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Responding to Economic and Ecological Deficits

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Abstract

Macroeconomic theory was shaken up in the wake of the financial crisis, with neoclassical approaches proving inadequate to analyze or respond to the need for policy action. Despite efforts to return to more conventional macro perspectives, a continuing re-evaluation of economic theory has important implications both for traditional economic concerns such as employment and inflation, and for ecological issues and the climate crisis. An emerging "green Keynesian" approach combines a radical Keynesian analysis with ecological priorities such as drastic carbon emissions reduction.

One important aspect of this reorientation of theory is the analysis of economic and ecological deficits. In the years since the financial crisis, both economic and ecological deficits have increased. This poses a challenge for "green Keynesian" policy. It is therefore necessary to have effective analyses to measure and respond to ecological deficits, as well as policy measures to deal with economic deficits.

This paper proposes a new approach to measuring ecological deficits, and a new perspective on economic deficits and debt. Since there is no single unitary measure for depletion or degradation of different kinds of resources, it is necessary to measure different kinds of deficit for different resources, with a goal of reducing all of these to zero or replacing them with surpluses. The analysis involves exploring the specific economic implications of reducing both ecological and economic deficits, which involves re-conceptualizing economic growth and "degrowth", and provides an alternative to current U.S. policies under the Trump administration, which are contributing to widening both deficits.

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1. Introduction

Macroeconomic theory was shaken up in the wake of the 2008 financial crisis, with neoclassical approaches proving inadequate to analyze or respond to the need for policy action. Despite efforts to return to more conventional macro perspectives, a continuing re-evaluation of economic theory has important implications both for traditional economic concerns such as employment and inflation, and for ecological issues and the climate crisis. One important aspect of this reorientation of theory is the analysis of economic and ecological deficits.

To some degree, the aftermath of the fiscal crisis led to a rebirth of Keynesian theory and policy. In the simplest terms, a classical or neoclassical view is best suited to a stable and growing economy, so that an economy that suffers from severe instability, and as a result plunges into major recession, necessitates a rethinking of classical principles, exactly the process that led Keynes to propose his alternative view in the 1930's. A somewhat similar rethinking was initiated by the financial crisis, but has been left incomplete, especially in terms of its ecological implications.

In the urgent situation of 2008/2009, when the economy of the United States and in many respects the entire world economy hovered on the brink of a new Great Depression, policymakers in the U.S. turned to Keynesian solutions: government action to rescue the banking system and to stimulate the economy through expansionary fiscal and monetary policy on a massive scale, significantly increasing fiscal deficits in the process. European policy makers were slower to adopt such measures, but there is considerable evidence that large-scale stimulus in the United States and in China saved the world economy from a 1930's-type fate.

At roughly the same time as the economic crisis unfolded, awareness was growing of the urgency of environmental problems, especially climate change. One of the features of the economic stimulus program adopted under the Obama administration in 2009 was a significant "green" component, including such measures as investment in energy efficiency, renewable energy, and other green spending. Green stimulus government spending in China was even higher, at over $200 billion (Tienhaara, 2018).[2] Thus the response to the economic crisis also involved at least a partial response to environmental crises as well.

The practical evidence of the success of Keynesian policies, including "green" investment, has not lead to a major change in either macroeconomic theory or practice. The European Central Bank eventually followed the lead of the U.S. Federal Reserve, adopting monetary expansion and "quantitative easing", expanding the monetary base and implicitly accepting that classically-oriented policies of austerity were a mistake, but there was no rush in the economics profession either in the U.S. or Europe to revise standard economic theory. Once economies had recovered significantly enough to reduce the immediate crisis and risk of collapse, it seemed that standard approaches were once again good enough to analyze economic developments, with perhaps a grudging nod to the temporary need for fiscal and monetary stimulus. Potentially larger-scale green Keynesian polices, such as extensive investment in the solar and wind power, especially in high-potential areas such as southern Europe or the U.S. Midwest, South and Southwest, have not been pursued. Only recently have such potential policies gained renewed attention with discussion of a "Green New Deal" in the U.S. Congress.

[2] http://www.wri.org/resources/charts-graphs/green-stimulus-spending-country.

Some critics have argued that the "green" Keynesianism approach presents an apparent paradox: if green Keynesian policies are effective at promoting economic growth they will likely be harmful to the environment, yet if they are environmentally effective they will not create much growth (Blackwater, 2012). In response to this, some have argued for policies oriented towards "degrowth". But a better approach to resolving this paradox is to think about how economic activity can be specifically directed with Keynesian policies.

Instead of thinking of consumption (C), investment (I), and government spending (G) in the aggregate, we can divide each of these terms into a component that is resource- and energy-intensive and another that is more environmentally benign. Thus, it is possible to achieve a growing economy, measured in terms of employment and well-being, while reducing throughput—the flow of inputs into the economy and outputs of wastes and pollution into the environment. As I have suggested:

> We can distinguish between those macroeconomic aggregates that should be strictly limited – resource-intensive consumption and investment, and energy-intensive infrastructure – and those that can expand over time without negative environmental consequences. The latter would include large areas of health, education, cultural activity, and resource- and energy-conserving investment. . . there is plenty of scope for growth in economic activity concentrated in these categories, without growth in resource throughput, and with a significant decline in the most damaging throughput, that of carbon-intensive fuels (Harris, 2013: 72).

There is an extensive debate on the possibility of achieving "absolute decoupling" – reducing overall resource inputs, specifically carbon-based fuels, while "growing" the economy. Advocates of "degrowth" argue that absolute decoupling is unlikely to be possible, meaning that consumption must be reduced if carbon reduction targets are to be achieved (Victor, 2008; Jackson, 2009; Martínez-Alier, Joan et al. 2010; Kallis et al., 2012; Kallis, 2018). But regardless of whether we anticipate only "relative decoupling" – reducing the carbon intensity of the economy – or absolute decoupling, some form of green Keynesian policies will be essential to redirect economic activity away from a carbon-intensive path (Pollin, 2015, 2018).

The use of Keynesian policies, whether conventional or "green", raises the issue of deficits. Keynesian policy, of course, often involves fiscal deficits. A well-established conservative critique of Keynesianism claims that it attempts to achieve short-term stimulus at the cost of increased deficits and debt, which will ultimately damage the economy, most likely through inflation but also possibly through an eventual sovereign debt crisis. Numerous predictions of ruinous inflation by conservative critics of the Obama stimulus failed to materialize, but the issue of deficits and long-term debt remains an important issue.

Another kind of deficit is also relevant to green Keynesian analysis and policy. Ecological deficits, not a traditional concern of mainstream economics, have been introduced as an important topic by measures such as the Genuine Progress Index (Talberth et al., 2007; Talberth and Weisdorf, 2017) and ecological footprint analysis (Wackernagel and Rees, 1996). These ecological economics perspectives emphasize that economic growth is typically accompanied by increased resource and environmental demands, often in excess of regional or planetary capacity.

Just as a traditional deficit arises from government spending in excess of its revenues, an ecological deficit is created when an economy withdraws resources in excess of the ecosystem's capacity to renew them, or overloads the ecosystem with waste outputs in excess of its ability to absorb them. There are various ways of measuring such ecological deficits, discussed further below. The accumulation of ecological deficits leads to long-term ecological debts, manifested in such phenomena as declining soil fertility or increased atmospheric carbon accumulation. A prime goal of green Keynesianism must be to reduce or eliminate ecological deficits.

In the years since the financial crisis, both economic and ecological deficits have continued in the United States and many other economies, leading to increasing long-term debt burdens. This poses a challenge for "green Keynesian" policy. It is therefore necessary to have effective analyses to measure and respond to ecological deficits, as well as policy measures to deal with economic deficits.

This paper proposes a new approach to measuring ecological deficits, and a new perspective on economic deficits and debt. The analysis involves reconceptualizing economic growth and degrowth and provides an alternative to current U.S. policies under the Trump administration, which are contributing to widening both deficits.

2. Measuring ecological deficits

The best-known measure of ecological deficits is the ecological footprint concept. This measures the use of ecological assets "including plant-based food and fiber products, livestock and fish products, timber and other forest products, and space for urban infrastructure" and compares it to biocapacity measured in standardized hectares of global average productivity.[3]

When asset use as measured by the ecological footprint exceeds available biocapacity, there is an ecological deficit, for a country, region, or the world as a whole. The global ecological deficit is estimated at 70% of global biocapacity, or as the Footprint Network more dramatically puts it, "humanity uses the equivalent of 1.7 Earths to provide the resources we use and absorb our waste."

A basic principle for ecological macroeconomics should be that resource use should not exceed biocapacity, and the ecological footprint analysis broadly indicates that this principle is being violated for the world as a whole, as well as for major countries and regions including as the United States, the European Union, and China. A more disaggregated view of the ecological footprint, however, reveals some serious shortcomings of the measure.

The footprint analysis divides land (and water) types into five major categories: built-up land, cropland, fishing grounds, forested land, and grazing land, with an additional category for carbon emissions, based on a theoretical estimate of how much land would be required to absorb carbon emissions. The methodology used calculates "global hectares" based on world average biological productivity for each type of land use for a given year.

[3] See https://www.footprintnetwork.org/our-work/ecological-footprint/

One result of this methodology is that the biocapacity and footprint for the category of cropland are identically equal, indicating neither surplus nor deficit. The identity is left unchanged by either expansion of cropland area or change in cropland productivity. For example, a 10% increase in global average cropland productivity would increase both cropland biocapacity and footprint by 10%, cancelling out exactly. The same notional equivalence is applied to built-up area: its "productivity" is considered to be exactly what is needed for the functions of urban or suburban use. For fishing grounds, forest products, and grazing land the total global biocapacity in each case exceeds the footprint of human use (see Table 1).

This breakdown of land use means that if we sum up total global biocapacity and total global footprint *excluding* carbon emissions, the result is a global surplus: global biocapacity for 2014 was approximately 12.2 trillion standard hectares, while footprint requirements were approximately 8.2 trillion hectares, resulting in a net global surplus of 4 trillion hectares. But when the carbon category is included, this surplus turns into a deficit of 8.2 trillion hectares (Table 1). Thus, the global ecological deficit, as estimated by footprint analysis, is entirely due to excessive carbon emissions. The forest, fishing, and grazing land categories each show a surplus, while cropland and built-up land show an exact balance as a necessary result of the methodology employed.

Table 1: Global Ecological Footprint and Biocapacity, 2014[4]

2014 TRILLION GLOBAL HECTARES	CARBON	BUILT-UP LAND	CROPLAND	FISHING GROUNDS	FORESTS	GRAZING LANDS	TOTAL without carbon	TOTAL with carbon
BIOCAPACITY	0	0.5	4.0	1.1	5.2	1.5	12.2	12.2
FOOTPRINT	12.4	0.5	4.0	0.7	2.0	1.1	8.2	20.6
SURPLUS/ DEFICIT	-12.4	0	0	0.4	3.2	0.4	4.0	-8.4

For purposes of ecological macroeconomics, this approach has serious problems. Taken at face value, it indicates no significant ecological problems with cropland, forest land, grazing land, and fisheries, since each category shows either a surplus of biocapacity over human use or, in the case of cropland, an exact equivalence. Conceivably deficits in these categories could arise at some point in the future if demand for forest products, fishery products, or grazing land grew significantly; but for cropland there will never be a deficit. Even if, for example, soil depletion cut agricultural productivity in half, this would simply reduce both output and biocapacity by the same amount, still giving an exact equivalence between the two.

The forest measurement is also problematic, since it compares total forest area to annual demand for forest products, converted into area terms via the global hectares methodology. This means that Brazil, for example has a large surplus of forest biocapacity, which in turn drives a large surplus in its ecological footprint as a whole. But this does not mean that there is no significant deforestation occurring in Brazil. It only indicates that demand for forest products in a single year is not sufficient to deforest the entire Brazilian Amazon, thereby confusing stocks (of standing forest biomass) and flows (of forest biomass annual harvest). Clearly, this is not the measure we should seek to indicate ecological deficits in forest management.

[4] http://data.footprintnetwork.org/#/countryTrends?cn=5001&type=BCtot,EFCtot

Even the carbon measure, which is what drives the "1.7 Earths" overall planetary deficit, has a significant problem. Suppose that it was possible, at some point in the future, to reduce global carbon emissions by 67%. If the other land use and biocapacity categories remained at about the same level, the deficit due to the remaining carbon emissions would be exactly offset by the surplus in forests, fishing, and grazing lands. This would eliminate overshoot in the global footprint, making it appear that resource use on the planet as a whole was sustainable (i.e. we would need only one Earth to supply human needs). But this result would conceal both the continuing increase in carbon accumulation and all other problems associated with deforestation, cropland and grazing land degradation, water overdraft, etc.

The ecological footprint analysis has played a useful role in drawing public attention to the concept of planetary overshoot, but in order to have a reliable indication of actual ecological deficits, we need more disaggregated measures, using different principles and methodology.

Rather than using total biocapacity as a standard, the operative principle for an ecological deficit measure should be that withdrawal or demand for resources or waste absorption should not exceed regenerative capacity in any given period, consistent with ecological economics principles articulated by Herman Daly (Daly, 1996). Since there is no single unitary measure for depletion or degradation of different kinds of resources, it will be necessary to measure different kinds of deficit for different resources, with a goal of reducing all of these to zero or replacing them with surpluses. A basic list of important areas of ecological deficit should include:

1. **Carbon.** Human generated carbon emissions in excess of natural absorption capacity constitute an ecological deficit that needs to be reduced to zero (or to a surplus, meaning net carbon absorption). This is the most obvious and urgent ecological deficit, and must serve as a fundamental guide to macroeconomic policy.

2. **Forests and Wetlands.** No net loss of forests and wetlands is a minimal goal. But in order to make progress towards the carbon goal, it will almost certainly be necessary to expand forest and wetland area, requiring protecting existing forests and wetlands as well as reforestation of degraded areas and overall expansion of forest and wetland area. Different types of forest need to be accounted for separately, since replacing tropical forest with second-growth or plantation forest, or with additional forested area in temperate zones, represents a net ecological loss.

3. **Soils.** Degradation of soils can be measured by loss of nutrients and carbon. This is a more appropriate measure than agricultural productivity, since increases in short-term yields can mask long-term degradation. Increasing soil carbon is also likely to be essential to the atmospheric carbon emissions reduction goal, so this also is an area where eliminating deficits is not sufficient; we need to move to surplus, in the sense of building up soil carbon and other nutrients.

4. **Fisheries.** Numerous global fisheries are in decline; to meet ecological criteria fisheries need to have stable fish biomass and ecological balance. Note that in theory some reduction in total fish biomass below maximum natural levels is acceptable, provided that the reduced level is stable and provides for sustainable yield over time. But most fisheries are already at or below sustainable yield levels.

5. **Grazing Lands.** As with soils, the quality of grazing lands needs to be maintained or improved over time. Excessive grazing and degradation of grazing lands constitutes an ecological deficit.

6. **Water.** Depletion or degradation of groundwater is an ecological deficit, as is sustained water pollution. Water withdrawals need to be at sustainable levels, taking into account reduced rainfall or snowpack resulting from climate change.

7. **Biodiversity.** Species loss is a clear ecological deficit. It is not possible under current circumstances to reduce species loss to zero, but that goal needs to be approached as much as possible. This objective, of course, is interrelated with deficit reduction goals for forests, wetlands, fisheries, and land use in general. Built-up land will inevitably increase over time, but specific locations need to be restricted to protect biodiversity; the same is true for expansion of agricultural land and grazing lands. Agricultural and grazing techniques are also highly relevant to biodiversity, with agroecological techniques being essential.

This listing is certainly not exhaustive, but the use of these deficit measurements to guide macroeconomic and industry-level policy would be a huge improvement over current practices, and has significant implications for economic theory, including the analysis of more traditionally measured deficits and debt.

3. Assessing economic deficits

Concern over economic deficits has traditionally been the province of conservatives, who criticize Keynesian willingness to engage in government spending, but recent developments in the U.S. have turned the usual logic on its head. The large individual and corporate tax cuts passed by the Trump administration and the Republican Congress in December 2017 brought warnings from more Keynesian-oriented economists that stimulus was being applied at the wrong stage of the economic cycle, and the Congressional Budget Office projected that, after falling during the later years of the Obama administration, the deficit was once again set to soar over $1 trillion by 2019 (CBO, 2018).

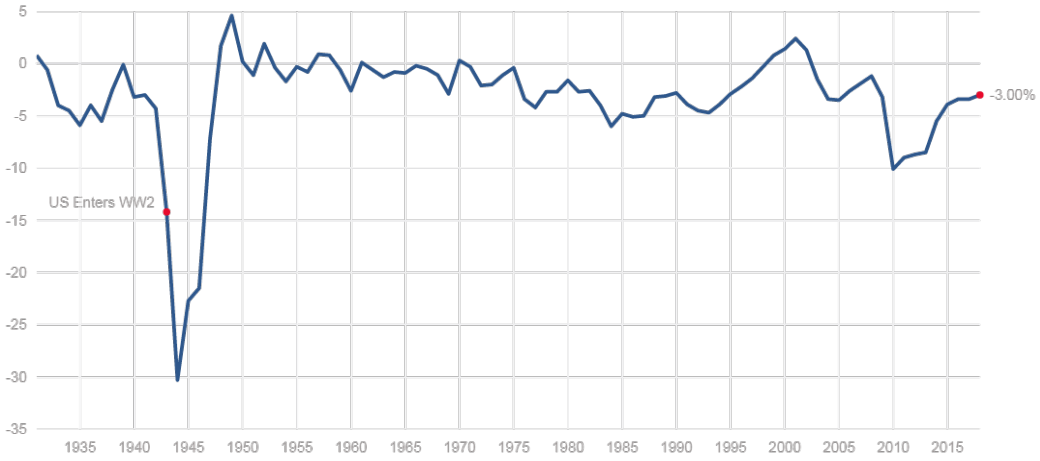
How can we evaluate this situation? Some Keynesian economists advocate a moderate approach. According to Jason Furman and Lawrence H. Summers:

> Long-term structural declines in interest rates mean that policymakers should reconsider the traditional fiscal approach that has often wrong-headedly limited worthwhile investments in such areas as education, health care, and infrastructure. Yet many remain fixated on cutting spending, especially on entitlement programs such as Social Security and Medicaid. That is a mistake. Politicians and policymakers should focus on urgent social problems, not deficits. But they shouldn't ignore fiscal constraints entirely . . . Unlike in the past, budgeters need not make reducing projected deficits a priority. But they should ensure that, except during downturns, when fiscal stimulus is required, new spending and tax cuts do not add to the debt. (Furman and Summers, 2019.)

Another rule of thumb that has often been used by Keynesian analysts to evaluate deficits and debt is that deficits, measured as a percent of GDP, should on average be no higher than the rate of economic growth. While giving some flexibility for stimulatory spending or tax cuts, this rule would keep the debt/GDP ratio approximately constant.

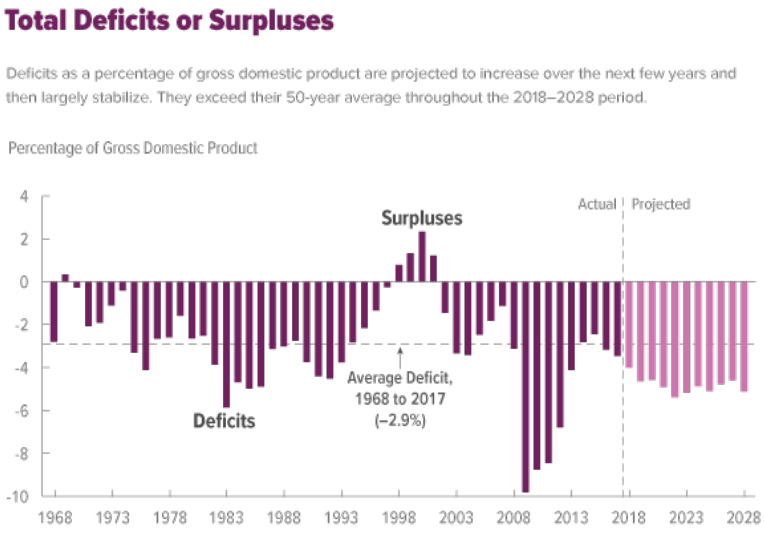
After running large deficits during the economic crisis and recovery period of 2009-2014, leading to a significant increase in the debt/GDP ratio, the Obama administration appeared to be more or less back in accordance with this rule by 2015, with deficits of $500-600 billion, or about 3% of GDP, in fiscal years 2015 and 2016 (Figure 1). But the Trump administration has moved rapidly back to larger deficits, with the deficit currently on track for over $1 trillion or about 5% of GDP, by 2019 (Figure 2).

Figure 1: U.S. Federal Deficit as a Percent of GDP



Source: White House Office of Management and Budget, *Summary of Receipts, Outlays, and Surpluses or Deficits as Percentages of GDP,* 2016.

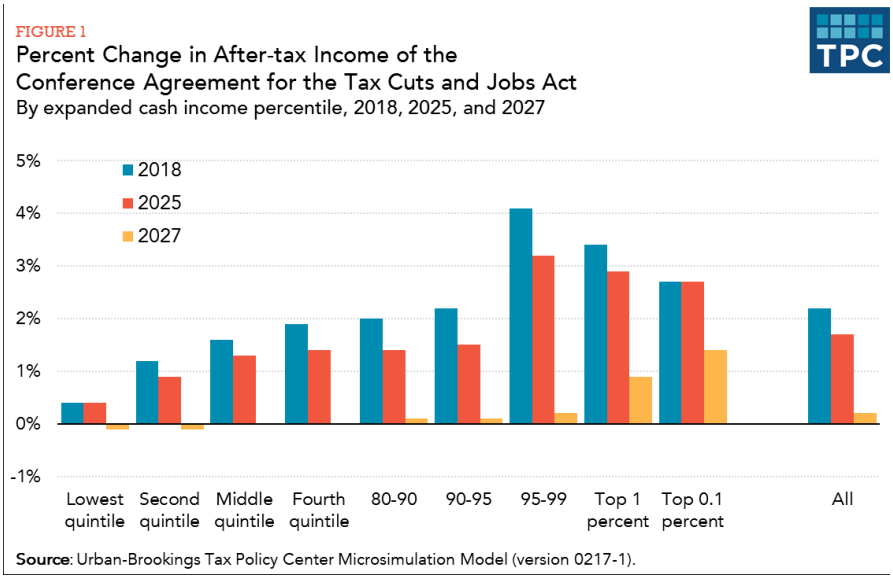
Figure 2: Projected Federal Budget Deficits through 2028



Source*:* Congressional Budget Office, *2018. CBO's Projections of Deficits and Debt for the 2018–2028 Period.*

What are the problems with increasing deficits and a rising debt/GDP ratio? One important issue is that high deficits and debt constrain infrastructure investment. This is especially the case with the Trump tax cuts, which benefit primarily upper-income taxpayers and large corporations (Figure 3). While increasing inequality, they also create a situation where social spending and infrastructure investment can only be achieved at the cost of even higher deficits.

Figure 3: Distributional Impact of the 2017 Individual Tax Cuts



Source: Tax Policy Center, *Distributional Analysis of the Tax Cuts and Jobs Act*, 2017.

If we adopt goals of stabilizing the debt/GDP ratio, expanding infrastructure investment including green investment, and promoting greater income and wealth equity, it will be essential to repeal most or all of the 2017 tax cuts. Some reductions in personal taxes that benefit primarily lower and middle-income taxpayers would be consistent with the goal of reducing inequality, but overall there is a clear need to raise significantly more revenue to address social and environmental goals.

The goal of stabilizing the debt/GDP ratio would become easier with more rapid economic growth (unconvincingly promised by the Trump administration). But on the other hand a move towards a slower-growing economy would make the deficit reduction goals tougher, and the no-growth economy environed by Daly, Victor, Jackson, and others would require a balanced budget as an eventual requirement for a steady state economy (Daly, 1996; Victor, 2008; Jackson, 2009). This indicates a likely conflict between the goals of reducing economic and ecological deficits. We therefore need to explore the specific economic implications of reducing ecological deficits.

4. Policies to reduce ecological deficits

What will it take to reduce or eliminate ecological deficits? The task is huge, but it does not necessarily involve high economic costs in all cases. Most ecological deficits arise from the

exploitation of "free" or low-priced natural resources. Putting a proper price on these resources can be consistent with both good economic theory and sound ecological principles, and generally implies a shift in economic techniques and activities rather than an absolute cost. In some cases, greater efficiency in resource use can save money as well as reduce ecosystem impact. In terms of the specific ecosystem deficits identified above, some policy options include:

1. **Carbon:** as noted above, an elimination of the atmospheric carbon deficit implies reducing net carbon emissions to zero, or possibly below zero to reduce atmospheric accumulations. At a minimum, this requires a complete transition away from carbon-based energy to energy efficiency and renewable energy. But it also almost certainly involves significant additional carbon absorption by forests, soils, and wetlands. Some aspects of this massive project will have major economic costs, specifically the infrastructure investment needed to create a new energy and transportation economy. Some of these costs will be borne by private companies, responding to economic incentives such as carbon taxes or cap-and-trade programs. But some will require government investment, which could in theory be offset at least in part by carbon tax revenues. Since carbon taxes are regressive, a portion of the revenue stream associated with them needs to be channeled into individual per capita rebates (which have the effect of changing the net tax impact from regressive to progressive or at least proportional), or into social investment that primarily befits lower-income individuals and families, such as health care and education. To the extent that necessary infrastructure investment is not covered by remaining carbon tax revenues, it will need to be funded out of general government budgets.

2. **Forests and Wetlands:** Protecting existing forests and wetlands and expanding forested area through reforestation is more a matter of implementing good policies than of major government expenditures. There may even be net positive government revenues from moving away from policies that currently subsidize exploitation of public lands through low access fees.

3. **Soils:** Agroecological practices that build up soil carbon and nutrients also do not necessarily involve large government expenditures. To the extent that costs are involved, for example through subsidies for organic and agroecological farming practices, these may be covered through redirecting existing, mostly ecologically damaging, subsidies currently favoring industrial agriculture. Another potential funding stream is certified carbon credits for carbon-storing farming and forestry practices, which can be sold to industries subject to cap-and-trade schemes. The latter raises institutional issues, specifically the need to avoid rewarding middlemen and land speculators at the expense of smallholders, but these issues are not unresolvable.

4. **Water:** In almost all areas of the world, water management and groundwater overdraft and pollution is a major issue, and in some areas it is a critical limiting factor on economic development. Climate change is likely to make these issues more pressing. But as with forests and soils, the necessary policies involve reform of current management strategies in order to conserve water, promote efficient and equitable water use, and prevent pollution. Significant expenditure is involved for water infrastructure, and since water privatization has a clear record of serious problems with inequity and corporate water overdraft, this area is an important aspect of infrastructure investment. Water

pricing, if appropriately managed for equity using increasing block rates, can provide some necessary revenue.

5. **Fisheries, Grazing Lands, Biodiversity:** All of these require sustainable management techniques and protection of ecosystems. Large expenditure is likely not necessary, and as with agriculture and forests, the redirection of current perverse subsides and the imposition of appropriate license fees, replacing e.g. giveaways of public land for grazing, can generate some additional revenue. Effective species and ecosystem protection requires limits on economic activity, which carry an implicit cost in terms of reduced production and possibly associated tax revenues, but direct government expenditures, for example for land acquisition, are probably not large.

In summary, the elimination of ecological deficits requires massive reform of current policies and significant modification of economic production techniques, but not necessarily a major increase in public expenditure, except for necessary infrastructure investment. This will be significant especially for restructuring energy systems. Some market-based reforms can shift costs within the private sector, in accordance with the principle of internalizing externalities, and some current government expenditures can be redirected from ecologically damaging to ecologically restorative functions.

5. Policies to control economic deficits and debt

As has been noted, the politics of deficit management has undergone a shift in recent years. Deficit alarmism has historically been used by conservatives primarily to call for cutbacks in social spending and "entitlements" (a loaded term intended to convey that fundamental social security and medical care are a kind of freeloading). Genuine concern about the need to control deficits would take a different form. As noted above, a reasonable initial goal would be a deficit of no more than about 3% of GDP, gradually reduced over time. This might be achieved by various measures on both the spending and revenue sides of the budget:

Spending: Major cuts in essential social programs such as social security, Medicare, and Medicaid in the U.S. and comparable programs in other countries, should be ruled out. If anything, spending in these areas should increase to meet social needs. Cost controls in the medical area, however, can make a big difference in the rate of increase without necessarily impacting the quality of health care, by shifting emphasis to preventative programs and moving towards single-payer insurance. Greater efficiency in other areas such as military spending can also reduce overall expenditure.

The distribution of Federal expenditures, with Social Security, Medicare, Medicaid, and military expenditure greatly exceeding other discretionary expenditure, means that other than improved efficiency there is little opportunity for cutbacks in spending without doing damage to essential government functions. One area that could potentially be reduced is agricultural subsidies, but this represents a small portion of the overall budget, and as noted above there may be a need to shift these subsidies rather than eliminating them, to encourage more agro-ecologically sound farming practices or land conservation.

Revenue: Clearly, given limited opportunities for expenditure reduction, reducing deficits must depend on increased revenues. In the U.S., this implies at a minimum reversing most of the 2017 tax cuts, especially those for upper-income individuals, and closing loopholes such as the infamous carried interest provision. There is room for continuing debate about appropriate corporate tax rates, but it is notable that earlier discussions of lowering corporate tax rates proposed lower rates as a tradeoff for closing loopholes; in fact, the 2017 tax package did little or nothing to close major loopholes.

Another opportunity for increased revenue is a carbon tax with rebate. A carbon tax can be made progressive or at least proportional without rebating all revenue, meaning that some net revenues received from upper-income (and high-energy consuming) taxpayers could be available for deficit reduction. Other options include a financial transaction or "Tobin" tax, set at a very low rate but with significant revenue potential due to the high volume of financial transactions, increased estate taxes, or introduction of a wealth tax.

The main reason for the currently increasing Federal deficits in the U.S. is the 2017 tax cut package, not rising "entitlement" spending (Baily et al., 2018). Therefore the reversal of these tax cuts is critical to economic deficit reduction, as well as to enabling the increased infrastructure spending that will be necessary to repair crumbling bridges, water systems, etc., to promote a renewable energy transition, and to reduce ecological deficits. Other sources of revenue consistent with a goal of reducing inequality will also be required for effective deficit reduction.

6. Growth, degrowth, and deficits

It is easier to manage deficits in a growing economy. But this in itself is not a case for promoting economic growth. Advocates of "degrowth" suggest that technological progress and shifts to less carbon-intensive energy sources will not be sufficient to meet necessary carbon reduction goals. Therefore, they argue, reduction in overall consumption is necessary (Hickel, 2018). Peter Victor and Tim Jackson have made a case for "Managing without Growth" and "Prosperity without Growth" (Victor, 2008; Jackson, 2009).

But the picture is somewhat more complex than simply a need for "degrowth". For example, if we examine the actual requirements for reducing carbon emissions, ultimately to zero, we find very significant potential for reductions through energy efficiency and a shift to renewable sources. I have proposed a "middle way" between growth and degrowth, including aspects of technological modification and aspects of growth reduction (Harris, 2009).

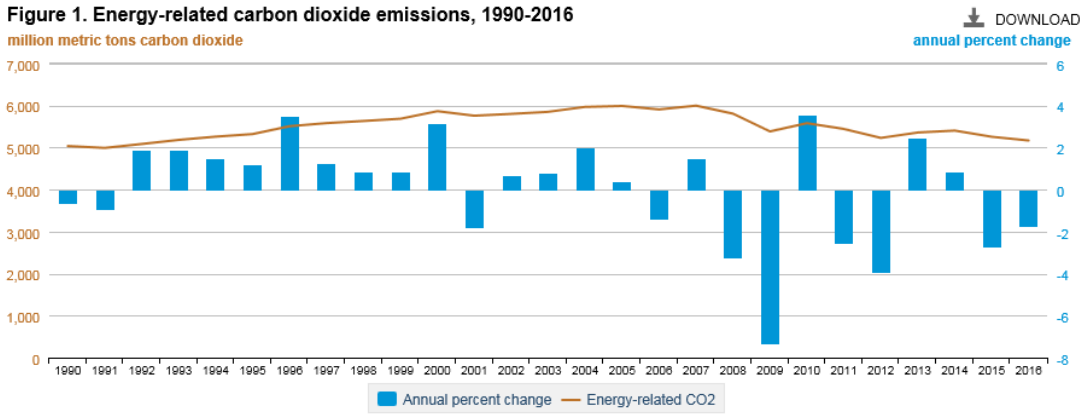
We might call this approach the 2% solution, based on the following principles:

- reduce overall energy use by 1% of current energy consumption per year;
- increase the share of renewables by 1% of current energy consumption per year.

Neither of these sounds like an impossible goal for currently developed economies. U.S. primary energy consumption has been approximately stable for the last 20 years, and has actually declined over the last 10 years, despite increasing population, while renewable energy production

has increased its share by about 5% of total energy production over the last ten years.[5] As a result, U.S. CO_2 emissions fell by 14% over the period 2007-2016 (Figure 4).

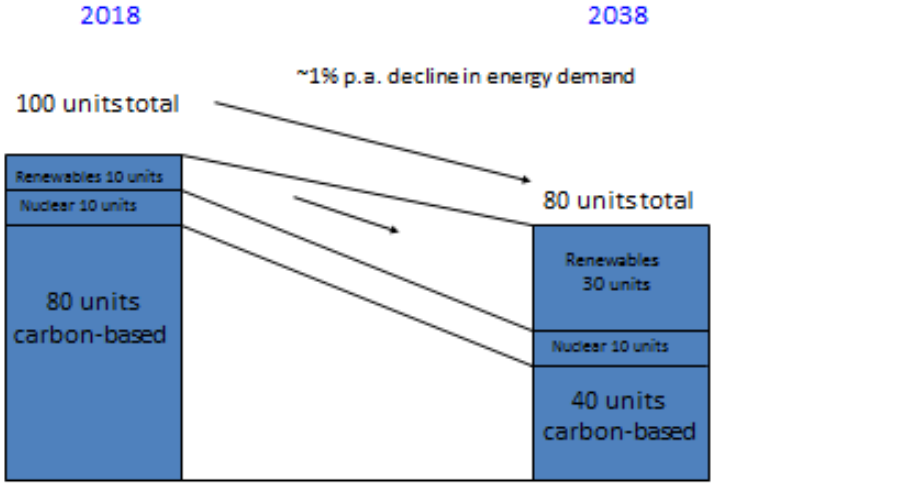
Figure 4: U.S. Energy-Related Carbon Dioxide Emissions



Source: U.S. Energy Information Administration, *Monthly Energy Review*, August 2017.

Thus, a modest increase in these current rates would lead to a net reduction in fossil fuel use of about 2% of total current energy use per year, resulting in a reduction of 50% in about 20 years (since current fossil fuel use is about 80% of total U.S. energy use), and a reduction to zero in about 40 years. This is achieved both by "lowering the ceiling" – reducing total energy use – and "raising the floor" – increasing the percentage of renewables – thereby squeezing the fossil fuel consumption between these two. Of course, the difficulty of achieving these targets would increase as we approached 100% reduction – but at least the first half of this trajectory seems relatively easily within reach (Figure 5).

Figure 5: Carbon Reduction Scenario with Efficiency and Renewables



[5] https://www.statista.com/statistics/265571/primary-energy-consumption-in-the-united-states/; https://www.eia.gov/totalenergy/data/monthly/pdf/sec2_3.pdf; https://www.eia.gov/totalenergy/data/monthly/pdf/sec1_5.pdf

A concern with increased energy efficiency is the "rebound effect" – if it becomes more efficient, and therefore cheaper, to operate a car or air-conditioner per mile or per degree, people will tend to increase their consumption in response. This effect would tend to reduce, and possibly even completely counteract, the impact of technological progress in cutting total energy use (Sorrell, 2008; van den Bergh, 2011; Wallenborn, 2018). But this problem can easily be dealt with, at least in theory, by increasing the price of energy to compensate for the efficiency improvement, so that the net cost per mile or per degree remains the same. This strengthens the case for a carbon tax or cap-and-trade system. The barriers to implementing this are political, not economic.

For developing economies, overall energy use is certain to increase over the coming decades. But for these economies, the potential for reducing the rate of increase through increased efficiency is very great, since many developing economies currently have highly inefficient energy use. The potential for renewables in these economies is also great, with Bloomberg New Energy Finance predicting that wind and solar will account for 64 percent of new generating capacity to be installed over the next 25 years (Bloomberg, 2016).

A similar logic may apply to other ecological deficits. It is true that these deficits are driven by increasing population and growth in resource use, putting pressure on forests, water, soils, fisheries, and other ecosystems. But there is considerable opportunity to reduce the deficits by efficient resource use and regenerative management.

A comprehensive study of global resource use found that best practices for efficient resource use could reduce projected 2050 resource use levels by about 50% (Dittrich et al., 2012). As with carbon emissions, further reductions are more difficult, and growing population and consumption mean that resource use levels trend upward even with high efficiency. To achieve stable or declining levels of resource consumption requires both low population growth, with global population stabilization by about 2050, and some consumption reduction in high and medium consumption countries. Consumption reduction does not necessarily mean lower standards of living. A shift towards more leisure time and low-resource forms of consumption can be compatible with improved quality of life.

There is clearly a need for major changes both in production techniques and in the composition of consumption, with overall reduction of consumption in resource-intensive areas (e.g. meat-eating, air travel) but also the possibility for expansion of human services such as health care and education. While eliminating ecological deficits will ultimately require both population stabilization and reduction in some kinds of consumption, very significant progress can be made without requiring drastic degrowth. The infrastructure investment required for a transition to renewable energy and ecologically sustainable production can in fact be viewed as a new kind of economic growth, with huge employment-creating opportunities (Global Commission on the Economy and Climate, 2018).

7. Towards consistent and effective policies, and a new macroeconomics

Macroeconomics for the twenty-first century requires a reorientation away from standard growth-oriented models, but does not necessarily require an overall commitment to degrowth. As Robert Pollin has argued, a "Green New Deal" could dramatically reduce carbon emissions

while increasing employment, without requiring drastic reduction in consumption (Pollin, 2015, 2018). Revised macroeconomic goals should include:

- Rapid reduction of carbon emissions through investment in energy efficiency and renewables, and through increased carbon storage in forest and soils.
- Adaptation to ecological limits to growth, including carbon limits but also sustainable use limits related to water, land, forests, fisheries, and other ecosystems.
- Limiting both economic and ecological deficits, with the ultimate goal of reduction to zero.
- Revenue generation through increased taxes on upper incomes and corporations, carbon tax with partial rebate, and financial transactions tax.
- Using "green" Keynesian policies for infrastructure investment and development of renewable energy technologies.

Economies based on these principles will look different, with more emphasis on human services and less on resource-intensive goods production, significantly lower overall energy use and a vastly expanded renewable energy infrastructure. But there is no reason that a combination of existing policy tools and newer ecologically-oriented policies cannot promote prosperity and increased employment opportunities, as well as stabilization of both economic and ecological systems. There is an increasing theoretical literature on the overlap of ecological, Keynesian, and post-Keynesian economics and the development of ecological macroeconomic models (Kronenberg, 2010; Fontana and Sawyer, 2016; Taylor, Rezai, and Foley, 2016; Hardt and O'Neill, 2017; Kemp-Benedict, 2018).

Macroeconomic theory developed along these lines can provide better guidance than conventional approaches to understanding and responding to problems of economic and ecological deficits. Constructive policies for reducing ecological deficits do not necessarily have to increase economic deficits, but increased tax revenues from progressive taxes consistent with promoting income equity will be essential.

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