Macroeconomic Policy in a Resource-Constrained Economy:
The Insight of Harrod's Growth Model

by

Alfredo R.M. Rosete* and Hendrik Van den Berg**

Abstract

After the 2007-2009 financial collapse, most mainstream economists supported pro-growth macroeconomic policies. Heterodox economists have differed only in that they called for more active government intervention, rather than quantitative easing and neoliberal reforms, to restore GDP growth. The lack of macroeconomic models that incorporate environmental constraints on growth has contributed to this bias in economic analysis. In this paper, we advocate the revival of Harrod's dynamic macroeconomic model, which provides insight into how to conduct macroeconomic policy in a resource-constrained economy and society. Specifically, resource shortages can push the economy into recession, and traditional macroeconomic policies are unlikely to provide guidnce for putting an economy on a full employment growth path. The model shows that full employment can be achieved in a resource-constrained economy, but this goal most likely will require non-traditional macroeconomic policies to actively restructure the economy towards low resource throughput production and to spur resource-saving technological change. We briefly review alternative policies in case such restructuring and innovation are not feasible in the short term.

Key words: Macroeconomic policy, Harrod model, Ecosystem

JEL Classifications:

*Assistant Professor Warren Wilson College, 701 Warren Wilson, Rd. CPO 6304, Swannanoa, North Carolina, USA 28778 ;
**Professor Emeritus, University of Nebraska, Lincoln, NE 68588-0489, USA; Currently Visiting Instructor, Department of Economics, University of Massachusetts Amherst, 217 Gordon Hall, 418 North Pleasant St., Amherst, MA 01002; hvandenberg@econs.umass.edu.

Macroeconomic Policy in a Resource-Constrained Economy
The Insight of Harrod's Growth Model

The bad news is that evidently things still have to get much worse before we will muster the courage and clarity to try to make them better. The "good news" is that things are indeed getting much worse—thanks to our mistaken belief that growth in GDP and its close correlate, resource throughput, must, even in a full world, always increase wealth faster than illth.

Herman Daly (2014, p. 238)

I. Introduction

During the 2007-2009 global economic recession, economists and policymakers debated how to restore post-World War II growth rates. Post Keynesians argued for active policies to expand aggregate demand and directly increase employment, while many mainstream macroeconomists advocated austerity and other neoliberal policies to reduce government debt, shrink government through privatization, and deregulate markets in order to make economies more "competitive?" This paper argues, however, that all sides of the policy debates have committed a fundamental error: scientific evidence makes it clear that it is impossible for any macroeconomic policy to "restore" or "revive" economic growth as we have experienced over the past two centuries. A continuation of energy- and natural resource-intensive economic growth would almost certainly be catastrophic for human society.

Further shifts towards neoliberal policies continue in the U.S. and Europe, largely supported by mainstream macroeconomic analysis. In the United States, a mixture of austerity (government budget cuts, dismantling of the social safety net, privatization of public assets, lowering of labor costs) and stimulative economic policies (deficit-expanding tax cuts and very ag-

gressive central bank injections of reserves into the banking system) have "restored" some traditional economic growth, but ten years after the *Great Recession* wages remain stagnant, labor force participation rates remain well below earlier levels, and nearly all gains from growth have gone to the highest income earners. In Western Europe, economic growth has been near zero, unemployment exceeds 10 percent, and government budget deficits are remain high. Less noticed is the fact that even the weak economic growth since 2009 has continued to cause carbon emissions and environmental degradation to increase. The 400 mark in carbon particles per million in the atmosphere was surpassed in 2017, in defiance of stated government policies to reduce carbon emissions and the scientific consensus that the atmospheric temperature can only be stabilized if particles per million remain below 350.

The failure of macroeconomists is, in part, attributable to the fact that macroeconomic models across the various schools of thought largely ignore the role of the natural environment within in the process of economic growth. In this paper, we argue that we do have an alternative model that can incorporate environmental constraints on economic growth and prescribe realistic full employment policies for an environmentally-constrained economy. This model is Harrod's (1939, 1948) dynamic model.

II. The Ecological Consequences of Growth that Economists Choose to Ignore

Earth's ecosystem is under severe pressure from the growth of the human population and its economic and social activity. Scientific evidence clearly shows that humanity's *footprint* on earth is causing rapid climate change, ocean acidification, mass extinction of living species, disappearing landcover, degradation of freshwater resources, disruption of the nitrogen and phosphorous cy-

cles, and many other transformations of our ecosystem.[1] Wackernagel and associates (2002) estimated that humanity's exploitation of the Earth's resources corresponded to 70 percent of capacity in 1961, but grew to 120% in 1999. The World Wildlife Fund (2008, p. 2) estimated that "humanity's demand on the planet's living resources...now exceeds the planet's regenerative capacity by about 30 percent." Humanity pushed natural resource use beyond the level at which the Earth's ecological system can sustainably replenish itself some time during the 1980s.

Efforts to compensate for the stress on nature's vital services and the depletion of non-renewable resources often made things worse. For example, the *Green Revolution* that increased the amount of food produced per acre during the latter half of the twentieth century was based on the rapid introduction of machines, chemicals, and industrial-like production methods in agriculture that undermined traditional rural communities, and displaced hundreds of millions of people. The consequences of the green revolution show up in the form of urban slums, mass illegal immigration, broken family structures, greater income inequality, and exploited wage laborers. Agriculture, among all sectors of the economy, is today the single largest contributor to global warming, even larger than transportation and power generation.[2] And, biodiversity has been substantially lost, as Magdoff (2015) explains, to *monoculture* motivated by economies of scale derived from the substitution of large equipment for labor, the heavy application of chemical fertilizers and insecticides in place of more labor-intensive and varied exploitation of the land, and industrial food processing operations in which machinery and assembly-line methods require uniform products.

---

[1] The concept of the *ecological footprint* is developed in Wackernagel and Rees (1996).

[2] See for example Union of Concerned Scientists.

Efforts to supplement carbon fuels have often been damaging for the ecosystem. Alternative sources of energy such as biofuels require vast amounts of land and water and the introduction of monoculture. Efforts to exploit new sources of petroleum, such as the development of the tar sands in Alberta, Canada, are even more environmentally damaging. And, the environmental consequences of new drilling methods such as "fracking" involve massive use of dangerous chemicals while also triggering the escape of large amounts of methane into the atmosphere.[3] The dirtiest of sources of carbon energy, coal, continues to be exploited because the poor functioning of markets results in the price of coal that reflects only a small fraction of the total true social cost of burning coal for fuel.[4]

The growth of economic activity has also caused social conflict and oppression. Obvious examples are the wars over oil supplies in Kuwait, Iraq, and Georgia, the continual threats of war by petroleum importers such as the United States against oil producers like Iran, Venezuela, and Ecuador, and the foreign-financed civil wars in more than a dozen African countries for control of assorted natural resources. The continued violence in the Niger Delta of Nigeria is driven by the extreme poverty that exists side by side with the oil industry. Large countries such as China, the United States, Russia, and others are actively engaged in a military arms race in order to expand and maintain their control over the world's scarce resources. Several countries, among them Iran, Pakistan, and North Korea, have developed or are seeking to develop nuclear weapons to protect themselves and their resources. These social stresses manifest themselves in many ways, including the long-distance international migration of large numbers of people.

---

[3] See Howarth, Santoro, and Ingraffea (2011).

[4] See Shindell (2015) and Diaz and Moore (2015).

4

In sum, humanity living in mostly monopoly capitalist economies has brought about large shifts in technology, as predicted by a broad spectrum of economists from Marx (1873) to Scumpeter (1936) to Solow (1956). These technological changes increased energy use and enabled much more rapid population growth, which caused more intense exploitation of the ecosystem and put human society on a dynamic path of complex and interrelated economic, social, and environmental changes whose true costs are much higher than current exchange values suggest.[5]

III. Economists' Failure to Deal with the Environment

Just as most academic economists, and virtually all private financial sector economists, failed to warn us about the (2000) "dotcom" bubble the global 2007-2009 "great recession," today we see economists ignoring clear scientific evidence of anthropomorphic ecological change. Even the Post Keynesian economists who understood the earlier financial bubbles often fall back to accepting tax cuts for corporations to spur investment in factories and income tax cuts to spur more material consumption.

Very few economists have sought to answer the question of how humanity reverses its destructive impact on Earth's ecosystem. The notable exceptions include Kenneth Boulding (1966), Nicholas Georgescu-Roegen (1971), and Herman Daly (1973, 1980, 2014), E.F. Schumacher (1973), and, more recently, Peter Victor (2008). A group of French economists known as "les Économistes Atterés" have advocated a set of policies that simultaneously deal with unemployment, social inequities, and environmental degradation that have been referred to in France

---

[5] See Wagner and Weitzman (2015) on how to go about calculating the current cost of an uncertain possibility of a catastrophic future event.

as *décroisssance* (degrowth).[6] Marx described the conflict between capitalism and the ecosystem as a *metabolic rift*, which is the long-distance movement of raw materials that severs the natura regeneration of the ecosystem.[7] And often forgotten is Harrod's (1939, 1948) dynamic growth model which incorporates both nature's long-run constraints on economic growth and the short-run short-term circular flow inconsistencies between the demand and supply sides.

II. Harrod's Growth Model

Roy Harrod (1939, 1948) built on the ideas of Keynes (1936) to construct a dynamic growth model."[8] Harrod corrected one of the weaknesses of Keynes' 1936 work by explicitly adding a supply side to Keynes' aggregate demand model. Keynes had focused on investment as a likely source of instability in aggregate demand for the economy's production. Long-term decisions on whether to invest in increasing the means of production are based on expectations of future returns and profitability, and Keynes argued that such expectations are characterised by *uncertainty* rather than calculable *risk*. This focus represented the dynamic of the 1930 quite well, and there was little debate over Keynes' contention that the Great Depression was characterized by unemployment caused by insufficient demand. Harrod took a longer-run view and noted that, over time, investment not only comproses a potentially-volatile component of aggregate demand, but it also adds to the economy's productive capacity. Thus, Harrod pointed out that, dynamically

---

[6] Les Économistes Atterés (2012), *Changer d'Économie!*, Paris: Babel; Denis Bayon, Fabrice Flipo, and François Schneider (2010), *La Decroissance: 10 Questions pour Comprendre and en Debattre*, Paris: La Découverte; see also the monthly French newspaper *Décroissance*, as well as the quarterly journal *Entropia*.

[7] See, for example, Foster and Clark (2018).

[8] Harrod (1939) and Evsey Domar (1946) independently presented very similar models that are sometimes lumped together as the *Harrod-Domar model*. We focus here on Harrod's version of the model because Harrod's model included a *natural* growth path that can represent the environmental constraints on growth.

6

over time, investment has both demand side and supply side effects. In the long run, economic

stability requires that investment and the other sources of aggregate demand grow just fast

enough to exactly absorb the increased output that the investment makes possible. If aggregate

demand does not grow as fast as output capacity grows over time, unemployment will become a

problem. Furthermore, Harrod shows that, under certain assumptions, a dynamic economy is

even more volatile than Keynes' (1936) macroeconomic model suggests.

The Supply Side

To clarify the potential inconsistencies between investment's effect on aggregate demand and its

effect on the growth of the economy's productive capacity, Harrod (1939) assumed a very simple

model of the economy's capacity to produce goods and services. Specifically, he assumed that

the marginal product of capital is constant, or $K/Y_S = \gamma$, where K is the stock of capital and Y_S

is aggregate supply. Such a constant *capital-output ratio* effectively implies that capital does not

suffer diminishing returns. Perhaps there is unemployed labor available to accompany the in-

creases in capital and keep factor inputs changing in proportion to output, as was the case during

the 1930s. A second assumption is that there is no depreciation, which permits Harrod to repre-

sent investment, I, as the change in the stock of capital, or $I = \Delta K$. Hence, aggregate supply, Y_S ,

can be written as $Y_S = C + \Delta K$. Finally, the Harrod model assumes that productive investment is

always equal to saving, so that

$$\Delta K = I = S = \sigma Y_S , \qquad (1)$$

where σ is the saving rate.

Since the model assumes that each additional unit of capital increases output by a fixed

proportion and every increase in saving directly increases investment, an increase in saving must increase the rate of growth in output. These assumptions about the supply side of the economy can be combined to give us

$$Y_S = (1/\gamma)K. \tag{2}$$

This linear relationship generates the Harrod-Domar model's conclusion that the rate of growth in output is exactly proportional to the economy's rate of saving. If we now put equations (1) and (2) together, it follows that

$$\Delta Y_S = (\sigma/\gamma)Y_S \tag{3}$$

Dividing both sides of equation (3) by Y, a simple formula for the rate of supply-side output growth of the economy emerges, which we denote as the growth rate of supply-side output:

$$G_{Ys} = \Delta Y_S/Y_S = \sigma/\gamma \tag{4}$$

Note that the model suggests that an increase in the rate of saving/investment would increase the growth of output, as would a decline in the capital output ratio.

The Growth of Demand for Output

In order to determine whether a given rate of investment is compatible with long-run demand for goods and services, the demand effects of investment must be brought into the model. Harrod assumed an abbreviated version of Keynesian aggregate demand, namely that aggregate demand (Y_D) is split between two categories of commodities, consumption goods (C) and investment goods (I), or $Y_D = C + I$. Harrod, like Keynes, views government expenditures, G, as an exogenous policy variable, and that can be brought in later in the analysis. Consumption demanded is equal to actual income not saved, or $C = (1 - \sigma)Y$. Harrod implies that the savings rate tends to

be fairly stable in the short run, generally showing only modest shifts in response to changing economic conditions. The other component of demand, I, can become quite volatile when overall economic conditions shift. If S = I, then all income not spent on consumption is instead spent on investment, Say's Law is satisfied, and aggregate demand equals aggregate supply.

In his *General Theory of Employment, Interest, and Money*, Keynes (1936) viewed investment as a complex function driven by a great many variables, including expectations of the inherently uncertain future. Keynes argued that the decision to invest was not the result of a precise decision process that compared future returns to the opportunity cost of investment. In reality, no one has enough information about the future to perform such a deterministic exercise: "Only a little more than an expedition to the South Pole, is it [investment] based on exact calculation of benefits to come."[9] Keynes suggested that investment was driven by "animal spirits," by which he meant the complex combination of confidence, optimism, and unsubstantiated faith in the future growth of the economy.

So how do investors make their decisions? Keynes surmised that as long as most investors' expectations were approximately validated, investment would continue to occur despite the impossibility of determining exactly what the returns would be. However, if a large proportion of investment projects fail to meet expectations, confidence in the likelihood of future earnings erodes and investment collapses. Suppose, therefore, that investment demand is a function of growth in demand for output:

$$I_D = b(\Delta Y_D) \qquad\qquad (5)$$

The variable b defines the relationship between the change in total actual output demanded, Y_D.,

---

[9] John Maynard Keynes (1936), p. 162.

and new investment I. Hence, aggregate demand, C + I, is:

$$Y_D = (1 - \sigma)Y_S + b(\Delta Y_D) \tag{6}$$

Suppose also that initially $Y_D = Y_S$, so the the economy is on its warranted growth path. For

the economy to remain on the warranted growth path, first of all, the equality between desired

investment and actual savings must be maintained:

$$b(\Delta Y_D) = \sigma Y_S \tag{7}$$

This implies that after shifting b and Y to the other side of the equal sign and setting $Y_D = Y_S$, it

becomes clear that under full employment the growth of demand is equal to

$$\Delta Y_D / Y_S = \Delta Y_D / Y_D = \sigma / b \tag{8}$$

Hence, in a state of full employment demand growth is equal to supply growth, given as $\Delta Y_S / Y_S$

$= \sigma / \gamma$ in equation (4), only if

$$\Delta Y_D / Y_D = \sigma / b = \Delta Y_S / Y_S = \sigma / \gamma \tag{9}$$

Thus, a continuous growth path at full employment requires that $b = \gamma$. The problem for

macroeconomic stability is that, first, the parameter b is dependent on the volatile state of in-

vestor confidence and Keynes' animal spirits. In fact, the capital-output ratio, γ, is also not al-

ways a constant. As a number of Cambridge economists have since pointed out, capital is not a

uniform thing, and the aggregate ratio γ will vary depending on the composition of investment.

Harrod argued that any discrepancy between b and γ would generate either an inflationary spiral

or a lengthy depression in output. This dynamic instability was due to the likelihood that the

capital-output ratio was greater than one. That is, the amount of investment, $I = \Delta K$ normally

exceeds the increase in annual output such investment brings about. For example, in order to

increase annual production by $1 million is likely to require an up-front investment on the order

of $3 or even $5 million. Such investment may be quite profitable in that it generates an additional $1 million in output for the next 25 or 50 years, but this year aggregate demand increases by $3 or $5 million while output only increases by $1 million. This discrepancy means demand exceeds output, and further investment is called for! But each such additional investment increases demand by more than supply, which calls for ever-more investment. An economic boom thus ensues, the consequences of which will, sooner or later, become problematic. Inflation is likely to set in, and the economy may bump into more fundamental barriers to long-run growth, such as population size, resource availability, or the sustainability of our ecological system.

III. The Harrod Model's Fundamental Dynamics

The dynamics of the system are captured by Harrod (1939, 1948) as the interactions among three different dynamic growth rates: the *actual* growth rate of output, which we designate as G_Y, the *warranted* growth rate, G_W, and the *natural* growth rate, G_N. These three rates of growth define the slopes of the actual, warranted, and natural *growth paths* of the economy, which can be represented graphically as continuous curves, as in Figure 1. This figure shows the special case where the economy's actual growth path coincides with the warranted growth path. Note that the continually rising growth path shown in Figure 1 implies a constant rate of growth. The warranted growth rate is the slope of the growth path along which ex ante (intended) aggregate demand equals ex ante (intended) aggregate supply, that situation described above as unlikely to happen given the uncertainty of investment. In the words of Harrod (1939, p. 23), the warranted growth path "is determined jointly by the propensity to save and the quantity of capital required by technological and other considerations per unit increment of total output."
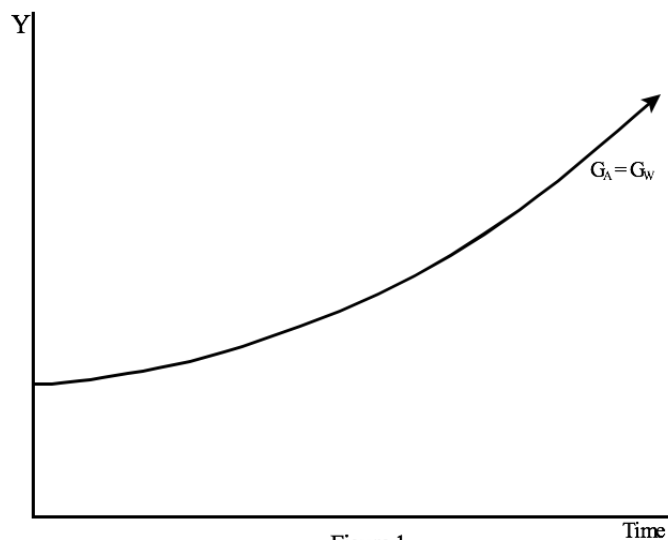
11

Figure 1
Sustainable Full Employment: $G_A = G_W$

Only if producers keep to this line will they find that on balance their production in each period has been neither excessive nor deficient. The warranted growth path does not necessarily coincide with full employment of the labor force; it merely defines the economy's sustainable level of output given the technical relationship between capital and output (the capital-output ratio), consumers' propensity to save, and investors' willingness to invest in new capital. Harrod thus describes a dynamic growth path that, like Keynes' (1936) static analysis, suggests that the economy does not always move toward an equilibrium characterised by full employment.

The warranted growth path is unstable because, under the assumption that the capital-output ratio is a fixed technological constant, the interaction between the actual and warranted rates of growth leads to a "knife's edge" phenomenon. When the capital output ratio is greater than one, which evidence suggests is normally the case, then any unexpected increase (decrease) in demand that exceeds (falls short of) the increase in output, pushes the economy off its warranted growth path to spiral upwards (downwards) into an inflationary boom (depression).
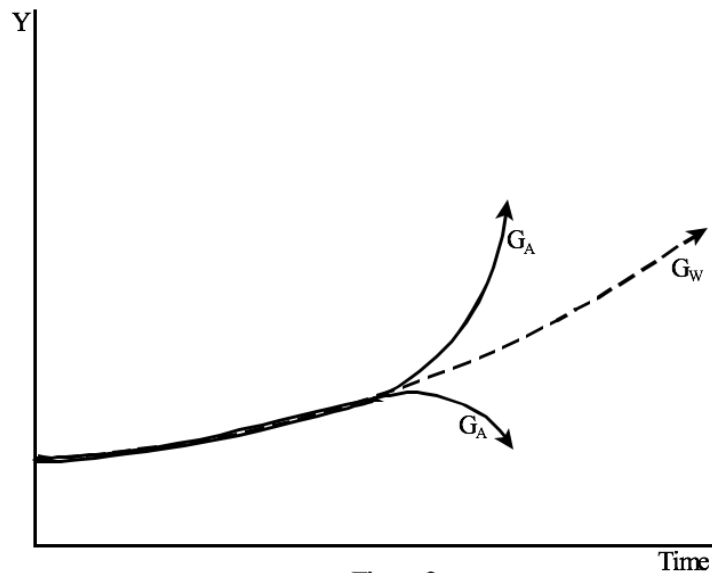
Figure 2
The Knife's Edge: Dynamic Instability of the Harrod-Domar Model

Harrod's "knife's edge" depicts a relationship that, at first glance, seems counterintuitive. Specifically, because of the role of investment in aggregate demand, "a condition of general over-production is the consequence of producers in sum producing too little….Over-production is the consequence of production below the warranted level. Conversely, if producers find that they are continually running short of stocks and equipment, this means that they are producing above the warranted level."[10] In this latter case, "we define their production as unwarrantably large, meaning by that that they have produced in excess of the unique amount which would leave them on balance satisfied with what they had done and prepared to go forward in the next period on similar terms." Figure 2 illustrates the "knife's edge."

But, are the assumptions of a constant capital-output ratio and a constant saving rate realistic. Is it possible that induced variations in their values could result in the economy remaining on the warranted growth path rather than diverging from it? According to Harrod (1939, p. 25):

---

[10] Harrod, 1939, p. 24

…it would be necessary to show that, in consequence of the experimental increase, s [the savings rate] was substantially increased or C reduced. It is unlikely that C would be reduced. The capital coefficient may often stand below the level appropriate to the technological conditions of the age, owing to the existence of surplus equipment. If this were so, the higher rate of output consequent upon the experimental increase would tend to raise C. A smaller proportion of firms would come to find their capacity redundant, and a larger proportion would have to support a greater turnover by ordering extra equipment.

Harrod (p. 25) suggests that "An expansion of activity might increase the proportion of income saved." However, he further shows that for feasible savings rates and realistic capital-output ratios, the shift in saving necessary to alter the growth rate of the economy even a little would be essentially impossible. He concludes (p. 26): "Thus for any normal warranted rate of growth and level of saving, the instability principle seems quite secure." Sato (1964) introduces a neoclassical production function into Harrod's framework in order to explicitly allow for factor substitution, and he reaches a similar conclusion about the ability of short- and medium-term adjustments to inputs to prevent Harrod's dynamic instability.[11] Therefore, it is safe to conclude that a growing economy is inherently unstable, and small shifts in investment, saving, output, and production away from their values on the warranted growth path will tend to push the economy towards a boom or a bust. Harrod's framework has implications for (1) short-term instability, (2) medium-term cyclical fluctuations, and (3) long-term tendencies in an economy.

---

[11] Sato (1964) explicitly specifies a neoclassical production function in place of Harrod's fixed proportions production function, but when he assumes realistic year-to-year levels of depreciation, private saving and investment relative to total capital stocks, public finance and public investment, shifts in the labor market, and technological change, he finds that it would take the economy more or less one hundred years, to reach a full-employment natural growth path. Sato (1964, p. 387) concludes: "The adjustment process in the dynamic model is so slow that fixed proportions may be a realistic assumption for practical purposes."

IV. Harrod's Natural Growth Path

There is another barrier to sustaining the warranted growth rate, namely the capacity of the economy to absorb additional capital. The economy's capacity to add tools, machines, factories, and infrastructure productively depends on whether there is available labor to operate the capital, tempered by the specific technologies associated with additional capital. Harrod conceptualizes this "capacity" in the form of the long-run *natural growth* path. Harrod's natural growth rate represents an upper limit to the economy's long-term rate of growth, the "maximum rate of growth allowed by the increase in population, accumulation of capital, technological improvement, and the work/leisure preference schedule, supposing that there is full employment in some sense."[12] Immigration influences the natural growth rate because it affects (1) population growth, (2) capital accumulation, and (3) technological change. Because this upper bound on the growth of the economy's productive capacity interacts with the warranted and actual growth paths in complex ways, immigration also has complex macroeconomic consequences.

In Figure 3, the three growth paths coincide, and so long as the economy is not bumped off the knife's edge, growth continues along the natural growth path. The economy can also continue growing on the knife's edge of the warranted path if that path falls below the natural growth path, as in Figure 4. However, while in this case, there is there is no problem with constraints on growth due to a shortage of labor or a shortage of natural resources, the low savings rate keeps the economy on a dynamic version of Keynes' unemployment equilibrium.
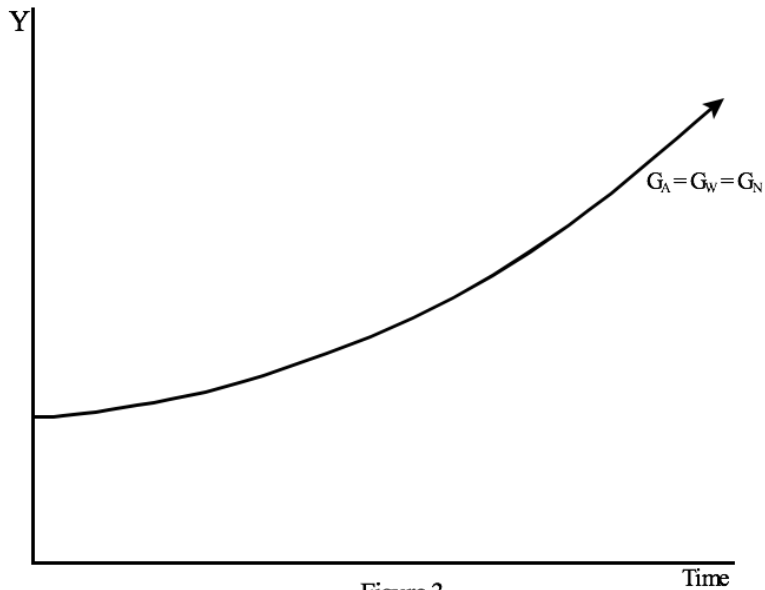
---

[12] Harrod (1939), p. 273.

Figure 3
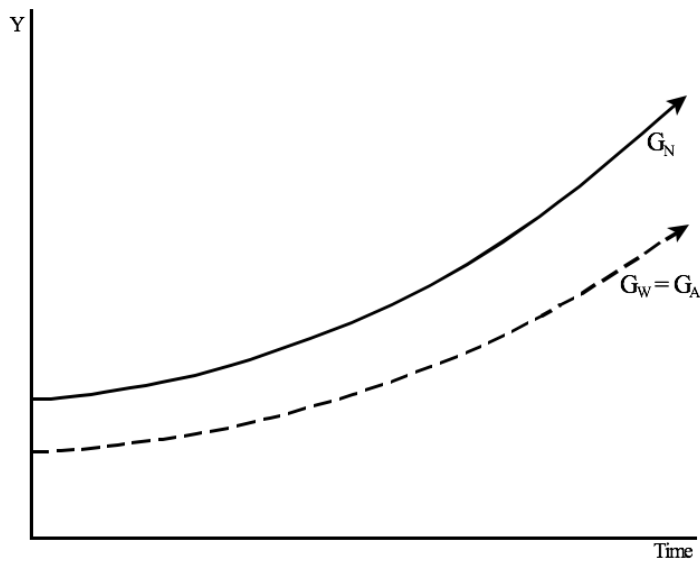Sustainable Full Employment: $G_A = G_W = G_W$

Figure 4
Sustainable Growth with Unemployment: $G_W = G_A < G_N$

There is always the possibility that some unexpected change in output or the capital output ratio pushes the economy off the knife's edge. Figure 5 shows that if there is a sudden excess supply in the economy: the recline in aggregate demand causes a downward spiral in output that pushes unemployment even farther from full employment.
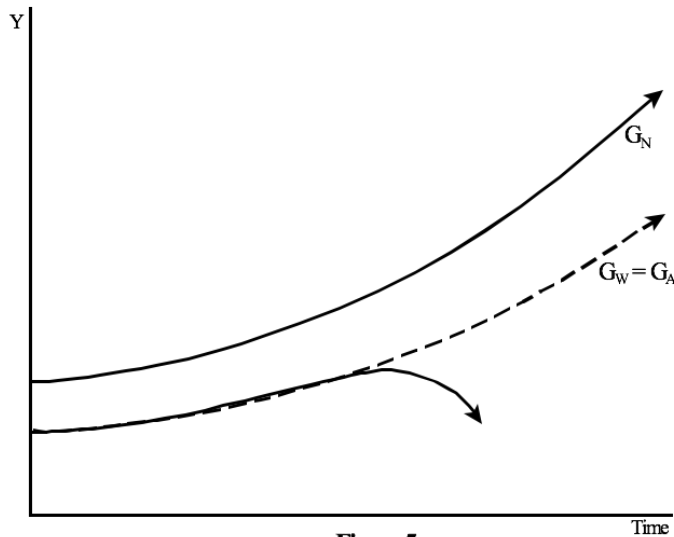
16

Figure 5
The Knife's Edge with Unemployment, Case 1: $G_A < G_W < G_N$

On the other hand, a sudden decrease in the capital output ratio of new investment, perhaps because of a failed investment or faulty business plan, or a sudden increase in aggregate demand, perhaps due to a sudden shift in optimism about future income or profitability, pushes the actual rate of growth above the long run warranted growth path. This triggers a spiralling path upward from the warranted growth path. Of course, the booming economy will sooner or later bump into the natural growth path that constrains real economic activity, as shown in Figure 6. Unemployment is eliminated, but at the cost of accelerating inflation as the economy bumps up to the natural growth rate, which sets the physical limits to the growth of output.

Just as in the static Keynesian model, active macroeconomic policy is called for to deal with unemployment or inflation. In Figure 3, active monetary and fiscal policies are needed to counter deviations from the warranted growth path, and in Figure 4 active policy is needed to put the actual growth path on the natural growth path of full employment. Such policies could target the savings rate, the investment rate or aggregate demand. In Figure 5, the downward spiral

17

must be reversed. In Figure 6, the initial boom spiral may be welcomed, but as the economy approaches the natural growth path, active macroeconomic policy must be exercised to prevent an inflationary boom when the actual growth path reaches the natural growth path.
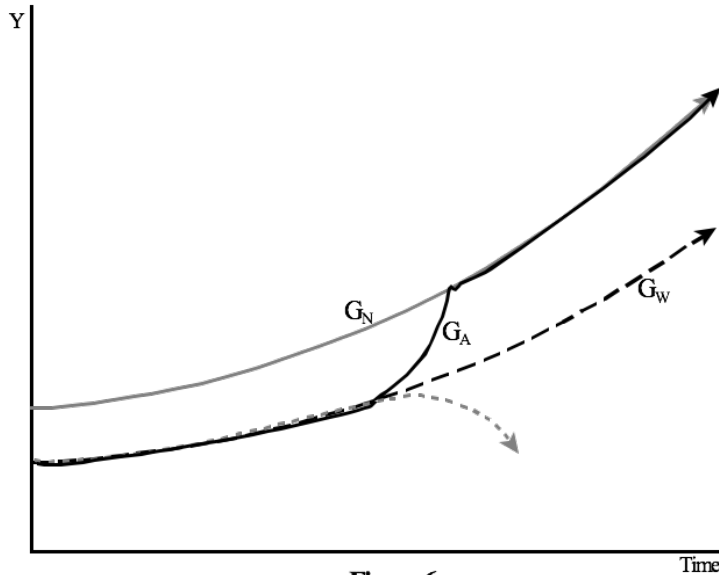

Figure 6
The Knife's Edge with Inflationary Boom, Case 2: $G_W < G_{WA} < G_N$

Finally, Figure 7 illustrates the case where the warranted growth path moves above the natural growth path, or $G_W > G_N$, the constraints on growth will, sooner or later, prevent the economy from reaching the warranted growth path. Policymakers are constrained from keeping the economy on its knife's edge, and the economy will persistently invest less than the savings rate that sets the hypothetical warranted growth path. Recessions continually threaten to take hold, and policymakers will have to continually take measures to prevent the economy from spiraling into depression. Any attempt to push the economy toward the warranted growth path bumps into the natural growth path and triggers potentially accelerating inflation rather than faster real growth.

This scenario reminds us of the 1970s, when the long post World War II boom ran into re-source scarcities, most clearly manifested by rapidly-rising oil and other commodity prices. Efforts to use traditional Keynesian policies to restore steady economic growth led to stop-go macroeconomic policies in response to the seemingly conflicting increases in unemployment and inflation.
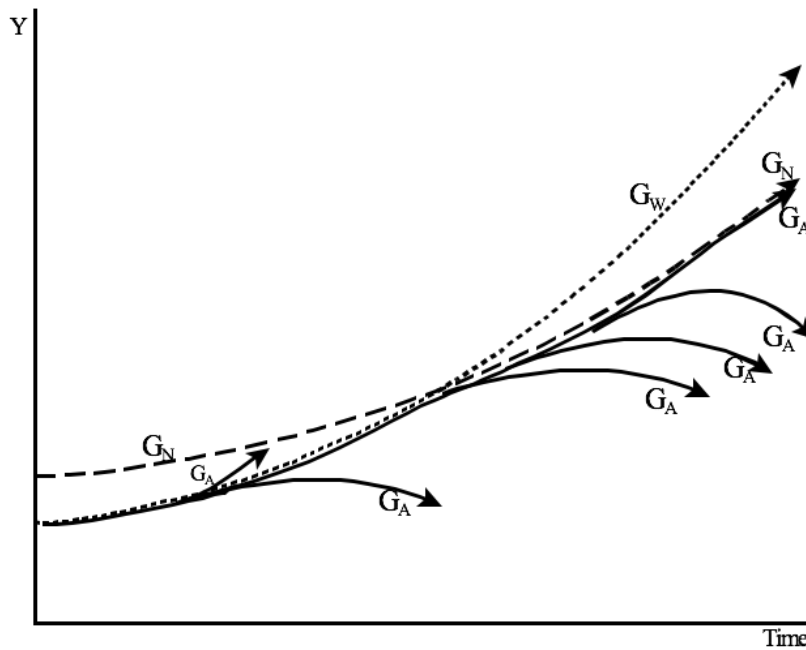

Figure 7
Persistent Tendency towards Recession and Unemployment when $G_W > G_N$

Figure 8 shows that, in order to avoid a 1970s outcome, either the natural growth path must be pushed upward, as, for example, to G_{N2} in Figure 8, or policymakers must find a way to maintain a slower rate of growth that does not bump into the natural growth path. But, exactly how would policymakers push up the natural growth path? And, would people accept a slower rate of growth of ma-terial output?
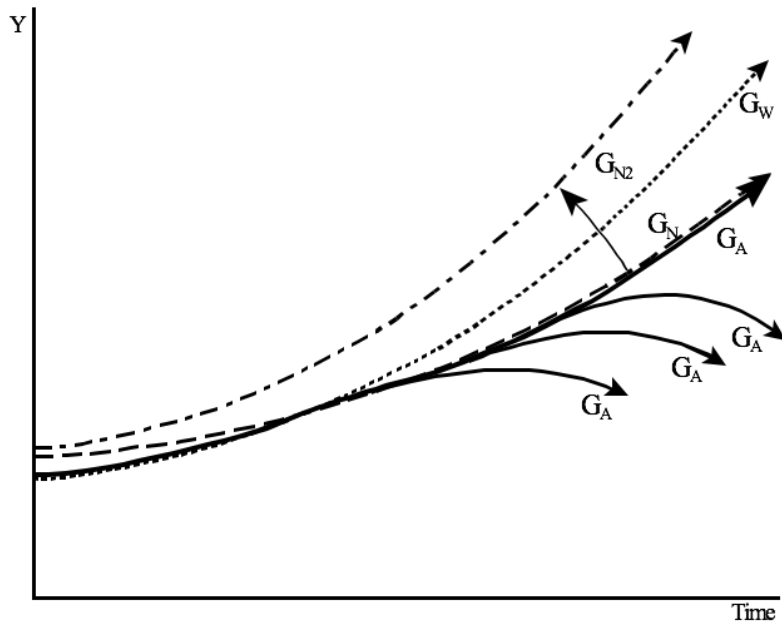
Figure 8
Raising the Natural Growth Path: Supply Side Policies
to Avoid Persistent Recessions/Unemployment

In sum, the Harrod model suggests that macroeconomic policy must consider supply side variables such as environmental constraints, labor shortages, and technological progress. Given the Harrod model's solid Keynesian heritage, it is clear that Keynesian macroeconomics can indeed deal with the supply side as well as the demand side of the economy. Claims that the Keynesian model lacks a supply side are inaccurate.

V. Dealing with the Macroeconomic Effects of Environmental Constraints

One policy response to the situation depicted in Figure 7 would be to slow down the economy. According to conventional macroeconomic thinking, this would make it difficult for policymakers to meet the politically important goal of full employment, but we suggest ways in which macroeconomic policy can be enhanced to sustain full employment with lower or even zero

growth. Such alternative reformulations have different political economy consequences, and they are generally not compatible with capitalism's need for continued economic surpluses.

Decroissance?

Some ecologists and environmental activists argue that it is not possible to prevent ecological disaster by making only marginal adjustments to our current capitalist system.[13] One such school of thought advocates abandoning the quest for growth, seeking instead what they call *de-croissance*.[14] Harribey, Quirion, and Rotillon (2012), of the French organization *Économistes Atterrés*, propose the following social/economic program to achieve decroissance:

1. Completely end the use of fossil fuels and nuclear energy.

2. Expand public transportation.

3. Shift freight to railroads and away from road traffic.

4. Food independence and agricultural sovereignty.

5. Public investment in restructuring the economy towards low throughput activity.

6. Use productivity increases to reduce work hours without reducing labor income.

7. Equalize the distribution of income.

8. For macroeconomic adjustment, adjust work hours rather than the number of jobs.

9. Reduce the scope of the market economy and expand the public commons.

10. Continualy evaluating the full environmental consequences of all human activities.

---

[13] See, for example, Klein (2014), Lohmann et al. (2006), or Rising Tide (2009).

[14] Note that the proponents of décroissance anticipated Naomi Klein (2014) and her popular book, *This Changes Everything*, by a decade or more in arguing that environnmental decline can only be reversed if we end the single-minded pursuit of profit endemic to our monopoly capitalist system where markets ignore many of the true costs of our energy-intensive production methods and our growing exploitation of nature's ecosystem.

Objectively considered, this ten point program is not radical if we aaccept the environmental challenges described by the various IPCC reports over the past 20 years. In today's political culture, however, those who have vested interests in maintaining our current social/economic system use their wealth and the power to prevent real change. This is why the Économistes Atterrés (2012) also seek a participatory political system that wealthy vested interests cannot dominate.

Shifting to low-throughput production

Perhaps full employment can be achieved because some types of production can grow provided other resource-using sectors are diminished sufficiently to make overall resource and energy *throughput* decline. But what production, exactly, do we expand and what production do we reduce or cease altogether?

Agrculture has been suggested as a sector where a reorganization of production could raise employment and reduce the throughput of natural resources. According to a 2014 report by the agricultural study group GRAIN:

> Although big farms generally consume more resources, control the best lands, receive most of the irrigation water and infrastructure, get most of the financial credit and technical assistance, and are the ones for whom most modern inputs are designed, they have lower technical efficiency and therefore lower overall productivity. Much of this has to do with low levels of employment used on big farms in order to maximize return on investment.

Think of the massive job destruction by modern energy-intensive, chemical-intensive, and capital-intensive agriculture: merely reversing this process will restore the environment as well as a very large amount of recently-lost employment.

Healthcare is a sector in which, in many high income countries, labor-intensive low-throughput activities can actually increase real output while replacing capital-intensive high-throughout activities. By focusing on more labor-intensive preventive care as opposed to reactive emergency-driven care, life expectancy can be raised and days lost to illness and disability can be reduced. Cuba provides a good example.

Education remains a labor-intensive process because so much learning is *tacit* in nature.[15] Economists from the times of Smith (1776) and Marx (1873) and educators like Dewey (1897) and Freire (1970) have convincingly argued that on-going educational activities for people of all ages are also necessary for maintaining a good social and economic environment. Freire (1970, Chapter 2) advocated *problem-solving education* that teaches people to think for themselves and to feel capable of making choices. Such self-liberating education necessarily requires substantial inter-active and nurturing labor input.

Finally, low-throughput activities like entertainment, art, maintenance services, repair services, sports activities, natural parks, scenic reserves, and activities related to maintaining the commons also require more labor. People consume goods and services both individually and jointly, fundamentally because some goods are rival goods that can only be consumed by one person at a time while non-rival goods and services can be consumed by many people simultaneously. A shift towards collective consumption and away from individualized consumption can reduce the overall energy and resource throughput of human production. This will require changes in how we allocate our time between work and leisure.

---

[15] Polanyi (1958) explains that not all technology and knowledge can be *codified*, by which he means those types of information that can be written down in the form of clear instructions, blueprints, or recipes, or explained in textbooks or on the internet. Instead, the passing on of society's stock of knowledge and technology requires personal example and guidance.

Reducing work hours combined with universal public reservices

The total number of jobs can be increased even in the absence of any growth in output by reducing the hours that each individual person works. The benefits would extend beyond achieving full employment: according to The New Economics Foundation (2010, p. 2):

> A normal workweek of 21 hours could help to address a range of urgent, interlinked problems: overwork, unemployment, over-consumption, high carbon emissions, low well-being, entrenched inequalities, and the lack of time to live sustainably, to care for each other, and simply to enjoy life.

Schor (2012) and Coote and Franklin (2013) argue that the quality of life issue is inversely related to working hours because it takes time to consume goods and services; community and cultural activities often are especially time-consuming. The latter are under-consumed in countries like the United States and Britain because long work hours effectively force people to favor individualized material consumption over more time-intensive social activities that actually increase the well-being of group animals such as human beings.[16] A shift to shorter working hours could be induced by policies such as higher overtime pay, workweek limits, and measures to support labor unions and worker solidarity. Note, however, that reducing work hours tends to raise the cost of labor unless employers are relieved of their obligations to provide fringe benefits like healthcare, retirement benefits, childcare, etc. Hence, reduced work hour will be more successful if benefits beyond wages are provided collectively by the government regardless of employment status to these extra costs do not enter employers' hiring decisions.

---

[16] Coote, Franklin, and Simms (2010) estimated that if British workers (rather than business owners) capture all expected annual productivity gains over the next three decades and if they take those productivity gains in the form of fewer hours of work, then working hours can be reduced to 21 hour without any loss in income accruing to workers.

Human happiness and consumption

There is overwhelming evidence that human well-being is not directly tied to material consumption. Surveys of people's satisfaction with life have been carried out for many years in many countries, and we can compare happiness across countries and over long periods of time. These survey results suggest the following:

- At a given point in time within the same country, people with higher incomes are happier, on average, than people with lower incomes.

- In the long-run, however, in high-income developed countries average human happiness does not change signficantly as real average per capita income grows.

- Cross-section studies that compare average national levels of happiness for low-income developing and high-income developed countries show that overall happiness rises with average per capita income only until real per capita income reaches about $10,000.

Typical of such happiness studies is the paper by David Blanchflower and Andrew Oswald (2000), who find that in both the U.K. and the U.S., people are less happy, all other things equal, when they are unemployed, not married, older, male rather than female, retired, or have lost their spouse.[17] Dolan, Peasgood, and White (2008) identify an even longer list of living conditions that are statistically related to individual happiness, which includes a) gender, b) friendship, c) age, d) marital status, e) education, f) health, g) relative income, h) self-employment, i) blood pressure, j) regular sex with the same partner, k) political leaning, l) religious belief, m) member-

_____

[17] A survey of many happiness studies for other countries, time periods, and data sets by Dolan, Peasgood, and White (2008) confirm Blanchflower and Oswald's findings. Among the many authors surveyed are Veenhoven (1988), Easterlin (1995), Diener et al. (1995), Oswald (1997), and Frey and Stutzer (2000). This growing literature has, so far, strengthened the conclusions outlined in the text above. Few anomalies have been uncovered, although much research remains to be done in this still-young field.

ship in organizations, n) volunteer work, and o) regular exercise. These and nearly all happiness studies confirm that people value marriage, status, respect of others, and participating economically in their societies. In short, the results confirm that people are social animals who value their status in society above absolute levels of material consumption, provided basic needs are met. Brickman and Campbell (1971) coined the term *hedonic treadmill* to describe the effort people exert in order to improve their status relative to others, an effort they demonstrate is futile because, when everyone does this, overall happiness changes little.

Evidence on human happiness from the fields of psychology, neuroscience, and behavioral economics provide additional insight into human social behavior:

▪ There are great variations in how the automatic, emotional, and cognitive processes of the human brain interact under diverse circumstances, which implies that individual welfare functions are not stable.

▪ People's happiness continually changes as they adjust to changes in their circumstances, the circumstances of their fellow human beings, and their relationships with those fellow human beings.

▪ People tend to have more empathy for persons they know or are located close to them, and they tend to have little or no empathy for people they do not know and are far away.

▪ People's welfare depends on much more than the goods and services counted in GDP.

▪ People relish recognition, prestige, and love; they are saddened by uncertainty, loss of status, and loss of friendship.

▪ People do not judge their well-being only by their current circumstances, but also by what they anticipate for the future and by what they enjoyed in the past.

- Humans tend to ignore long-run issues because short-run problems tend to hog their attention.

These results all suggest that a slowdown in economic growth may not be such an impotant issue at all.

Reduce population growth

Humanity's overall environmental footprint is the product of (1) how many of the earth's resources each one of us consumes, directly and indirectly, times (2) how many of us there are. Hence, the *growth* of the footprint is the sum of the growth rates of population and per capita production. For variety of economic, political, and cultural reasons, the importance of population growth in determining the human environmental footprint tends to be left out of the conversation. But, the conflict between employment and environmental sustainability would be less onerous if population growth were reduced.

Guaranteed public employment

Obviously, expanding public employment can push the economy closer to full employment. But, a guaranteed public employment program can, simultaneously, play a direct role in restructuring the economy towards lower-throughput production. Governments already employ large numbers of people in most countries of the world, and because they already provide most of the world's formal education, healthcare, social services, and public transportation, they are well-positioned to expand low-throughout production. In many countries, government also provides financial services, personal care services, and most infrastructure services. Guaranteed pubic employment

has another important, if seldom recognized, role to play: by ensuring all workers will have a job, this program eliminates the common resistance from organised labor to environmentally-motivated adjustments in the economy. To date, labor organizations have often sided with capitalists against environmental regulations and eco-taxes because of the fear that workers would lose their jobs when capitalists are relieved of some of their capital. With employment guaranteed, workers need not fear unemployment from an economic restructuring.

VII. Conclusions

Policies exist to solve the apparent conflict between slow growth and full employment. Objectively seen, these approaches are no more radical than the ubiquitous global monopoly capitalism that has completely, within little more than one century, reordered the way humans live, reorganized their economic activity, and accumulated some very costly ecological burdens. Now, we must make a choice between putting the future of human survival into jeopardy, or building an alternative social structure that reverses humanity's collision course with nature. The problem is tha the required economic and social restructuring clashes directly with the needs of the capitalist class, which needs economic growth for the continued accumulation of capital and its survival. Recall that when the U.S. economy bumped into the natural growth path in the 1970s, as depicted in Figure 7 above, policymakers did not challenge capitalist interests and, instead, sought quick fixes to restore growth, such as facilitating more consumer debt, privatizing the commons, supporting new forms of primitive accumulation overseas, and perpetuating hot and cold wars. Meanwhile, scientific evidence shows clearly that the growing human footprint is destroying the ecosystem, and the failure of the market system to internalize this destruction causes the growth

28

of an *ecological exploitation* bubble. The longer we wait to restructure human production, the

greater the eventual decline in human well-being when the ecological exploitation bubble bursts

and the less growth we will be able to sustain in the future. Meanwhile, Daly's quote at the start

of the paper becomes increasingly relevant. The refusal of the capitalist class to permit econo-

mists or policymakers to pursue serious solutions to the looming ecological bubble seems to

make little sense given the likelihood that all classes will suffer from a destructive ecological col-

lapse. Perhaps the ruling class is playing for time in the hope that new technological break-

throughs, like massive carbon scrubbers or safe nuclear power, that will make possible both a

shift in the natural growth path and new profitable opportunities for capital accumulation.

References

Arrhenius, Svante (1896), "On the Influence of Carbonic Acid and Air upon the Temperature of the Ground," Philosophical Magazine 41(2):237–272.

Bayon, Denis, Fabrice Flipo, and François Schneider (2010), La Decroissance: 10 Questions pour Comprendre and en *Debattre*, Paris: La Découverte.

Blanchflower, David G. and Andrew J. Oswald (2000), "Well-Being Over Time in Britain and the USA," NBER Working Paper No. w7487, January.

Boulding, Kenneth E. (1966), "The Economics of the Coming Spaceship Earth," in H. Jarrett (ed.), Environmental Quality in a Growing Economy, Resources for the Future, Baltimore: Johns Hopkins Press.

Brickman, Philip, and Donald Campbell (1971), "Hedonic Relativism and Planning the Good Society," in M. H. Appley (ed.), *Social Comparison Processes: Theoretical and Empirical Perspectives*, New York: Wiley.

Coote, Anna, Jane Franklin, and A. Simms (2010), *21 Hours: Why a Shorter Working Week Can Help Us All Flourish in the 21st Century*, London: New Economics Foundation.

Coote, Anna, and Jane Franklin, eds. (2013), *Time on Our Side: Why we all need a shorter working week*, London: New Economics Foundation.

Daly, Herman, ed. (1973), *Toward a Steady-State Economy*, San Francisco: W. H. Freeman and Company.

Daly, Herman, ed. (1980), *Economics, Ecology, Ethics: Essays Toward a Steady-State Economy*, San Francisco: W. H. Freeman and Company.

Daly, Herman (1980), "Introduction" to Herman Daly (1980).

Daly, Herman (2014), *From Uneconomic Growth to a Steady-State Economy*, Northampton, MA: Edward Elgar.

Dewey, John (1897), "My Pedagogical Creed," School Journal 54 (January):77-80.

Diaz, Delavane, and Frances Moore (2015), " " *Nature Climate Change*

Diener, Ed, Marissa Diener, and Carol Diener (1995), Factors Predicting the Subjective Well-Being of Nations," *Journal of Personality and Social Psychology* 69:653–663.

Dolan, P., T. Peasgood, and M. White (2008), "Do We Really Know What Makes Us Happy? A Review of the Economics Literature on the Factors Associated with Subjective Well-Being," *Journal of Economic Psychology* 29:94–122.

Easterlin, Richard A. (1995), "Will Raising the Incomes of All Increase the Happiness of All?" *Journal of Economic Behavior and Organization* 27:35–47.

Easterlin, Richard A. (2003), "Building a Better Theory of Well-Being," IZA Discussion Paper No. 742, March.

Économistes Atterés (2012), *Changer d'Économie!*, Paris: Babel.

Foster, John Bellamy, and Brett Clark (2018), "The Robbery of Nature: Capitalism and the Metabolic Rift," *Monthly Review* 70(3)1-20.

Freire, Paulo (1970), *Pedagogy of the Oppressed*, New York: Continuum.

Frey, Bruno, and Alois Stutzer (2000), "Happiness, Economy and Institutions," *Economic Journal* 110(446):918–938.

Friedman, Michael (2015), "Capitalism's Distortion of Biological Processes," *Monthly Review* 66(20):19-34.

Nicholas Georgescu-Roegen (1971)

GRAIN (2014), "Hungry for Land," report on small farm productivity, GRAIN, May.

Grossman, Gene, and Elhanan Helpman (1991), *Innovation and Growth in the Global Economy*, Cambridge, MA: MIT Press.

Harribey, Jean-Marie, Philippe Quiron, et Gilles Rotillon (2012), Les enjeux d'une transformation écologique qui soit sociale, in Les Économistes Atterés (2012), *Changer d'Économie!*, Paris: Babel, pp. 69-100.

Harrod, Roy F. (1939), "An Essay in Dynamic Theory," *The Economic Journal* 49:14-33.

Harrod, Roy F. (1948), *Towards a Dynamic Economics*, London: MacMillan and Company Ltd.

Howarth, Robert W., Renee Santoro, and Anthony Ingraffea (2011), "Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations, A Letter," Climate Change 106(4):679-690.

Intergovernmental Panel on Climate Change (2007), *IPCC Report on Global Warming*, New York: United Nations.

Johnson, Simon (2009), "The Quiet Coup," Atlantic Monthly, May.

Kempf, Hervé (2007), The Rich Are Destroying the Earth, White River Junction, VT: Chesae Green Publishing Company.

Keynes, John Maynard (1936), *The General Theory of Employment, Interest, and Money,* New York: MacMillan.

Klein, Naomi (2014), *This Changes Everything: Capitalism vs. The Climate*, New York: Simon & Schuster.

Loewenstein, George F., and N. Sicherman (1991), "Do Workers Prefer Increasing Wage Profiles?", Journal of Labor Economics 9:67–84.

Lohmann, Larry (2006), *Carbon Trading: A Critical Conversation on Climate Change, Privatisation and Power*, Development Dialogue (48), The Dag Hammarskjold Centre, September.

Lopes, Helena (2011), "Why Do People Work? Individual Wants Versus Common Goods," *Journal of Economic Issues* 45(1):57–73.

Lykken, David T. (1999), *Happiness: What Studies on Twins Show Us about Nature, Nurture, and the Happiness Set Point*, New York: Golden Books.

Magdoff, Fred (2015), "A Rational Agriculture Is Incompatible with Capitalism," *Monthly Review* 66(10):1-18.

Marx, Karl (1959[1894*]), Capital,* Vol. III, New York: International Publishers.

Meadows, Donella, Dennis Meadows, Jorgen Randers, and William Behrens (1972), *The Limits to Growth*, New York: Universe Books.

Meadows, Donella, Jorgen Randers, and Dennis Meadows (2004), *The Limits to Growth: The 30-Year Update*, White River Junction, VT: Chelsea Green Publishing Company.

Neumark, David, and Andrew Postlewaite (1998), "Relative Income Concerns and Rise of Married Women's Employment, Journal fo Public Economics 70:157–183.

Oswald, A. J. (1997), "Happiness and Economic Performance," *Economic Journal* 107(445): 1815–1831.

Polanyi, Michael (1958), *Personal Knowledge, Towards a Post Critical Philosophy*, London: Routledge.

Rising Tide North America (2009), "Hoodwinked in the Hothouse; False Solutions to Climate Change," pamphlet downloaded from www.risingtide.org, November.

Romer, Paul (1990), ""Endogenous Technological Change," *Journal of Political Economy* 98(5):S71-S102.

Sato, Ryuzo (1964), "The Harrod-Domar Model vs the Neoclassical Growth Model," *The Economic Journal* 74(294):380-387.

Schor, Juliet (2013), "The Triple Dividend," in Coote, Anna, and Jane Franklin, eds. (2013), *Time on Our Side: Why we all need a shorter working week*, London: New Economics Foundation.

Schumacher, E. F. (1973), *Small Is Beautiful, Economics as if People Mattered*, New York: Harper & Row.

Shindell, Drew (2015), "The Social Cost of Atmospheric Release," *Climate Change*

Smith, Adam (1776 [1976]), *An Inquiry into the Nature and Causes of the Wealth of Nations*, Chicago: University of Chicago Press.

Veblen, Thorstein (1904), *The Theory of Business Enterprise*, New York: Charles Scribner's Sons.

Veenhoven, Ruut (1988), "The Utility of Happiness," *Social Indicators Research* 20:333–354.

Veenhoven, Ruut (1996), "Happy Life-expectancy: A Comprehensive Measure of Quality-of-Life in Nations," *Social Indicators Research* 39:1–58.

Victor, Peter (2008), *Managing without Growth: Slower by Design, Not Disaster*, Northampton, MA: Edward Elgar.

Wackernagel, Mathis, and William Rees (1996), *Our Ecological Footprint: Reducing Human Impact on the Earth*, Gabriola Island, British Columbia, Canada: New Society Publishers.

Wackernagel, Mathis, et al. (2002), "Tracking the Ecological Overshoot of the Human Economy," *Proceedings of the National Academy of Sciences* 99:9266-9271.

Wagner, Gernot, and Martin Weitzman (2015), *Climate Shock: The Economic Consequences of a Hotter Planet*, Princeton, NJ: Princeton University Press.

Weitzman, Martin (2007), "Structural Uncertainty and the Value of Statistical Life in the Economics of Catastrophic Climate Change," NBER Working Paper No. 13490, October.

Wisman, Jon (2013), "Government Is Whose Problem?" *Journal of Economic Issues* 47(4): 911-937.

World Wildlife Fund (2008), *Living Planet Report 2008*, Gland, Switzerland: World Wildlife Fund for Nature.