CLIMATE CHANGE AND ECONOMIC SYSTEM CHANGE (10,036 words)

Abstract

This paper addresses the following questions: (1) Is global neoliberal capitalism on track to trigger catastrophic and possibly irreversible climate change? (2) Must economic growth cease in order to avert environmental disaster? (3) Is there an alternative economic system which would allow economic wellbeing to flourish indefinitely while also adequately protecting the natural environment? (4) Is the solution to climate change to replace capitalism with eco-socialism? This paper argues that the answers to the first and third questions are "yes," but the answers to the second and fourth questions are "no." It goes on to argue that even while most countries have capitalist economies, if we act decisively now it is still possible to avert cataclysmic climate change before it is too late.

JEL Classifications: Q5 - Environmental Economics, B5 - Current Heterodox Approaches

Introduction

Consider the following four questions:

(1) Is global neoliberal capitalism now on track to *all too soon* trigger catastrophic and irreversible climate change?

(2) Must economic growth cease in order to avert environmental disaster, *as many in the steady-state and de-growth movements claim*?

(3) Could an alternative, "eco-socialist" system allow economic wellbeing to increase indefinitely while also protecting the natural environment?

(4) Does this mean that the solution to "climate change" is "economic system change," i.e. to replace capitalism with "eco-socialism" as many anti-capitalists argue?

This essay argues that the answers to the first and third questions are both a resounding "YES!" However, the answers to the second and fourth questions are clearly "NO!" And the reason is quite simple: Possibly cataclysmic and irreversible climate change may well be only a decade away. But unfortunately economic system change is clearly more than a decade away in the vast majority of countries. To ignore these two facts is to behave like the proverbial ostrich who sticks its head in the sand when danger approaches. However, this article goes on to argue that fortunately, if we act decisively now, it is still possible to avert cataclysmic climate change before it is too late.

Is Climate Change Immanent?

YES!

All one need do is read the reports from environmental scientists working under UN auspices charged with advising us about the status of various environmental system "tipping points." Climate change has already begun, and we have at most ten years to act to prevent cataclysmic consequences.[1]

Reacting to the latest findings of the Intergovernmental Panel on Climate Change (IPCC) the UN Secretary-General, Antonio Guterres, insisted that unless governments everywhere reassess their energy policies, the world will be uninhabitable. In a video message Mr. Guterres said: "Unless action is taken soon, some major cities will be under water, there will be unprecedented heatwaves, terrifying storms, widespread water shortages, and the extinction of a million species of plants and animals," adding "this is not fiction or exaggeration. It is what science tells us will result from our current energy policies".

On July 20 2023 Dharna Noor reported in an article in *The Guardian* newspaper titled "Leading NASA Climate Expert says July likely to be the hottest month on record" that Gavin Schmidt, "the Director of Nasa's Goddard Institute for Space Studies, told reporters July will likely be Earth's hottest month in hundreds if not

[1] The truth is the situation is even more dire than many allow ourselves to believe. Otherwise, we would realize that working to right the many wrongs humans inflict on one another *will hardly matter* if we fail to prevent cataclysmic climate change.

thousands of years… as a persistent heatwave baked swaths of the US south. Deadly floods have struck New England. Canadian wildfire smoke has choked US cities. And tens of millions of people have been placed under heat advisories, with areas across the US south and west breaking temperature records. 'We are seeing unprecedented changes all over the world,' Schmidt said. 'Though the changes may feel shocking, they are not a surprise to scientists, he added. There has been a decade-on-decade increase in temperatures throughout the last four decades.'"

On July 19 2023 *The Guardian* published an article titled "Extreme weather: the climate crisis in four charts," which for those who don't like charts, also reported at length on a record breaking heatwave in Phoenix Arizona, unprecedented wildfires around Athens Greece, and record setting floods in parts of Asia. The first chart showed worldwide average daily air temperatures for every year since 1979 up through 2023 so far. A blue line in the graph represented the average of those daily temperatures for the years 1979 through 2000, and a black line connected the world average temperature for each day so far in 2023. *The black line is significantly above the blue line for every day this year.* The second chart is a map of the world showing how much the average temperature in 2023 in every location deviates above the long-run average temperature for that location (coded in shades of red), or below the long-run average temperature for that location (coded in shades of blue). While of course there are some locations in shades of blue, the map is overwhelmingly more red than blue. The third chart records monthly average global sea temperatures from 1971 through July 2022. While monthly deviations are *below the mean* (blue) for almost every month before 2001, deviations are above the mean (red), and increasing, for almost every month after 2001. The final graph charts the extent of Antarctic sea ice in millions of square kilometers. A blue line in the graph represents the average of those areas for the years 1979 through 2000, and a black line connects the area covered by ice for each day so far in 2023. *The black line is significantly* ***below*** *the blue line for every day this year.*

Professor Lesley Hughes, distinguished professor of biology at Macquarien University in Australia, and lead author in the IPCC's 4th and 5th assessment report, expressed sentiment among the scientific community this way: "This is what climate change looks like now… though it will likely continue to get worse. I don't

know how many more warnings the world needs. It's as if the human race has received a terminal medical diagnosis and knows there is a cure, but has consciously decided not to save itself. But those of us who understand, and who care, just have to keep trying – after all, what other choice do we have?"[2]

New data shows average global temperatures in September were not just the hottest ever recorded, but 0.5C above the previous record for the month. They were about 1.8C above temperatures in pre-industrial times before humans started pumping vast amounts of heat-trapping greenhouse gases into the atmosphere. The scientist and writer Zeke Hausfather is not prone to hyperbole but was quick to put this into context on social media, saying on Bluesky that "in his professional opinion as a climate scientist it was *bananas!*" adding "it's hard to overstate just how exceptionally high global temperatures are at the moment."

Is Capitalism Responsible for Causing Climate Change?

YES!

Lessons from mainstream economic theory: Let me begin with what the mainstream of the economics profession tells us. Negative and positive externalities, public goods and bads, free access to common property resources, and resource extraction under private ownership all create *perverse incentives* that can take us a long way toward understanding the sources of environmental problems. If anyone cares to listen, mainstream economic theory predicts that market forces will lead us to produce too much of goods whose production and/or consumption entail negative externalities, and therefore to pollute too much; will lead us to produce too little of goods whose production and/or consumption entail positive externalities, and therefore we will protect the environment too little; and will lead us to produce too few public goods which on average have a smaller environmental footprint per person than private goods do. And while Elnor Ostrom was the first women to win a Nobel Prize in economics for her historical case studies of when people have overcome perverse incentives to overexploit "common pool" resources, she and her fellow researchers found many *more*

2 https://www.theguardian.com/commentisfree/2023/jul/25/northern-hemisphere-heatwaves-europe-greece-italy-wildfires-extreme-weather-climate-experts

historical examples when people have failed to do so, leading to what Garrett Hardin famously called "the tragedy of the commons."

Nor does one have to go outside the mainstream of the profession to discover why decisions made in market systems use a rate of time discount that is too high when deciding how fast to extract natural resources, and therefore we extract them faster than is socially efficient. An ample literature on future market failures leads directly to the conclusion that we will extract resources too fast. And whenever the bargaining power of employees is insufficient to reduce the rate of profit to the rate of growth of net national welfare per capita, mainstream economic theory also predicts that profit maximizing natural resource extracting businesses will use discount rates which are too high, and therefore extract resources faster than is socially efficient.[3]

So in large part the problem is *not* that reasons to expect we will over exploit the natural environment in various ways cannot be found in mainstream economic literature. The problem is that this part of mainstream literature on perverse incentives is under advertised by a profession which has become dedicated to providing ideological support for the dominant economic system of our age.

Warnings from heterodox economic theory: But what do non-mainstream schools of economic thought have to say? It is sometimes possible to come to the right conclusion for the wrong reasons. And in my view that is what has happened in the case of ecological economists who write "on a finite planet infinite economic growth is impossible," and Marxian economists who write "capitalism is a system that must continually expand. No-growth capitalism is an oxymoron." I believe the conclusion they come to is correct: Today's capitalist economies *do* contain an unhealthy and environmentally destructive growth imperative for reasons that go beyond what the under advertised warnings from mainstream economics reveal. But unfortunately the reasoning process of many ecological and Marxist

[3] For a demonstration of the logic of this last perverse incentive see Roemer 1981, chapter 4. Over the past thirty-five years profit rates in the US have been four to five times higher than credible estimates of the rate of growth of per capita net national welfare, which implies there is every reason to believe over extraction has been considerable.

economists on this subject is logically flawed and for the most part amounts to assuming their conclusion.[4]

In my opinion the problem is *not* that human beings have become more and more economically productive. The vision of infinite economic growth should be understood as a statement of faith in the capacity of humans to continue to become ever more clever about how we go about our economic activities. It is an expression of faith that there is no inherent reason we cannot continue to satisfy our economic needs in an ever-shrinking portion of the twenty-four hour day – provided we are careful to increase the efficiency with which we use inputs from the natural environment as fast as we increase the efficiency with which we use our labor, and provided we do not needlessly expand our economic needs. When understood in this way, the problem is not increasing productivity or an economic system that promotes energetic and creative pursuit of increasing economic productivity. Instead the problems are: (1) what we *do* with increases in our productivity, (2) how we expand economic needs into desires whose satisfaction does little or nothing to increase economic wellbeing, and (3) failure to increase the efficiency with which we use inputs from the natural environment as fast as we increase the efficiency with which we use hours of labor.

According to standard measures productivity in the American economy increased fivefold between 1950 and 2000. Yet the average American worker worked more hours per year at the end of the last century than at the midpoint of the century. This is amazing when you pause to think about it. Had Americans taken our increased productivity as leisure, our material standard of living would have been exactly the same in 2000 as it was in 1950, and the standard workweek, not workday, would have been eight hours instead of forty. In other words, working only one day a week instead of five, we could have been materially no worse off, and environmental throughput would have been no greater in 2000 than in 1950. Clearly it is not endless increases in labor productivity that threaten the environment!

[4] See chapter 5 in Hahnel 2011 for my argument that both prominent ecological economists and Marxists fail to make a compelling case that capitalism contains an *unhealthy* growth imperative, but instead make simple errors in logic and essentially assume their conclusion.

Of course there is more to say. In the 1950s people were far less aware that increased consumption was leading to environmental destruction. And because much of the increase in production has been captured by those at the top of the income distribution over the past fifty years, the majority of Americans were left no choice but to work long hours merely to maintain their standard of living. But the astounding irrationality of the outcome prompted Juliet Schor to follow up on her best seller, *The Overworked American* (1992), in a second book, *The Overspent American* (1998), in which she built on Thorstein Veblen's famous heterodox economic theory of "conspicuous consumption" to develop a theory of what Schor calls "competitive consumption." Stimulated to further investigation by Schor's work, sociologists have since offered competing hypotheses about why Americans do not take more of our productivity gains as leisure. Some emphasize that time spent in work is not a voluntary decision by employees but is instead constrained by the demands of employers.[5] Recent research also suggests that increases in average income seem to have little positive effect on how happy people are on average, while increases in income inequality have a negative effect on most people's sense of wellbeing.[6]

Many sociologists and environmentalists, but few mainstream economists, now see a tragicomedy unfolding: A social species, hard-driven to compete for status in hierarchical societies, is fast becoming like the proverbial lemmings, trapped in an economy where the primary means of demonstrating social status is through competitive consumption which yields diminishing aggregate benefits even as it accelerates destruction of the natural environment we depend on.

But let me be clear: I do not believe the problem is that capitalist economies are driven as never before. Executive officers of corporations whose stock is publicly owned – which actually means privately owned by absentee owners – have a legally binding fiduciary responsibility to maximize profits. Managers who fail to do so are likely to be dismissed by shareholders whose only interest is the size of the dividends and the market value of their shares. And corporations that fall

[5] For a review of competing hypotheses and evidence see Maume and Bellas 2001.

[6] For an early example of what has now become a large body of research in this field confirming this conclusion see Zoltas 1981.

behind in the race to maximize profits will be replaced by more successful corporations as financial markets favor more profitable firms. It was Adam Smith, not Karl Marx, who taught us that "it is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from the regard to their own interest" ([1776] 1999, chapter 2.) The question is not if the economic system is driven. The question is not if the system is soul-less. Smith knew that production is for profit and not for use in capitalist economies long before Marx was born. In short, Smith knew capitalism for the heartless creature it is, but argued that it serves us well nonetheless.

However, Adam Smith was unaware of many of the perverse incentives described above.[7] Nor did he have before him the mounting evidence available to us that crucial ecosystems have now been compromised. The question for us today, who *do* understand the perverse incentives, and *can* see the environmental damage they have wrought, is whether our situation is all the more precarious because the system is designed to relentlessly maximize profits come hell or high water. I think it clearly is, but we must go beyond mainstream economic theory to understand why.

Under capitalism we are like a racer who is programmed to run fast, but prone to running off in wrong directions. The problem is not our speed *per se*, but that we run in wrong directions. However, given the fact that we are prone to run in wrong directions, running fast does takes us farther afield, and therefore *is* part of the problem. But there is another reason capitalism is programmed to damage the environment which mainstream economic theory is blind to. Mainstream economists pride themselves on "taking people's preferences as givens" and refuse to play the role of preacher and argue that some preferences are more worthy than others. But preferences don't simply fall from the sky. They depend on people's human characteristics, and therefore develop and evolve over people's lifetimes as those characteristics change. A more realistic theory of *endogenous preferences* which takes this process into account reveals yet another reason to believe that

[7] While unaware of other problems relevant to how capitalism systematically over exploits the environment, Smith *was* keenly aware that monopolies create inefficiency and waste, and warned against the dangers of market concentration, which modern day apologists for monopoly capitalism who praise Smith seldom mention.

private enterprise market economies will race off ever faster in environmentally destructive ways.

Once we recognize that markets and private enterprise are not neutral institutions that register different categories of preferences without prejudice, once we realize that markets do not provide an even playing field for public and private goods, or for goods with associated positive and negative externalities, an interesting question arises regarding how people will respond to these *institutional biases* in our economic system. As explained above, markets make it more difficult for people to acquire environmental protection and preservation than it should be, and cheaper for people to buy goods whose production or consumption generates pollution than it should be. If some things are harder to obtain or more expensive than they should be, while other things are easier to obtain or less expensive than they should be, how will people respond? Mainstream theory focuses on one sensible response called the "substitution effect." In the short run people will buy less of anything they are overcharged for and more of anything they are under charged for. So when prices deviate from social opportunity costs there will be a degree of inefficiency mainstream theory acknowledges. However, while this is where mainstream theory stops, this is not the end of the story if people's preferences are not fixed, or *exogenous*, but are instead *endogenous*. If people's preferences can change over time in ways they have some influence over, why would they not try to diminish their preference for things for which they are consistently charged more than their true social cost, and increase their preference for things that are cheaper than they should be? And if people do this, what does it imply about the degree of inefficiency, and in our case over exploitation of the natural environment, to be expected in the economy? In chapter 7 in Hahnel and Albert 1990 we proved the following theorem:

> If consumers have endogenous preferences not only will markets misallocate resources in some initial time period – undersupplying goods whose production or consumption have greater than average positive external effects, and oversupplying goods whose production or consumption have negative external effects; there will also be a cumulative divergence away from optimal allocations in future time periods as individuals "rationally" adjust their personal characteristics to diminish their preferences for goods

with positive external effects and expand their preferences for goods with negative external effects.

In other words, we should expect the *extent* of over pollution, and the *extent* of under protection of the natural environment to increase, or *snowball* over time to the extent that people's preferences are endogenous and people not only take the preference fulfillment effects of their choices into account, but the preference development effects as well. So a more realistic theory of how people's preferences evolve in response to different institutional settings teaches us to expect the extent of over pollution and over exploitation of the natural environment in market economies to grow over time. I close this section with two caveats:

(1) During the twentieth century the centrally planned economies in the Soviet Union and Eastern Europe *also* greatly increased their carbon emissions and abused the natural environment in other ways as well in their haste to prioritize economic growth in their race to "compete" with capitalism. So capitalism is clearly not the only environmentally unsustainable economic system. But except for the tiny economies of Cuba and North Korea, centrally planned, non-capitalist economies have now passed into the dust bin of history, and are therefore clearly no longer the problem.

(2) Sometimes a thought experiment is instructive: What if planet earth had not contained any fossil fuels when humans evolved? I see no reason to conclude that this would have prevented capitalism from evolving to exploit workers using alternative energy sources instead. So, *is capitalism possible without fossil fuels?* I believe it clearly is. But after capitalism evolved corporations quickly discovered the many advantages of fossil fuels, and the fossil fuel industry arguably became the most powerful industry in real world capitalism… with everything to lose if we now replace fossil fuels with renewables as fast as we must to avoid climate change.

Is it Possible to Adequately Protect the Natural Environment and Also Increase Economic Wellbeing Indefinitely?

Many who write in favor of a "steady-state economy," or insist that "de-growth" has become necessary would have us believe that what they loosely call "economic growth" is incompatible with environmental sustainability. Some argue it is

theoretically impossible to "de-couple" economic growth from environmental deterioration. Some who are more cautious argue that decoupling is a practical impossibility even if it is theoretically possible. But it is not only theoretically possible, as I have proved in a theorem,[8] I will shortly give one important example of where it has actually happened, and therefore is clearly a practical possibility as well.

Early leaders in what came to be known as the ecological school of economics deserve credit for defining a concept which is key to being able to think clearly about environmental sustainability. Ecological economists define *environmental throughput* as physical "inputs" such as oil and lumber taken from the natural environment which are "used up" in production processes, as well as physical "outputs" such as airborne particulate matter and greenhouse gases which are released back into the natural environment's various "sinks." Throughput must be measured in some appropriate physical unit, such as barrels of crude oil, board feet of lumber, pounds of particulate matter, and metric tons of greenhouse gases.

However, it is helpful to start by abstracting from the undeniable "fact" that environmental throughput is heterogeneous, just as we sometimes abstract from the "fact" that labor is heterogeneous[9] in order to talk about increases in environmental throughput efficiency in general, just as we talk about increases in labor productivity in general. After becoming clear about how changes in labor productivity and changes in throughput efficiency are related in general, we can return to discuss how the fact that throughput is heterogeneous complicates matters.

[8] For proof of the theorem, as well as a more in depth discussion of issues covered more briefly here, see chapter 2, "Environmental Sustainability in a Sraffa model," in *Income Distribution and Environmental Sustainability: A Sraffian Approach*, Routledge, NY: 2017.

[9] Just as crude oil is different from timber, which is different from the storage capacity for greenhouse gases in the upper atmosphere, an hour of ditch digging labor is different from an hour of welding labor, which is different from an hour of surgery labor. Or, to put it differently, just as different categories of environmental throughput are not perfectly substitutable for one another, different categories of labor are also not perfectly substitutable for one another.

In a Sraffian model where there are only two "primary" inputs, homogeneous labor (measured in hours), and homogeneous nature (measured in units we can call "greens"), it is possible to calculate how many hours of labor it takes both directly and indirectly to produce a unit of every good (known as "labor values"), *and* to calculate how many "greens" of environmental throughput it takes both directly and indirectly to produce a unit of every good (which because they are analogous, we might call "nature values"). It is also possible to calculate the size of the change in overall labor productivity, $\rho(l)$, caused by any change in technology in any industry (see theorem 18 in Hahnel 2017), *and* to calculate the size of the change in overall environmental throughput efficiency, $\rho(n)$, caused by any change in technology in any industry (see theorem 20 in Hahnel 2017.) In which case it is easy to demonstrate that as long as all technological changes which take place during a year do not increase labor productivity, $\rho(l)$, by more than they increase environmental throughput efficiency, $\rho(n)$, increases in labor productivity, and therefore economic wellbeing, *do not* increase environmental degradation. (Hahnel 2017 pp. 72-73.) This result rebuts claims of many advocates for steady-state and de-growth economics who claim *it is not possible in theory* to increase economic wellbeing per capita *indefinitely* without *necessarily* further degrading the natural environment.[10] However, of course there is more to say:

(1) First, and foremost, this is clearly *not* what has been happening! Labor productivity has been increasing much faster than environmental throughput efficiency over the past few hundred years, *which is why we are rapidly approaching a number of environmental tipping points and may have already passed some.* However, contrary to what many environmentalists believed in the

[10] By framing the debate in a Sraffian framework it is possible to avoid any number of complications about how GDP is measured, and the numerous ways in which GDP fails to accurately measure something we refer to loosely as "economic wellbeing." In my theorems complications introduced by price changes between years, as well as un-marketed production and externalities which go unaccounted for in many estimates of GDP, never need enter the story. I model an increase in labor productivity as an *equal percentage increase* in the *quantity* of production of *each and every* good, measured in whatever physical units the good is measured in. As discussed below, readers will see this is a worse-case scenario since of course much of what we will have to do to achieve environmental sustainability will be to enjoy further increases in labor productivity as more leisure rather than more consumption, and to substitute consumption of goods which require less environmental throughput for goods which require more, i.e. change the proportions of different goods in our consumption bundle.

1970s, it now appears that we are exhausting the ability of the planet to absorb different kinds of physical wastes sooner than we are exhausting the ability of the planet to continue to provide natural resources.[11] But either way, in the words of Herman Daly, there is strong evidence that we left the "frontier economy" where human impact on the natural environment was not yet significant long ago, have been barreling through the "bull in the china closet economy" for a couple hundred years where humans increasingly pose a serious threat to ecosystem resilience, and have now entered what we need to see as a "spaceman economy" where every aspect of our natural environment must be meticulously managed as described below.

(2) Obviously as long as population grows environmental sustainability is harder to achieve since in this case environmental sustainability requires that $\rho(n)$ exceed $\rho(l)$. However, once popular doomsday visions due to population growth have fallen out of vogue for several reasons I will only mention. It now appears that as economic wellbeing rises birth rates decline. It also appears that as women become more empowered birth rates decline as well. And as consciousness of environmental constraints increases people may decide to restrict how many children they have voluntarily. So even if rising economic wellbeing and improvements in healthcare lead to longer lives, it no longer appears that world population will continue to increase indefinitely. Current estimates are that world population will peak at somewhere between 9.4 and 9.8 between 2070 and 2080, and will have fallen to 9 billion by the end of the century.

(3) Not only is it theoretically possible to increase economic wellbeing while decreasing environmental throughput, it is also a practical possibility. During the past 2 years in the US people have driven more total miles, yet carbon emissions from autos have fallen. *Why?* We have replaced enough gas burning vehicles with EVs to turn the tide on auto emissions *while also enjoying more rider miles*. Of course we need to pick up the pace. Nonetheless, clearly it is *possible* to increase economic wellbeing (in this case driver miles) while also protecting the environment (in this case reducing GHG emissions from autos).

[11] A few decades ago it was not uncommon for those concerned about environmental constraints to warn us about how fast "peak oil" was approaching. But it turns out that oil is not as scarce as the capacity of the upper atmosphere to store greenhouse gases. Or, to put it differently, ironically "peak oil" has not come soon enough!

(4) Environmental resource economists have long drawn a distinction between *reproducible* natural resources like trees which regenerate to some extent, REG > 0, and *non-reproducible natural resources* like iron ore which we can assume do not regenerate, REG = 0. For natural resources and environmental sink services which *do* regenerate the conditions for sustainability are:

- As long as throughput is less than REG: $\rho(n)$ can exceed $\rho(l)$ until throughput reaches REG.

- Once throughput is equal to REG: $\rho(n) = \rho(l)$ is sufficient to maintain environmental sustainability.

- If throughput is greater than REG: $\rho(n) > \rho(l)$ is required to re-achieve environmental sustainability.[12]

However, as a matter of simple logic, if there is even one good which enters either directly or indirectly into the production of every good, and if production of this "basic" good requires a positive amount of *any* input from the natural environment which is non-reproducible, *no* positive production program is *infinitely* sustainable.[13] But this does not mean that a sustainable *strategy* is impossible. What does such a "coping strategy" look like?

(5) As much as it may stick in the craw of many environmental activists, the *only* strategy to achieve environmental sustainability is one that amounts to "kicking the can down the road." Not only do we need to search for new technologies that increase environmental throughput efficiency in general, we need to search for new technologies that substitute renewable throughput for non-renewable throughput, and new technologies that substitute non-renewable throughput that is farther from exhaustion for non-renewable throughput nearing exhaustion. We also need to adjust *the proportions in which we consume different goods* to consume more goods and services which are less throughput intensive and fewer goods and

[12] See Hahnel 2017, pp. 76-77.

[13] Ironically, the doomsday scenario which steady-state and de-growth theorists obsess over is actually not gloomy enough. While they reason that the existence of non-reproducible resources means that we must not increase (steady-state), or must decrease economic production (de-growth); in truth *no positive level of production* would prevent the disaster they envision!

services which are more throughput intensive, to consume more goods and services produced by reproducible resources and fewer goods and services produced by non-reproducible resources, and to consume more goods and services produced by non-reproducible resources which are farther from exhaustion and fewer goods and resources that are nearing exhaustion.

But what can be said to those who say: "But isn't all this 'shucking and jiving' pointless if sustainability is ultimately impossible?" The answer to these environmental doomsayers is simple: Kicking the environmental can down the road is not only what environmental sustainability has always been about, it is not pointless at all!*"* Even in a worst case scenario in which there is a non-reproducible service from nature that proves to be impossible for human production activities to do without, i.e. that remains "basic" because no change in technology or adjustment to our consumption bundle permits us to do without it altogether, "ultimately" can be a very, very, very long way off.

(6) Finally, when we talk about increasing production "continually" by using the "coping strategy" of "kicking the can down the road," just how long are we talking about? At some point the solar system will no longer exist. Before that, planet Earth may become as lifeless as Mars through non-human causes. But most assume these "endings" are a long way off, and more importantly they are irrelevant to the debate over whether or not human economic well-being can continue to grow indefinitely.

On the other hand, prominent founders of ecological economics such as Nicholas Georgescu-Roegen and Herman Daly have suggested that the *second law of thermodynamics* provides a possible ending to our story which, unlike the end of our solar system, is relevant to the growth debate. This law states that the amount of energy available for work in a closed system necessarily decreases with use. This law is also known as the "entropy law" and is often stated: In a closed system if work is done entropy necessarily increases. However, not only is the Earth an open, not a closed system since we get inputs of entropy decreasing energy from

the sun, death by entropy could only take place so far in the future that the human species would be lucky to last long enough to die from too much entropy![14]

Protecting the Environment in a Participatory Economy

There is at least one theoretical alternative to capitalism which now contains concrete measures which would adequately protect the natural environment while increasing economic wellbeing indefinitely as well. In brief, this is how the model known as "a participatory economy" would achieve environmental sustainability while increasing economic wellbeing.

Incorporating a pollution demand revealing mechanism into annual planning [15]

First, we must add pollutants to our list of produced "goods"—in this case "bads"—and in each iteration of the planning procedure the Iteration Facilitation Board (IFB) must quote the current estimate of the damage caused by releasing an additional unit of each pollutant along with current estimates of all other opportunity and social costs.

Second, when worker councils make proposals they must also include the amount of any pollutants they wish to emit. The damages from emissions will then be calculated by multiplying the number of units of a pollutant the worker council proposes to emit times the current estimate of the damage from one unit announced by the IFB. These damages will be added to the cost of using the inputs the enterprise has requested when calculating the overall social cost of the enterprise's proposal, to be compared with the social benefits of the outputs it proposes to produce.

Third, we create *Communities of Affected Parties* (CAPs), which comprise all who are damaged by emission of a particular pollutant. For example, there would be a CAP for volatile organic compounds and nitrous oxide emissions that cause smog

[14] Whether or not the entropy law of thermodynamics is relevant or irrelevant to the growth debate has been hotly debated. While I believe it is clearly irrelevant, I offer no exhaustive defense of this conclusion here. See Schwartzman (2008) for a compelling explanation of why entropy is a red herring with regard to our current environmental problems.

[15] See chapter 7 in Hahnel 2021 for a more extensive explanation, including examination of how possible perverse incentives could be overcome.

in the Los Angeles area. And we include all these CAPs along with worker and consumer councils and federations as "actors" who participate in each round of the planning procedure. Then:

- Worker councils propose how much of a pollutant they want to emit, knowing they will be charged for those emissions an amount equal to the current estimate of the damages per unit times the number of units they propose to emit.

- CAPs propose how many units of a pollutant they are willing to allow to be released, taking into account that the CAP will be compensated by an amount equal to the current estimate of the damages per unit times the total number of units the CAP allows to be released.

What does this pollution demand revealing mechanism (PDRM) achieve? In chapter 7 of *Democratic Economic Planning* we prove that once the PDRM is incorporated into the annual participatory planning procedure, under standard assumptions it will achieve the following:

1. It reduces pollution to reasonably **efficient** levels, i.e. allows emissions up to the point where the marginal social cost of emissions is equal to their marginal social benefit.

2. It satisfies the "**polluter pays principle**" since worker councils are charged for the damage their emissions generate.

3. It **compensates the victims** of pollution by giving them consumption credit for damages suffered.

4. *And most importantly,* it induces victims of pollution to truthfully reveal how much they are damaged because the PDRM is what economists call "**incentive compatible**."

Devising a PDRM that will induce victims to reveal truthfully how much they believe pollution will damage them is not a trivial accomplishment. However, this mechanism is useful *only* for pollutants whose effects are relatively well understood by victims, and most importantly, for pollutants which do *not* primarily affect future generations who cannot be present during annual planning. Obviously, there are many pollutants which do not fit this description, most

notably greenhouse gas emissions. But we have now also proposed how to create and revise long-run environmental plans to address pollutants which will affect many generations.

Creating and updating long-run environmental plans[16]

In chapter 14 of *Democratic Economic Planning* I present a concrete proposal for how to organize long-run environmental planning which (1) induces participants alive today to behave as "honest brokers" for future generations through a *generational equity constraint,* (2) maximizes popular participation of worker and consumer federations, taking both access to information and motivation of participants into account, and (3) uses results from subsequent annual plans to identify mistakes in estimations of key parameters in long-run environmental plans, and updates long-run environmental plans accordingly to mitigate welfare losses.

A generational equity constraint: We propose to place limits on how much aggregate consumption, c, can differ between any two years which we call a generational equity constraint.

$$\text{A: } c(t+1) < 1.\beta c(t), \underline{\textit{and}} \text{ B: } c(t) < 1.\beta c(t+1) \text{ for all t.}$$

Suppose changes in productivity yield optimal values for c(t) and c(t+1) that are close together, say within 3 percent. In this case there is no problem because the optimal solution is reasonably equitable. *But suppose they differ by 30 percent and this is deemed morally unacceptable.*

If c(t) is 30 percent smaller than c(t+1) because the social rate of return on investment is extremely high, generation-t will wish they had voted for a small β, say .05, to trigger constraint A. But if they vote for β = .05, this same β appears in part B of the generation equity constraint and thereby also protects the interests of generation-(t+1) in the eventuality that c(t+1) is 30 percent smaller than c(t) because the social rate of return on investment turns out to be extremely low. So even though those voting on β know they are in generation-t, whatever level of

[16] See chapter 14 in Hahnel 2021 for a more extensive explanation of how we propose long-term environmental planning be conducted, and in particular how inevitable errors can be detected and corrected in order to mitigate welfare loses and improve outcomes.

protection they secure for themselves against a disadvantageous outcome, they extend to generation-(t+1) against an outcome that would be disadvantageous and unfair to them.

Estimating effects needed to calculate an efficient long-run environmental plan: The efficiency conditions for environmental planning are that the increase in wellbeing from the last dollar spent on consumption every year be equal to the sum total future increases in production from the last dollar spent on environmental enhancement/protection *times* the future increases in wellbeing from the last dollar spent on consumption, *plus* the *direct* future increases in wellbeing from the last dollar spent on environmental enhancement/protection. These efficiency conditions can be solved for the efficient level to invest in environmental protection and enhancement every year once we know:

1. What environmental economists call the *existence and use value* benefits people will get on changes in the natural environment in the future.

2. How much increases (or decreases) in environmental assets will increase (or decrease) future production.

3. How much increases (or decreases) in future production will benefit (or harm) future consumers.

4. How much it will cost to enhance or protect the natural environment.

Who should estimate these four future effects? We believe the National Federation of Consumer Councils (NFCC) is best situated to estimate the existence and use value people will place on changes in the natural environment in the future (#1) We also believe the NFCC is best suited to estimating future benefits from more consumption (#3). We believe industry federations of worker councils are the best judges of how much changes in natural capital will affect future production in their industries (#2). And we believe the Ministry for the Environment knows best what it costs to protect or enhance the environment (#4).

Who should then formulate, and who should approve the long-run environmental plan? An environmental planning agency can take these four estimates, plug them

into the efficiency conditions, and "solve" the equations to find an efficient environmental investment plan. This plan must then be checked to see if it violates the *generational equity constraint*, and if not, revised until it does. At which point we propose there be a national debate about the plan, where different political and advocacy groups argue for either more or less investment in environmental enhancement/protection, followed by a national referendum or vote by the national legislature to approve or reject the long-run environmental plan.

Detecting errors and updating the long-run environmental plan: Perhaps our most significant contribution to the theory of planning for the future is we have *demonstrated how mistaken estimates of parameters can be detected* by results from subsequent annual plans. At which point it is possible to modify the environmental plan for later years, either increasing or decreasing our investment to mitigate welfare losses. There is no doubt those we charge with estimating various benefits will make "honest mistakes." There is also a danger that those we charge with estimating the magnitudes of different terms in the conditions for an efficient long-run development plan will be tempted to make "dishonest" mistakes to advance their own interests. However, *the good news is we have shown how misestimates will soon be revealed by results from subsequent annual plans, so our long-run environmental plans can be updated to mitigate welfare losses.* The ability to identify mistakes and make appropriate adjustments makes long-run environmental planning considerably more attractive![17]

[17] Everyone proposing a model for 21st century socialism now claims their proposal would protect the natural environment. Unfortunately, what proponents hope, and believe to be the case, may not actually be true. As far as I know there is *no other* post-capitalist proposal in the literature which would actually reduce emissions of pollutants to efficient levels annually, much less protect the interest of future generations by preventing environmental deterioration over the long-run -- as much as those who advocate for these models may wish and believe to be the case. Those interested should see the appendix to *Democratic Economic Planning* (Routledge 2021) where I evaluate five other concrete proposals for 21st century socialism in the literature in a number of regards, including their ability to adequately protect the natural environment.

Is there Still Time to Prevent Cataclysmic Climate Change Before it is Too Late?

As explained in the first section, the window of opportunity is small and closing fast. However, there is reason to believe that cataclysmic climate change can still be prevented until such time as we can finally replace the economics of competition and greed, a.k.a. neo-liberal capitalism, with the economics of equitable cooperation, a.k.a. participatory eco-socialism. What is the answer? What must we do?

Fortunately, even at this late date, even while most economies remain capitalist, we can still prevent cataclysmic climate change before it is too late. However, if we ever expect anyone to listen to us on any subject, we socialists must put our shoulder to the wheel along with everyone else striving to prevent climate change in the here and now before it is too late, rather than sit on the side lines telling everyone else their efforts are in vain as long as capitalism persists.[18]

International Negotiations: Differential Responsibility and Capability

No country can solve the problem of climate change on its own because reducing carbon emissions is a *global public good* which creates a *perverse incentive* for every country to attempt to *free ride* (not reduce its own emissions), but to instead wait and benefit when other countries reduce their emissions. Therefore, to prevent what Garett Hardin famously called this "tragedy of the commons" requires effective international cooperation. What must this look like?

[18] As long as we do put our shoulder to the wheel and work with others to prevent climate change while capitalism continues to rein… without reservation, hesitation, or caveat… there is no reason we cannot *also* explain all the disastrous ways in which capitalism creates and aggravates environmental destruction… *because it does!* And there is no reason we cannot *also* explain why and how a well-designed eco-socialist economy would adequately protect the natural environment… *because it can!***...** even while a *properly designed* eco-socialist economy which is environmentally sustainable could *also* continue to raise living standards for everyone contrary to what many steady-state and de-growth advocates would have people believe.

We need an international agreement to be effective, equitable, and efficient. **Effective** means that by 2050 annual global greenhouse gas emissions must be down *at least* 90% below their level in 1990. **Equitable** means that national responsibilities for emission reductions must be allocated according to countries' *different responsibilities and capabilities*. And **efficient** means that reductions should take place *wherever they cost the least.*[19] What does such an international agreement look like?

- The size and speed of global emission reductions must be chosen based on information provided by climate scientists. What do *they* tell us global reductions must be in order to make it *highly probable* that average global temperatures will *not* rise by more than 1.5 degrees centigrade?
- The distribution of national reductions must be done in accord with *differential responsibility and capability*. The intellectual problem, which went unsolved for decades, was how to make "differential responsibility and capability" of countries operational – i.e. how to *quantify* these concepts.
- Fortunately, climate equity "experts" at EcoEquity and elsewhere have now solved this intellectual problem, and national *"fair shares"* of global emission reductions can now be easily calculated.[20]
- Country governments should be allowed, *if they wish*, to certify emission reduction credits (CERs) for sources within their territories to sell in an international carbon market.
- When calculating whether or not a country has done its fair share to prevent climate change, reduction credits purchased by any entity within the country should be *subtracted* from the country's reduction responsibility, while any credits sold by any entity within the country should be *added* to the country's reduction responsibility.

[19] If readers only consult one source of information about international climate negotiations make it this one: www.ecoequity.org.

[20] See https://calculator.climateequityreference.org/ where one can calculate every country's fair share of emission reductions and compare it with what the country has pledged to do.

NOTHING *h*as repulsed anti-capitalists more than the idea of buying and selling carbon reduction credits. However, as I have proposed them here there are *no compelling objections*. And without an international carbon market the global cost of avoiding climate change will be greatly increased, which means without the kind of international carbon market I propose it will be far less likely that we reduce global emissions enough to avoid climate disaster. If done as I suggest, why will CERs avoid all of the objections critics of an international carbon market have raised?

While it is difficult to determine how many credits to award any individual applicant for emission reductions, *as long as national emissions are capped,* and compliance with national caps are enforced, any mistakes a country government may make when awarding emission reduction credits *cannot* undermine overall global emission reductions, which is all that need concern the international community.

Why won't other approaches in vogue today work? Because charity and guilt are far less powerful incentives in today's world than self-interest, negotiations over *climate reparations, climate debt, technology transfers, and adaptation funds* will continue to yield much less than what is needed and deserved. Therefore, do-gooders will continue to accomplish little by focusing on these strategies. On the other hand, if we instead concentrate on the fight to set national emission caps fairly, self-interest will drive emission sources in more developed countries (MDCs) to purchase certified emission reduction credits from sellers in less developed countries (LDCs) *and thereby provide LDCs the opportunity to achieve economic development in an environmentally sustainable way.*

Of course none of this solves the political problem, which is convincing countries they must take responsibility for their fair share of reductions! But the good news is that delegations from countries which *are* pledging to do their fair share of reductions now confront countries which are *still not* pledging to do their fair share with increasing effect at international climate meetings.

A short detour…. NO! China is not the problem!

Particularly in the US a popular myth is that the big problem is China, which has now passed the US in annual greenhouse gas emissions. *But nothing could be*

further from the truth! Only two countries were responsible for more than 10% of global carbon emissions in 2015 -- China was responsible for 30% and the US was responsible for 15%. So ***yes***, China emitted more in 2015 than the US, and continues to do so. But the population of the US was only 325 million in 2015, and the population of China was 1.4 billion – more than four times as large! The relevant metric when thinking about who is responsible for creating the problem is *emissions per capita*, which in 2015 was only 7.7 tons in China, but was 16.1 tons in the US. Moreover, since greenhouse gases can remain in the upper atmosphere for over a hundred years, what produces climate change is *cumulative* emissions. If we compare cumulative emissions from 1970–2015, the US ranks first, the countries that now comprise the European Union rank second, and China is a distant third -- even though China has a much larger population than either the US or the EU. At the Paris meetings in 2015 the US pledge to reduce its annual greenhouse gas emissions by 2020 *fell short* of its fair share by 4.2 metric tons per person. While the Chinese pledge *exceeded* their fair share of annual greenhouse gas emission reductions by 0.2 metric tons per person. Now back to the big picture. Where do international negotiations stand today?

Good News and Bad News

The pledges from most LDCs are the good news because they have pledged to do their fair share, and if MDCs would do likewise we would be well on our way to a global emission path that reduces the risk of cataclysmic climate change to an acceptable level. The bad news is that *no* MDC has pledged to do their fair share, and the largest MDC, the US, is still, under the Biden Administration, the worst offender. However, the bad news may contain a silver lining.

Many MDCs have pledged to reduce their *domestic* emissions sufficiently. The problem is that MDCs' greater responsibility and capability requires them to pay for more emission reduction than they can accomplish reasonably cheaply through domestic reductions. Fortunately, MDCs can make up for the remainder of their fair share of reductions at a reasonable cost if emission sources in MCDs are allowed to buy CERs from sources in LDCs. A recent study by the Political Economy Research Institute at the University of Massachusetts estimates the cost of both domestic reductions and credits purchased for reductions elsewhere for the

US to do its fair share would be roughly 1.5% of GDP… which is far less than the 3.5% of GDP the US currently spends on its military!

National Green New Deals

Replacing fossil fuels with renewables, transforming transportation, industry, and agriculture to be much more energy efficient, and rebuilding our entire built infrastructure to conserve energy will be an immense historic undertaking. What is needed if we are to avoid unacceptable climate change will be a technological "reboot" on the scale of what the US, Europe, Japan, and the Soviet Union did during WW II. Just as those countries moved quickly from peacetime to wartime production, MDCs must now transform what we should think of as their *Fossil-fuel-estans* into *Renew-conserve-estans*. In the US we have a name for this historic transformation called a *Green New Deal*. And while the Biden Administration has barely begun a GND at the national level,[21] it is already underway in states such as California, Washington, and Oregon where Democratic Governors and state legislatures have managed to launch GNDs in their states even while national legislation is slow to materialize.

Can Beginning Local Work?

As already explained, the free rider problem suggests that any country reducing emissions unilaterally will have little effect on climate change while bearing costs citizens of other countries avoid. The same logic applies to any state in the US acting unilaterally. Worse still, when states act to reduce emissions unilaterally, businesses can easily relocate to other states and take jobs with them. As a matter of fact, designing unilateral state climate policy is largely a matter of avoiding this undesirable effect! For example, the *Clean Energy and Jobs Bill* in Oregon exempted emissions in agriculture and forestry, and gave emission permits away free of charge to manufacturing companies to keep firms who are the major employers in the state from relocating to other states. All of which is why economists have long argued that climate change should be addressed globally and not through local initiatives.

[21] Had Democratic Senators Manchin and Synema not insisted on considerably watering down the initial Biden Administration proposal when the Democrats had a majority in the House as well as a slim majority in the Senate, the US would already be much farther on its way to launching the kind of Green New Deal needed.

However, it turns out that those among us who believed this were overly pessimistic. Despite advice from the dismal science, individual countries have done more voluntarily to reduce emissions than international treaties and agreements have required, and some individual states have done more to reduce emissions than the US federal government requires. *Why?* The answer lies in the most important rule of development economics: Whoever gets ahead of the technological learning curve will prosper. And whoever falls behind will become an economic backwater, and suffer accordingly. If there is a future worth living, that will be a future that looks like *renew-conserve-estan*, not like *fossil-fuel-estan*. Which is why Californians, Oregonians, and Washington state residents are being *smart* to reduce carbon emissions even while other states do not. It is smart to do whatever heavy political lifting is necessary to get started on the transition *to renew-conserve-estan* as quickly as possible. And that is why more states, including some red states like Texas and South Dakota, are following California, Oregon, and Washington State to do just this.

Preventing Climate Disaster: Conclusion

It is fortunate that so many of us economists were wrong. Because it has proven far easier to begin the transition from fossil-fuel-estan economics to renew-conserve-estan economics locally than at the national and international levels. However, preventing climate disaster will require *scaling up* -- *very, very soon!* Eventually it will require a massive federal Green New Deal that goes far beyond what the Biden Administration was able to push through before Democrats lost the House in 2022. It will require similar GNDs in all the other MDCs. And it will require an international agreement along the lines of the one I outlined.

The problem is *not* that we do not know what solutions look like – at the international, national, and state levels. The problem is *not* that we must resort to untested technologies like carbon capture and storage or geoengineering. The problem is simply overcoming the *political obstacles* that stand in our way to launching the program just outlined, both internationally and domestically. And make no mistake: The most important obstacles are the fossil fuel industry, and in the United States, the Republican Party. However, *fortunately,* all this can still be done without replacing capitalism globally or in the United States, because that will take more time than we have to prevent climate change before it is too late.

Postscript

I think the major points argued in this essay have become increasingly obvious to anyone with an open mind. So why do so many leftists continue to insist that only economic system change can prevent climate change, which is not only as I have argued unrealistic, but a clear path to political irrelevance?

(1) *We* anti-capitalists want everyone to believe that what *we want* is the solution to *all* problems… so they will join and work with us to bring about *our* goal -- economic system change. For over two centuries anti-capitalists have appealed not only to those who want economic justice and economic democracy, but also to those who want racial equality, sexual equality, and world peace to embrace the cause of socialism as the solution to the problem that concerns them. And *we* socialists now appeal to the growing millions who want to prevent cataclysmic climate change and protect the natural environment to join the socialist movement as well.

(2) In numerous ways the capitalist economic system *is* responsible for creating climate change and other forms of environmental degradation as well, as many have long argued, and I have summarized here again.

(3) *Only* a well-designed, eco-socialist economy can adequately protect the natural environment, as I have also argued at length in numerous publications, and summarized here again.

But if anti-capitalists continue to stand on the side lines and preach to those fighting to prevent climate change before it is too late that their efforts are in vain because only economic system change can prevent climate change, they will weaken efforts to prevent climate change before it is too late, and by discrediting themselves damage prospects for eventually achieving economic system change as well.

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