehow a distraction from the real issue at hand. The passing reference to Roemer's work on sustainability without any attempt to discuss its relevance makes me feel that these paragraphs in Nordhaus's book were an afterthought. The same seems true when Nordhaus makes an attempt to quantify our concerns about future generations in a way that reflects how we are less concerned about the fate of our great-grandchildren than we are about the fate of our grandchildren and cannot possibly make decisions based on equal degrees of concern for all future generations. He scribbles some numbers on the blackboard and then walks away saying, "This argument sounds like a bit of flaky pseudo-mathematics, but it is exactly the nub of the

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[20] Nordhaus p. 186f

[21] Nordhaus p. 187

[22] Nordhaus p. 145

[23] Nordhaus p. 145

deep mathematical analysis of zero discounting made by Nobel Prize–winning economist Tjalling Koopmans."[24]

Nordhaus's colleague at Yale, John Roemer is a political scientist and economist who majored in mathematics and began working on a PhD in math before switching to economics.[25] I have only read one of his papers, but it seems to me he may be analyzing precisely the aspects of Nordhaus's thought that give me pause. Unfortunately for a reader like me who is not completely at home with the mathematical notation involved in calculus, he tends to present ideas via equations. I can manage with algebraic equations in economics, but the type of expressions he uses from calculus to deal with changes over time involving many variables are difficult for me to digest. Fortunately he introduces and summarizes his formulas with verbal explanations so that the lay reader can get the gist of what he is saying.

Roemer shares Nordhaus's concerns about greenhouse gases:

> The rapid growth in greenhouse gas (GHG) emissions and concomitant increase in atmospheric carbon concentration during the past century have raised, in a dramatic way, the spectre of catastrophic effects for the welfare of mankind: in the last century, the only comparable events were the two world wars and worst-case scenarios associated with nuclear proliferation. Unlike these events, the effects of increased atmospheric carbon concentration, mainly due to associated temperature increases, will occur gradually and with a long time lag.[26]

Roemer distinguishes his approach to the climate problem from that of both Nordhaus and Stern as being concerned with sustainability rather than maximizing consumption in some way. All of this he frames as being part of a larger question concerning "the social objective function." This is apparently a mathematician's term for what I would call the moral dimension of political and economic choices in a society. In other words, what are our goals. Nordhaus and Stern both adopt the conventional economic utilitarian ethics with a goal of maximizing welfare in terms of per capital gross domestic product or per capital income. Roemer proposes an expansion of the

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[24] Nordhaus p. 193

[25]According to Wikipedia "Roemer received his A.B. in mathematics summa cum laude from Harvard in 1966. He then enrolled as a graduate student in mathematics at the University of California, Berkeley. He became intensely involved in the anti-Vietnam-War movement, transferred to the doctoral program in economics, and was suspended by the university for his political activities. He taught mathematics in San Francisco secondary schools for five years. Eventually he returned to Berkeley and received his Ph.D. in economics in 1974." https://en.wikipedia.org/wiki/John_Roemer Getting suspended from Berkeley in the late 60's for political activities must have been a good trick.

[26] Humberto Llavador,, John E. Roemer and Joaquim Silvestre. "Should we sustain? And if so, sustain what? Consumption or the quality of life? " p. 1 https://cpb-us-w2.wpmucdn.com/campuspress.yale.edu/dist/6/414/files/2013/04/Fouquet-03.31.12-copy.pdf

concept of welfare to include "not only commodity consumption, but also education, leisure, and two public goods – the stock of knowledge and biospheric quality."[27] He emphasizes that education is an end in itself and not just an investment in human capital justified by greater productivity in the way it is often perceived by economists. It should be noted, however, that many economists including Nordhaus and Stern attempt to include health, education and leisure in their calculations of welfare, but they do so in a way that produces very different recommendations.

Roemer also questions the value of growth as a goal rather than a broader definition of quality of life including the preservation of our natural environment. His modeling is an attempt to describe how we have to change our consumption patterns now in order for future generations to enjoy at least the same quality of life as we do if not an even better one. It is to my mind ultimately a moral argument about the goal of human society no matter how much mathematical notation is used to present it.

I cannot do justice to Roemer's analysis here, especially the way in which he incorporates a Rawlsian sense of intergenerational justice as parameters in complex mathematical expressions. His basic direction of his argument is clear enough to me, however, that I believe it is worth serious consideration and perhaps more convincing than much of what Nordhaus presents. Ultimately Roemer concludes

> welfare can be sustained forever at levels higher than present levels, while on a production path that reduces GHG emissions to levels which converge to atmospheric carbon concentrations of 450 ppm. We emphasize the need to keep GHG emissions on track, given the available scientific knowledge.
>
> Our results are encouraging by showing that this is possible to drastically reduce GHG emissions while maintaining the quality of life across generations, but our work shows that only moderate growth rates can be sustained, suggesting slow-growth policies.[28]

Nordhaus has dismissed slow-growth policies as detrimental to our standard of living without, it seems to me, explaining fully what really constitutes our standard of living.

The importance of the issue of discounting for policy discussions becomes immediately obvious when you realize how the discount rate affects the "present value" of a future reduction in damages. Nordhaus provides a comparison of the effect of the discount rate in the case of a hypothetical proposal for a $10 million wind energy investment that will reduce CO_2 climate-change damages by $100 million in 50 years:[29]

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[27] Llavador et al. p. 31

[28] Llavador et al. p. 31f

[29] Nordhaus p. 190

Illustration of how discounting changes the present value of $100 million received in 50 years	
Discount Rate (% per year, real)	**Present value of $100 million reduction in damages in 50 years.**
1	60,803,882
4	14,071,262
7	3,394,776
10	851,855

If we use a 4% discount rate, a $10 million investment is justified because the discounted reduction in damages is greater than the present investment, i.e. there is a positive "return" on the investment. It would not be justifiable if we assume a 7% discount rate, since the present value of the future benefit is less than the investment so it is the equivalent of investing in something that will result in a loss. We would be better off in the long run if we invested elsewhere. But would we, if the alternative investment does nothing to prevent the $100 million in damages from climate change?

If one accepts the idea that climate change is an emergency of an unprecedented sort, then surely "opportunity costs" are not the only thing to weigh in deciding how much to invest in fighting it. Maybe some people opposed our involvement in World War II on the grounds that it would be harmful to the US economy (even though they might have seen in retrospect that it revitalized the economy), but I doubt that anyone could come up with a cost-benefit analysis of the war effort that was convincing in any way. How do you quantify the cost of the loss of so many lives, not to mention the benefits of not living in a fascist police state. Even the Cold War in which relatively few people died but which involved vast expenditures of money on weapons and preparedness does not seem to me to lend itself to a cost-benefit analysis.

Any form of consumption presumably involves opportunity costs. If nothing else I could have used the time to do something more productive than taking a walk in the park. If I use my savings to buy a sports car rather than investing it for retirement, I'll probably have to explain the decision to my wife. If we continue to use our resources to produce appliances that we can talk to or self-driving vehicles or vacations in outer space, we shall surely be answerable to our grandchildren if we have not adequately dealt with climate change caused by CO_2 emissions.

If you ask for a purely economic evaluation of climate change policy, perhaps the best you can get is a cost-benefit analysis, but I confess I am unconvinced that this kind of cost-benefit analysis is realistic enough to use as the basis for limiting current investment in climate-change abatement, especially when it involves projections of 50

years. One need only look at the first half of the twentieth century to see how much can happen that may seem explainable in retrospect but certainly was not anticipated by anyone in 1900.

Applying a discount rate to the benefits of a climate change mitigation project seems relevant to policies involving direct investment in technology or infrastructure that will reduce CO_2 emissions, but things get more complicated when a policy attempts to set a price on carbon. Nordhaus does not object in principle to direct government investment in programs designed to reduce CO_2 emissions so long as a cost-benefit analysis shows they are justified, but he prefers policies which put a price on carbon and enlists market forces to get the job done more efficiently.

> What will persuade you and me and everyone else to undertake the necessary actions? How can we be induced to buy fuel-efficient cars? To vacation close to home rather than flying around the world? What incentives will lead firms to redesign their operations in ways that reduce carbon emissions while keeping their stockholders happy by maximizing profits? What will convince scientists and engineers and venture capitalists that a promising area for their talents is investing in new low - carbon processes and products? These questions are likely to make your head spin. Fortunately, there is a simple answer. The history of economic interventions in the energy sector and elsewhere shows that the best approach is to use market mechanisms. And the single most important market mechanism that is missing today is a high price on CO2 emissions, or what is called " carbon prices. "[30]

In a world populated by economic actors whose decisions are based on some form of cost-benefit analysis, the way to steer them away from things that involve CO_2 emissions is to make them pay for the privilege of putting CO_2 into the air regardless of whether they do it directly or indirectly. You find a way to put a price on carbon that will make it too costly to continue putting more and more CO_2 into the air. Nordhaus provides a succinct sketch of how this will work.

> Putting a price on the use of carbon serves the primary purpose of providing strong incentives to reduce carbon emissions. It does this through three mechanisms: by affecting consumers, producers, and innovators.
>
> First, a carbon price will provide signals to consumers about what goods and services have high carbon content and should therefore be used more sparingly. Consumers will find that air travel becomes relatively more expensive than visiting local sights or taking the train, which will reduce air travel and therefore the emissions from air travel.
>
> Second, it will provide signals to producers about which inputs use more carbon and which use less or none. It thereby induces firms to move to low-carbon technologies so as to lower their costs and increase their profits. One of the most important signals will come in electric power generation. The costs of generating electricity from coal will rise sharply; costs from natural gas will rise somewhat less; and those from nuclear power

[30] Nordhaus p. 221

> and renewable sources like wind will rise not at all. Of all the adjustments, reducing CO_2 emissions from coal is probably the most important step for the United States.
>
> A high carbon price will get the attention of electricity generators. Indeed, many companies already build the possibility of high carbon prices into their long-term plans, even though the current price in the United States is zero. For example, a survey of twenty-one electric utilities in 2012 in the United States found that sixteen had built a positive CO_2 price into their planning, with the average price for 2020 being slightly below $25 per ton of CO_2.
>
> A third and more subtle effect is that carbon prices will give market incentives for inventors and innovators to develop and introduce low-carbon products and processes to replace current technologies. Suppose you are the executive in charge of research and development (R & D) at a large company like GE, which had an R & D budget of $5 billion in 2012. You make equipment for generating electricity from different sources — coal, nuclear energy, and wind. Most generating facilities will last for decades. If carbon prices are going to be zero or very low, then coal-burning plants will continue to be an important source of profits, and you will continue to do substantial R & D for coal technologies.
>
> On the other hand, if you expect carbon prices to rise sharply, few conventional coal stations will be built, and zero-carbon technologies like wind and nuclear power will be the areas on which to place your bets. In other areas where consumer or producer demand is sensitive to carbon prices — air travel, consumer appliances, and automobiles being good examples — companies with big R & D budgets will be sensitive to the signals given by carbon prices and redirect their investments accordingly.[31]

When I test my understanding of these "mechanisms" I find myself coming to dead-ends of one sort or another. I'll start with why we decided to buy a hybrid car in 2007. It wasn't because we knew it would be cheaper to operate than a comparably priced gasoline or diesel car. It wasn't because we loved everything about the design and construction of the car. I really believe that it was largely because it seemed like the right thing to do. We were willing to accept compromises in design and construction because we felt that it was important to reduce pollution and dependence on gasoline. Price was only a consideration to the extent that the car was within our price range, as were plenty of other cars. I recall my son commenting on the decision by pointing out that "You get a pass with a Prius," meaning that in terms of its status value a Prius was worth more than just its price tag because concern about pollution and fossil fuel dependence had so saturated the popular culture. (Keep in mind that I live Los Angeles.) I later saw proof of this in the fact that a real estate agent with a very high-end clientele was driving a Prius rather than the Mercedes he might normally drive.

Ad agency executives can tell you more about how to steer consumers' behavior than I can. Perhaps Nordhaus can quantify an increase in status or alleviation of insecurity as a component in the benefits included in a consumer's cost-benefit analysis,

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[31] Nordhaus p. 224

but I think human motivation is a very complex thing that cannot be reduced to any kind of numerical cost-benefit analysis.

To take another of Nordhaus's examples, what determines whether I fly to Africa for a vacation or how I decide to get to San Francisco from Los Angeles? Perhaps airlines would be doing a huge service to humanity if they eliminated coach class on their flights thereby sparing thousands of people a day from a kind of physical torture only the CIA could justify and drastically reducing the CO_2 emissions from jet liners because the remaining tickets sales would only support a fraction of the flights they currently offer. It is conceivable we would not have gone to Africa if we had not been able to fly inexpensively in coach, but flying to San Francisco rather than driving or taking the train might still be worth the convenience in terms of time saved. If there were a bullet train that I could get to easily and that went directly to San Francisco, I would probably take the train, but I doubt that airlines are going to pool their resources to invest in trains when the cost of jet fuel starts to put them out of business.

Clearly my decisions about what kind of car to buy or how to travel are less significant than whether or not California decides to outlaw the use of coal in power generation, so let's take the example of the effect of carbon pricing on electrical power generation. First of all the market mechanism Nordhaus is describing seems more relevant to private industry than it does to a public utility of the sort that I at least believe electrical power should be. I am not aware of electrical suppliers competing for my business like cell phone companies or long-distance services on my landline. Checking with Wikipedia, I discover that the LA Department of Water and Power is in fact a public utility, but that it has not eliminated coal from its power stations the way other investor-owned power companies in California have. So score one for private industry.

Even if a power company is not answerable to stockholders, it is presumably still trying to keep its costs down and will react to a price on its CO_2 emissions. According to Nordhaus this "signal" encourages them to look for ways to cut their costs. I suspect they would first look for a way just to pass the increased cost along to its customers unless they are prohibited from doing so by some regulation. In fact this seems to be what most economists assume they will do while also keeping an eye on ways to reduce costs.

What happens if the power company just passes the cost along to its customers? Customers on a really tight budget might look for ways to reduce their use of electricity, but unless the rate increase is enormous, I suspect most people will continue to use the same amount of electricity and make an adjustment somewhere else in their budget. If they are persuaded to set their thermostats higher in the summer to conserve energy used by air conditioning, I really think it is more likely because of PR campaigns urging

them to do so rather than the savings they will achieve. How high do you have to set the price on carbon to have an effect on consumption of electrical power? Whatever that point is, it will have a much greater impact on the portion of the population that can least afford to use excessive amounts of electricity. In any case my question is whether a lessening in demand will put enough of a dent in the power company's profit margin to cause them to stop burning coal and even eventually eliminate the use of natural gas to generate power.

Power plants have shifted to natural gas because it is already cheaper than coal, and presumably the savings justify the investment in retrofitting coal power plants for gas or building new plants to use natural gas. (Apparently converting to gas enables a reduction in the labor required to operate the plant as well as reducing the cost of the fuel.) This is proof that power companies will try to reduce their costs by using a less expensive fuel, but even if the entire industry converted all their coal-burning power stations to natural gas we would still have a problem. Natural gas is a limited resource, and it still emits CO_2 when it is burned. What is needed instead is an enormous investment in renewable energy sources which are clean. I find it hard to be as optimistic as Nordhaus with regard to the way in which carbon pricing will encourage entrepreneurs to fund the research and infrastructure required to move to completely renewable energy sources.

One of the most striking things about the Economists Statement on Carbon Dividends is how it is advocating a carbon tax that is "revenue neutral."

> To maximize the fairness and political viability of a rising carbon tax, all the revenue should be returned directly to U.S. citizens through equal lump-sum rebates. The majority of American families, including the most vulnerable, will benefit financially by receiving more in "carbon dividends" than they pay in increased energy prices.[32]

It seems to me that the economists are tripping over themselves in advocating a "dividend" payment to every citizen. The assumption seems to be that the increased cost of carbon will be passed along to consumers in the form of increase energy prices, but any effect that price increase will have on the consumption of energy is undermined by making sure that everyone receives a dividend that more than compensates for the increase in energy costs. Money has been redistributed in some way, but any incentive to reduce energy consumption has been cancelled by a rebate check. Similarly the incentive for the power companies to switch to other fuels has evaporated by the fact that they are assumed to have passed the cost along to the consumers. Surely such a carbon dividend throws a monkey wrench into the workings of the market mechanisms. A carbon tax might be more effective if it is accompanied by regulations which prohibit passing all the cost along to the consumer and if the revenue is used for

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[32] https://www.econstatement.org/

investments in the development of renewable energy sources where all taxpayers are footing the bill rather than just private capital.

One of the advantages cited by the Economists Statement is that a "sufficiently robust and gradually rising carbon tax will replace the need for various carbon regulations that are less efficient. Substituting a price signal for cumbersome regulations will promote economic growth and provide the regulatory certainty companies need for long-term investment in clean-energy alternatives."[33] How is a carbon tax more efficient, and why are regulations cumbersome? Apparently a "price signal" provides a kind of certainty required for planning. Part of the argument seems to be that once a tax is in place it is less likely to be revisited by Congress with a change in administration than a more complex regulatory law. I do not find this convincing, but I am not a student of how Congress functions or malfunctions. Similarly the assumption seems to be that regulations require more bureaucracy than taxes, which can be handled by the IRS. Again I am not convinced. Taxes like regulations require specifying which specific industries are subject to the law and both require monitoring CO_2 emissions and enforcement procedures. Perhaps any attempt to impose a fine could be challenged and end up in court, but the same thing can happen when a company refuses to pay taxes or engages in various tax dodges. Perhaps regulations could require arbitration the way so many consumer contracts do.

Some regulatory approaches are indirect. One example is the regulations requiring energy efficiency in appliances. The ultimate goal of such regulations is to reduce the use of electricity, thereby reducing our dependency on fossil fuels and the amount of CO_2 emissions from power stations. This is an admirable goal, but it is hard to believe that such an increase in appliance efficiency can really put that much of a dent in the use of electricity and CO_2 emissions. I think the main benefit of such regulations may actually be the increase in public awareness of the underlying issues. If I am presented with a choice between buying an appliance with an Energy Star certification and one without it, I become more aware of the idea that energy consumption needs to be reduced.

Requiring catalytic converters and emissions testing in order to register a car has obviously had a direct effect on certain types of pollution. Taxing gasoline at the pump may be a fair way to raise revenue to build and maintain roads, but as a means of reducing the use of gasoline it seems to me to have a burdensome effect on those who can least afford it and no effect on those who consume the greatest amount of gas.

What is the difference between a carbon tax and a law setting limits on CO_2 emissions and imposing fines on those who do not comply? Both require monitoring and enforcement. The carbon tax may have as its goal reducing CO_2 emissions, but in

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[33] https://www.econstatement.org/

effect it condones emissions of CO_2 and simply requires that companies "pay for the privilege" in the hope that this will incentivize them to find a less expensive alternative. Why is this likely to be more effective than legislating limits to emissions and fining those who exceed their limit? The public at large does not generally care if a company is operating at maximum efficiency, but it does look askance on companies that break the law. A fine has the added impact of bad PR in addition to its cost, so there is greater incentive to find an alternative. It also might be easier to prevent passing the extra cost along to consumers if the cost is a fine for illegal activity. Would the power company simply reduce its output in order to comply with emissions limits and serve up rolling blackouts to its consumers instead of higher rates? This would certainly encourage consumers to look for alternative and perhaps localized sources of energy. It might provide a needed boost to solar and wind power generation technology companies.

I have no problem with a carbon tax if it actually works. Nor do I have a problem with cap-and-trade, as much as I dislike the idea of a market for the "privilege" to pollute. With cap-and-trade the government sets limits and lets a market set the price. I just think if the government can set limits, it should just set limits and enforce them rather than invoking the "invisible hand." I do not have any faith in a market to produce a more equitable result than direct government enforcement of limits.

Should economists be our principal advisors in setting policies designed to combat climate change? Obviously they should have a seat at the table to help us see clearly the net effect of various policies on such things as employment, inflation, income, and productivity. But the core principle in most economic theory is efficiency. Nordhaus is in a prime position to articulate this since he is the co-author with Samuelson of what is generally regarded as the standard college textbook on economics. In the introduction they list various topics defining economics and extracts one common theme:

> Economics is the study of how societies use scarce resources to produce valuable goods and services and distribute them among different individuals. …
>
> If we think about the definitions, we find two key ideas that run through all of economics: that goods are scarce and that society must use its resources efficiently.[34]

There is nothing inherent in the study of the use of scarce resources and the distribution of goods and services that implies various different ways of doing this need to be evaluated in terms of efficiency or any other criterion. An economist just assumes that is the point of studying these phenomena and that scarcity naturally implies the need to be efficient.

> Given unlimited wants, it is important that an economy make the best use of its limited resources. That brings us to the critical notion of efficiency. **Economic efficiency** requires

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[34] Paul A. Samuelson and William D. Nordhaus. *Economics: Nineteenth Edition* (New York: McGraw-Hill, 2010) p. 4

> that an economy produce the highest combination of quantity and quality of goods and services given its technology and scarce resources. An economy is producing efficiently when no individual's economic welfare can be improved unless someone else is made worse off.[35]

Note that wants are assumed to be unlimited. There is no end to human desire and as abstract "wants" there is no distinction between need and desire or legitimate and what I used to think of as "meretricious" desire.[36] The definition of economic efficiency slips in a value judgment, however, in specifying "quality" as well as quantity of goods. Presumably both count in determining an individual's "economic welfare."

More importantly, however, there is no concern with anything like "equity" in the definition of efficiency. If one were to design a mathematical model to maximize efficiency, there would be an infinite number of solutions because even if you are maximizing the production of quality goods and services you can always transfer them so that one person is better off at the expense of another and there is nothing that says it is better to make 100 people better off at the expense of one person. Both solutions before and after the transfer are equally efficient. This is where economics draws the line with regard to a distinction between descriptive and prescriptive or as Nordhaus prefers "positive economics" and "normative economics."

> When considering economic issues, we must carefully distinguish questions of fact from questions of fairness. Positive economics describes the facts of an economy, while normative economics involves value judgments.[37]

The concept of economic efficiency already involves a value judgment, however. It values the satisfaction of the greatest number of individual "wants" regardless of what they are. If fashion dictates feathered hats, it seems to be OK to kill birds almost to the point of the extinction of some species – at least until consumers no longer want feathered hats because they have been persuaded that birds ought not to be slaughtered. Perhaps it would be inefficient to eliminate a species prized for its feathers since consumer desire for feathered hats could no longer be satisfied, but desires stemming from fashion are ephemeral and there is no readily apparent method for balancing current and future wants. It is possible to tell, however, when a society is inefficient.

> **Efficiency** denotes the most effective use of a society's resources in satisfying people's wants and needs. By contrast, consider an economy with unchecked monopolies or

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[35] Samuelson and Nordhaus p. 4

[36] An archaic meaning of meretricious is "relating to or characteristic of a prostitute" and its root comes from a Latin term indicating prostitute and meaning literally to be hired – in other words a market transaction.

[37] Samuelson and Nordhaus p.6

> unhealthy pollution or government corruption. Such an economy may produce less than would be possible without these factors, or it may produce a distorted bundle of goods that leaves consumers worse off than they otherwise could be—either situation is an inefficient allocation of resources.[38]

Here we still have some distinction between wants and needs, but this comment actually precedes the more rigorous definition of economic efficiency above that is highlighted in red in the original text. Presumably a "distorted bundle of goods" is one which contains too much of one good and not enough of another so that resources are wasted producing goods that are not wanted and wants are left unsatisfied that could have been satisfied. It is primarily the allocation of the resources that is the focus of economics rather than the distribution of the goods, although a surplus of food stored in one place while people are starving in another would presumably be inefficient.

What is the relevance of economic efficiency to the problems of climate change? To what extent do consumers know what they need as opposed to what they want? Do consumers want to stop global warming? Apparently not so much, since so much of the public seems to be skeptical about the urgency of doing very much. Economic actors apparently need to be incentivized.

Even if consumers want to stop global warming, how does economic efficiency guide them? It can help them evaluate the opportunity costs to see whether a proposed course of action is too costly for the benefits it will deliver in the future. But opportunity costs include the development of fancier cell phones and remote-control appliances. Does it really tell us anything about what kind of environment our grandchildren or great-grandchildren will live in and whether cell phone technology will be of any use?

It might seem that regarding all "wants" as equally valid is a non-judgmental attitude in keeping with a purely descriptive analysis of how scarce resources are allocated and how goods and services are distributed. The billionaire's desire to have the biggest yacht in the harbor is no more or less "valid" than the desire of hundreds of kids to have a decent lunch at school. People want what they want, and it is not the job of the economist to decide who should get their wants satisfied so long as we are making the most efficient use of our resources – no matter how much the economist may think there is a difference between needs and desires or between quality and quantity of goods and services. Perhaps a corollary of this is "Who am I to judge, if people want to make the planet uninhabitable in the future in order to satisfy their current wants?"

The idea of "economic welfare" implies a judgment that some conditions are better than others. It can be made "better" or "worse." I am sure economists have ways of

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[38] Samuelson and Nordhaus p. 4

measuring "marginal utility" of increases in welfare that will assign less value to an improvement in a billionaire's welfare than it will to a comparable improvement in the welfare of someone who is poor or middle class. I am not sure that such an adjustment is factored into the cost-benefit analysis for climate change policy proposals.

Public policy decisions can not avoid moral judgments, and despite the efforts of mathematician-philosophers, I do not think moral judgments can be encapsulated in numerical expressions. What to do about climate change is a moral issue. Any decision should obviously be based on the best science available and made with a view to the collateral economic effects it will have, but we should not let an economist tell us that something we need to do is not "cost effective" or does not satisfy the criteria an investor uses to determine whether an investment will maximize his profit.