Post-Keynesian economics and sustainable development

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Abstract: This paper looks at the relationship between sustainable development and economics. Neoclassical economics with its current methodological approach is not well suited to understand or analyse the problem of sustainable development. Post-Keynesian economics – with its focus on macro and policy outcomes, the role of institutions, uncertainty, historical time, and its criticism of gross substitution and ergodicity – has elements within its methodology that makes it better suited to incorporate sustainability into its analysis than neoclassical economics.

Keywords: sustainable development; neoclassical economics; post-Keynesian economics; ergodicity.


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1 Introduction: economic sustainability

Sustainability means to support before a collapse [1,p.1]. This is an issue that post-Keynesians have always been concerned about since the Great Depression – how to sustain and stabilise a world economy that is susceptible to economic and financial crises and collapse. Ecological economists have a broader meaning of sustainability than post-Keynesians to include eradicating unemployment and poverty today, while securing natural resources and a stable environment for future generations. To put it clearly: the test of economic sustainability is how you deal with unemployment and poverty today without damaging and depleting the natural resources and ecological systems needed for economic opportunities for future generations.
Much discussion has surrounded the concept of ‘economic sustainability,’ what it is, and why it is important. The term became widely known in the early 1970s when a team of scholars at the Massachusetts Institute of Technology published a report for the Club of Rome (The Limits of Growth, [2]) which was based on their findings from a computerised global systems dynamics model that identified environmental limits to growth. The model was unique at that time for it could:

- Simulate exponential growth, found in many natural systems.
- Apply both positive and negative feedbacks to any particular growth process.
- Permit the analytical linking of different processes within a system [2–3].

Given the level of extractions and use of natural resources, population growth, and the level of pollutants being discharged into the environment, the study concluded that increased economic growth could not be sustained without adverse effects and the limiting of future growth possibilities. They also argued that there was “no technical solution” to this problem and that limits must be put on “population growth and capital investments in industrial processes” [3,p.132]. Following the writings of John Stuart Mill [4] and the later writings of Herman E. Daly [5], the report advocated a steady-state economy where the goal was to stabilise levels of population and use of natural resources. It is important to point out the report did not conclude that a global economic collapse was inevitable, but instead that modifications were needed for the world’s economic system to ‘sustain’ itself. The most controversial part of the report was its insistence on the redistribution of wealth and income between rich and poor countries as a way of dealing with present world poverty and to sustain long-term economic growth. After the report was issued, there was a healthy debate as to whether the report was biased and whether its views on technology were correct [6].

The concept of economic sustainability also gained worldwide attention in 1987 with the Bruntland Report that led many national leaders to use it as a guiding principle for economic development [7]. The report was produced by the World Commission on Environment and Development under the aegis of the United Nations General Assembly when, in 1983, they set up a resolution to look at the impact of worldwide economic growth and its impact on the environment and “to propose long-term environmental strategies for achieving sustainable development…” [3,p.124]. The Chairwoman of the Commission was Gro Harlem Bruntland, a former Prime Minister of Norway. The report was concerned with the increase in the inequitable distribution of the world’s wealth between rich and poor countries, and how the wealth gap affected environmental degradation. The richer industrialised countries contributed to environmental problems through resource extraction and pollution, particularly fossil fuel use causing such environmental problems like global warming. The poorer countries also contributed to environmental degradation through such behaviour as tropical deforestation and population growth. The solution the report recommended was a policy of worldwide sustainable development. The report provided a general but working definition of economic sustainability that has been widely used [7,p.40]:

“Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future.”
The *Bruntland Report* differed in its definition of sustainability from the *Limits of Growth Report* by not arguing for a steady-state. It instead argued for a transition “to not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs” [7,p.40]. Instead of calling for a cessation to economic growth, it asked for a moderation to the increase of economic growth, thus making the *Bruntland Report* more generous in its policy of compatibility of economic growth with sustainable development by stating:

“The medium-term prospects for industrial countries are for growth of 3–4%, the minimum that international financial institutions consider necessary if these countries are going to play a part in expanding the world economy. Such growth rates could be environmentally sustainable if industrialised nation can continue the recent shifts in the content of their growth towards less material and energy intensive activities and the improvement of their efficiency in using materials and energy.” [7,p.51]

Since these reports were published there has been a constant debate and discussion among ecological economists and others about what sustainable development is and what it means. The discussion has led today to two definitions – a weak and a strong sustainability. Weak sustainability is met when the losses of a nonrenewable or renewable resource (natural capital) can be compensated by a substitution – *i.e.*., of man-made capital – of equal value. Strong sustainability sets up a constraint where the stock of the existing natural capital should not decrease or be substituted by man-made capital given its unique and complementary quality. The present debate between neoclassical economists and ecological economists surrounds the issue of how we should define sustainability, along with the role of economic growth and environmental quality.

## 2 The neoclassical response

Most mainstream economists can accept the idea that actions today need to be responsible and that we need to appropriately manage our natural resources and control pollutants. Many also concede that we owe to future generations a living standard, both economically and environmentally, at least of the same level that we have today, if not higher. Neoclassical economists argue that the best way to sustain natural resources, minimise pollutants, and enjoy continued economic growth is to allow the efficiency of markets to work. With free competitive markets, good information, and substitutes, we can achieve the goal of sustainability and economic growth – that is, have our cake and eat it too. This assumes and requires that elements of all capital, both natural and man-made, can be aggregated and measured. For mainstream economists this means money values can be placed on natural capital – that environmental quality, effects, and stocks can be measured and a monetary value put on them. This allows the neoclassical economists to use the rules of cost-benefit analysis and to make optimisation decisions of how to achieve a consistent level or capacity of sustainable capital over a period of time.

An example of the neoclassical approach to sustainability can be found in the work of Hartwick [8–9] and Solow [10–12]. Their work has been known as the Hartwick-Solow model. I will not go into great detail about this model, but what it does is look at the
extraction of a nonrenewable resource over an infinite time horizon, and asks whether the resource can be sustained over time. The answer to the question depends upon the substitutions that exist for the resource. If the resource is essential for current production, and there are no substitutes, the sustainability of output over time is zero. But, if there are substitutes, then what is known as the Hartwick-Solow rule can be used, which gives the optimum extraction and substitution rate needed to sustain the resource. When the resource is consumed or extracted, there is a required user rent added to the cost of extraction, which is then invested to add an amount of capital equal to the amount that is extracted. The only way the Hartwick-Solow rule can work is if there are adequate substitutes, which Hartwick and Solow assume. What is important in this analysis is its reliance on an efficient depletion plan based on complete and adequate information, having agents that act rationally, coming up with a correct discount rate, and, of course, the existence of substitutes.

Colander [13] points out that the neoclassical story might be a plausible one, but does it represent the reality we face? As mentioned earlier with the Solow-Hartwick model, neoclassical economists deal with environmental management as an optimisation problem that assumes fixed tastes and rational atomistic agents working in an ergodic world of logical time with the goal being efficiency. Colander points out that this approach does not ask the question whether efficiency should be our goal. He questions the neoclassical story by arguing that social welfare theory needs to be put in a broader contextual framework that looks at institutional, social and, in this case, environmental welfare. This context can be found in writings of one of the first environmentalists, John Stuart Mill, where efficiency is not an end in itself – it is simply a means to an end. Efficiency only has meaning when one clarifies the goals that society and individuals want to achieve. This has always been a concern of post-Keynesians and also of ecologists.

The neoclassical story is always in reference to a unique equilibrium point representing efficiency, which in the Hartwick-Solow model means sustainability. Market forces will naturally lead to that point of sustainability, which is equal to efficiency. Prices do it all. Limited natural resources lead to price rises as they become finite and limited. This takes us to conservation and substitution and, alas, we have sustainability with scarce resources. This, of course, is not how ecologists define sustainability, which means more than just reaching a determined equilibrium point.

Both ecological economists and post-Keynesians have always had problems with the explanation that market forces will inevitably lead to a particular equilibrium outcome at some future time. Post-Keynesians and ecological economists talk about multiple equilibria where not all points are equal. Once you start talking about multiple equilibria, you also refer to dynamics analysis, complex theory, and nonlinear optimisation. In response, neoclassical economists throw up their hands and say enough and criticise ecologists and post-Keynesians for being too vague, general, moral not scientific, and asking far too many questions. A good example of this is Solow’s argument in his article “Sustainability: An Economist’s Perspective” [14]. Though sympathetic with the idea of sustainability, he states:

“...don’t forget that sustainability is a vague concept. It is intrinsically inexact. It is not something that can be measured out in coffee spoons. It is not something you could be numerically accurate about. It is, at best, a general guide to policies that have to do with investment, conservation and resource use. And we shouldn’t pretend that it’s anything other than that.” [14,p.138]
What is really going on here is that sustainability requires nonlinear optimisation, which simply goes beyond the mathematical and analytical abilities of neoclassical economics. Once you take multiple equilibria outcomes seriously then mainstream economics is lost and cannot come up with its unique solution. Instead of admitting the limitation of their methodology, neoclassical economists attack the messenger by saying what you are trying to do is vague, general, cannot be done, not economics, meaningless, and not efficient. Solow continues in his article with the following [14,p.132]:

“Sustainability as a moral obligation is a general obligation not a specific one… sustainability is about distributional equity… it says something about a moral obligation that we are supposed to have...”

The point that Solow is making is that neoclassical economists have problems with sustainability because it represents a normative statement, and as we all know, efficiency has nothing to do with normative use. In fact, normative judgments just get in the way of economic analysis. For those who have tried seriously to work with neoclassical economists, you know the response. Once you start talking about something like sustainability, uncertainty, historical time, path dependencies, hysteresis, circular and cumulative causation, they look the other way and claim ‘there you go again with your heterodox imprecise, vague, normative, nonworkable and ultimately meaningless statements’. Just because the neoclassical methodological approach cannot handle sustainability does not mean it is a meaningless term and that it should simply be defined as being equal to efficiency. Post-Keynesians have a broader methodological approach that allows them to make sense of sustainability, which will be discussed later in the paper.

Another issue where there is tension between ecological economists and neoclassical economists is on the role of economic growth and environmental quality. The neoclassical argument is that economic growth is actually good for the environment. They cite empirical evidence suggesting a correlation between per capita income and environmental quality [15]. When per capita income grows to a certain point, people put a higher value on environmental quality. If we look closely at this argument, what we find is that the correlation between economic growth and environmental quality is limited at best and not sufficient for environmental improvement. For example, economic growth and environmental quality usually reduces a specific group of pollutants associated with poor sanitation and impure water supplies [15]. Though this is good, it begs the question of whether economic growth is able to deal with the most pressing environmental problems we are facing. Also, there are different economic development paths associated with environmental quality, which depend upon the political and social institutional arrangements found in countries. For example, with some countries, as per capita incomes rises, there is an increase in CO₂ emissions per capita, while in other countries, there is a decline (i.e., countries that support public transportation over the use of automobiles). Ecological economists have many other concerns with the neoclassical argument of the positive correlation between growth and environmental quality. Here are some of them briefly [16]:

- There is no evidence to suggest that the environmental resource base is capable of supporting unlimited growth.
Continued economic growth at some point could lead to permanent damage to our environmental resource base that could put future economic growth at risk, given the hysteresis and accumulative impact that different pollutants might have.

Studies that look at the correlation between per capita growth and environmental quality just look at short-term costs and do not take into consideration accumulation effects of waste that can lead to long-term costs like global warming, which seems to function with increase income.

The studies do not look at resource stocks, important for sustainable development, but only emissions of pollutants.

The studies do not address the systemwide consequences of pollutant emissions on the biosphere or ecosystems.

The studies do not look at worldwide effects, whereby the reduction of pollutants in one country might be transferred and increased in another.

Such studies undermine the importance of institutional reforms as an important part in determining environmental quality and the development of market-based incentives.

Global markets are shifting environmental costs to the poor, future generations, and developing countries.

In general, what these neoclassical studies lack is an awareness that all economic growth depends upon a variety of resources, which include ecological systems, which are limited. The use of such resources could lead to an irreversible reduction of creating material production in the future. This has led ecologists to call for the wise management and conserving of these resources, referred to as natural capital, and to look at it as a stock and a complement to other forms of capital, not a substitute.

It should be pointed out that natural capital is not static. It is based on technology, consumer preferences, and a dynamic relation between the physical and a biotic environment that can be unpredictable. To come up with an exact measured amount of the existing natural capital stock is difficult, but that does not mean we cannot come up with some type of measurement or general index of the stock. Ecological economists have advocated for indicators that give us early warning signs of environmental stress and depletion. With the work of Dick Norgaard [17] and others, this can be tested through ‘adaptive management’ techniques, which look at different regions, locations, and evaluating different ‘scales.’

For the ecological economist, although the level of activity and its effects on resiliency is unknown, we can develop policies that look at improving the signals of our impact on natural capital. This is important because ecological resiliency can erupt abruptly, and might be irreversible. To develop adequate signals that can be used and developed in policies that create adequate incentives, we need to think about the dynamic effects of changes in the ecosystem and look at buffering capacity and thresholds and institutional restrictions. Given the uncertainties about ecosystem dynamics, and unpredictable outcomes, we need to think in terms of institutional constraints that might force us to act in a precautionary way. Such activities are important for the following reasons [16]:
At some point of massive production and population pressure, we could see the discontinuous change in ecosystem functions that could be associated with a sudden loss of biological productivity, reducing our planet's capacity to support human life.

We could find ourselves with an irreversible change in the set of options open both to present and future generations with depletions of groundwater reservoirs, deforestation, and loss of biodiversity.

Continued economic and population growth could lead to discontinuous and irreversible changes from familiar to unfamiliar states that increase the uncertainties associated with the environmental effects of economic activities.

Because of uncertainty, it might be difficult for us to know the effects of economic activities on the resiliency of our natural resources and environmental systems, but what is important is to start looking and doing some serious work that tries to measure the effects of economic activities that are sustainable and resilient with our ecosystems and natural resources.

3 Sustainable development and post-Keynesian economics

By evaluating the ecological economists' response to neoclassical economics, we can see some compatibility with post-Keynesian economics, particularly those working with complexity theory. With complex systems, we do not talk about a unique point of equilibrium or simply focus on the automatic forces leading to that point. We do not talk just about rationality, but look at system analysis along with individual behaviour acting in an environment that is constantly changing and coevolving. Talking about sustainable development makes sense here. We have a dynamic process where we reach one position and forces push it to another, which is most likely unpredictable. This way of thinking fits with post-Keynesians' worldview.

Think about how sustainability fits with post-Keynesian analysis. Instead of having a single equilibrium, you can have a variety of possible solutions with some being more likely than others. We can evaluate the likely outcomes through evaluating the whole system and developing heuristic or formal simulation models. We can go beyond equilibrium to look at a system being driven with a variety of possible outcomes. For example, we can have replicator dynamics where the outcome is system dependant with an outcome that most likely cannot be predicted by any individual agent. The work of many post-Keynesians have looked at markets as part of, and affected by, social and political institutions. This takes into account uncertainty and historical time, which seems to be compatible with the ecological view of evolutionary development under uncertainty with the difference that ecologists have defined systems to include not just social and political institutions, but also ecological and biospheres. Let us look at the ecological economists' position.

Ecological economists look at natural and created capital more as complements than substitutes. They look at natural capital as a stock that can be exhausted. They also look at natural systems as being fragile and unpredictable, defined better by complex relations with outcomes being highly uncertain. They look at the economy as being a subset of the whole environment. Though not hostile to market incentives, they are skeptical that they can, by themselves, deal with the environmental problems we are facing. They look to
government or other institutional organisations taking a role of setting sustainable policies to protect natural capital and to restrict environmental degradation, which means public policies that deal with environmental standards in the economic decision-making process. There are two primary concerns of ecological economists:

1. The relationship between economic growth and environmental quality.
2. The link between economic activity and the carrying capacity and resilience of the environment.

Can the views of post-Keynesians and ecological economists be reconciled? Can post-Keynesians help the ecologists with their concerns? My argument is that they can. Post-Keynesians and ecological economists recognise that traditional neoclassical economics, besides not being able to provide a free lunch, is usually out to lunch with an economic system that fully anticipates a statistically predictable future. Post-Keynesians and ecological economists share a more inclusive and activist position in dealing with real-world problems. Though Keynes did not focus on it, I would argue that the ecological economist’s concern with sustainability is something Keynes would appreciate. In fact, Keynes does touch on it, though not directly, in his essay “The Future” [18, pp.363–364]:

“...of the absolute needs – a point may soon be reached, much sooner perhaps than we are all of us aware of, when these (economic, word add for clarification) needs are satisfied in the sense that we prefer to devote our further energies to non-economic purposes...I draw the conclusion that, assuming no important wars and no important increase in population, the economic problem may be solved...this means that the economic problem is not – we look into the future – the permanent problem of the human race...The pace at which we can reach our destination of economic bliss will be governed by four things – our power to control population, our determination to avoid wars and civil dissensions, our willingness to entrust to science the direction of those matters which are properly the concern of science, and the rate of accumulation as fixed by the margin between our production and our consumption; of which the last will easily look after itself, given the first three.”

What Keynes says here is something ecological economists can also embrace, that is, his concern with controlling population growth, to avoid wars and civil dissensions, to entrust science, and finally, to recognise the relationship between production and consumption and achieving a certain level of sustained capital stock for economic prosperity. Also in the essay, you find that Keynes returns economics to a moral philosophy directed toward raising the quality of life today and for future generations.

We can see many elements from post-Keynesian economics that can be used by ecological economists. First, our methodology: We believe in methodological pluralism that is based in realism, as compared to the neoclassical view of constrained maximisation and instrumentalism. This methodological pluralism is the foundation of ecological economists [19]. Following Keynes, we hold onto a form of organicism as compared to the methodological individualism of neoclassical economics.

Second, because of historical time, post-Keynesians do not turn to neoclassical marginal analysis, but to path dependency and irreversibility – a key concern for ecological economists. Joan Robinson was the one who highlighted the difference between logical and historical time for post-Keynesians. A good example of logical time analysis is the neo-Walrasian Arrow-Debreu-Mackenzie model that dominates the
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neoclassical method [20]. Here agents optimally plan all present and future economic activities, and all economic outcomes are determined simultaneously at a single instant. The system can move back and forth with no track of the processes involved. While logical time is essentially spatial/mechanical, historical time is social and behavioural. Historical time is a unidirectional sequence of events, in which the present occurs in the context of the given and influenced by a series of prior events that make up the past. Putting the present in the context of what has gone on beforehand allows for the possibility that ‘history matters,’ in the sense that the past has an influence on the subsequent outcomes of a system. The consequence is that the concrete historical functioning of a social system will always be associated with path dependent change as movement through historical time results in changes in stocks of experience that has an impact on behaviour and subsequent future outcomes.

In historical time, then, the impact of past events on the present cannot be completely undone in such a way that restores the initial conditions prevalent before a concrete historical experience. As Georgescu-Roegen [21] pointed out, unlike logical time, historical time is irrevocable; we move strictly from the present to the future, which plays an important part in Georgescu-Roegen’s views on entropy and the economic process. The notion of that history matters obviously implies that current actions and events can have impact on future outcomes. Unlike logical time, then, the determinants of future outcomes in historical time are not time-invariant laws. Rather, these determinants are partly constituted in a historical (sequential) fashion, and include innovative behaviours which, by their very nature, cannot be known about in advance. The analytical omniscience that is possible in logical time is denied in historical time, and instead decision making is subject to uncertainty [20].

Another area in which post-Keynesian economics can provide some insights and share with ecological economists is the idea of uncertainty. The work done by post-Keynesians show a relationship between uncertainty, institutions, knowledge, and bounded rationality. The work done by post-Keynesians like Barkley Rosser, Jr. [22] have recognised and used the work of Herbert Simon and Georgescu-Roegen that look at complex dynamics that imply a lack of predictability about the future is very helpful for ecologists.

Finally, the work of Marc Lavoie [23] has looked at consumer theory within post-Keynesian economics with the following framework:

- Procedural rationality: bounded knowledge and uncertainty undermine optimising behaviour.
- Satiable wants: some needs are more basic than others (the principle of needs hierarchy), and that a distinction between wants and needs is necessary.
- Separability of needs: needs can be separable from each other implying there is a restriction to the degree of substitution between goods.
- Needs hierarchy: needs are subordinate and hierarchical.
- Growth of Needs: Income effects are more important than substitute effects on the goods a person consumes.
- Non-independence: preferences are not made independently.
All of these conditions are compatible with the view of ecological economics, and their methodological approach to deal with sustainable development.

Where there seems to be tension between post-Keynesians and ecological economists is with the role of effective demand in a modern money-using entrepreneurial economy. The view of post-Keynesians is that, in our modern economy, we face at most times unemployed labour with an excess productive capacity and that this type of economy is demand driven both in the short and long-run. Post-Keynesians reject the classical and neoclassical view that economics is the science of scarcity analysis and, because of this, there is not a natural rate of unemployment or interest. This would also explain why we focus more on income and production effects compared to substitution effects.

Also post-Keynesians understand the role of money and that the money supply is demand-dependent upon the endogenous behaviour of banks associated with liquidity, uncertainty, and credit, which is developed and explained in the writings of Keynes, Kalecki, Paul Davidson, Hyman Minsky, and others. Understanding the role of money and financial markets has been a major concern and focus for post-Keynesians where, for ecological economists, it hardly plays a role. Also for some post-Keynesians the ideal of sustainability and natural capital brings back the classical view of supply constraints that dominate the classical literature. The notion of sustainable development identifies the need to constrain economic growth to preserve genetic and species diversity, and to support essential ecological and life support systems and natural stocks of nonrenewable and renewable resources.

What I want to argue is that:

- As post-Keynesians, we need to make a distinction between natural and human capital; that what seems to be unemployed is artificial and human capital, not natural capital; and that we need to treat natural capital differently.

- Following Keynes, the economic problem can be solved and we need to broaden our conception of the economic problem beyond the neoclassical view. Like Keynes, we need to look at the future and the qualitative improvement in our lives for future generations.

I believe that ecological economists would agree that effective demand does drive the economy and that full employment requires institutional and public policies to sustain such levels. The question is whether we can achieve full employment, reduce worldwide poverty while sustaining our natural resources, reduce environmental degradation, and protect a fragile ecosystem for future generations? This is what the sustainable development debate is all about, and I believe the post-Keynesian approach is in a better position to deal with this issue than the neoclassical approach. Are there tensions between post-Keynesians and ecological economists? Yes, but it seems to me that the post-Keynesian story is one that is compatible with the ecological view of evolutionary development where there are many possible paths, some more sustainable than others.
4 Policy recommendations

Finally, here are some concrete examples of how post-Keynesian economics can help with developing policies for sustainability. Post-Keynesians like Hyman Minsky [24] and Randy Wray [25] have advocated what has been called an ‘employer of last resort’ policy. Under this policy, the government would provide a steady state of full employment to any one willing and able to work. The ELR policy would expand and contract around a steady state of full employment as the economy expands and contracts. If the private sector expands, the number of people employed in the public employment programme would decrease, and if the private economy contracted, then the public programme would expand guaranteeing a steady state of full employment in the economy. This idea of using buffers or guaranteeing levels of full employment can also be used as a way of guaranteeing a steady state of natural capital that can be sustained over time. For example, to guarantee that we do not run down our existing stock of natural capital, we can use what is called the Herman Daly rule:

“Never reduce the stock of natural capital below a level that generates a sustained yield unless good substitutes are currently available for the services generated.”

There is a lot of discussion on exactly what the rule means, which I would not go into now, but it is an idea post-Keynesians can relate to – an idea of a buffer. I like the idea of Ciriacy-Wantrup [26] and Bishop who talk about a safe minimum standard for resources with highly uncertain future values. This advocates that we establish a stock or buffer or level of natural capital indexed at what is considered to be a safe minimum standard for unique resources that should be preserved at levels that prevent irreversible depletion. If new scientific evidence shows that the minimum amount needs to be changed, either increased or decreased, then the stock or amount can be changed. Another factor is the types of substitutes found that could affect the minimum standard, which could cause a contraction or an expansion of the stock amount of the natural capital.

Another area where post-Keynesian policies can have an impact on ecological economics is recent work done by post-Keynesians with complexity theory [22,27–28]. By developing policies that deal with nonlinear complexities in a global ecologic-economic system, this work looks at establishing critical boundaries and threshold levels in order to determine catastrophic collapses by following a series of principles called the Lisbon Principles [29]. They include the Responsibility Principle, the Scale-Matching Principle, the Precautionary Principle, the Adaptive Management Principle, the Cost Allocation Principle, and the Full Participation Principle. These principles are similar to the ‘Daly Rule’ in that they establish social guidelines and institutional suggestions to deal with uncertainties that could lead to catastrophic outcomes.

Another example is the work that Barkley Rosser, Jr. has done with fisheries and forest systems [22,30], which can exhibit complex nonlinear dynamics that complicate traditional policy-making efforts. Chaotic dynamics and catastrophic discontinuities can arise. These can be exacerbated in hierarchical systems with evolving mean-field dynamics as well as in complicated multi-species systems, such as predator-prey relationships. These difficulties have been quite evident in fisheries, thus presenting severe challenges to policymakers. Such difficulties tend to emphasise the need to put in place safeguards to remain within critical boundaries or thresholds – in short, a serious
application of the Precautionary Principle. They also emphasise the need to clearly identify the relevant scale levels in hierarchical systems at which policies and access controls should be implemented by the Scale-Matching Principle. Flexibility of policies in an adaptive framework would seem to be appropriate as well [30].

All these efforts are all contingent on the emergence of appropriate institutions and arrangements for dealing with these policy problems, something that post-Keynesian economists would agree with and have much to contribute.

5 Conclusion

This paper has looked at the relationship between environmental sustainability and economics. Given that neoclassical economics defines the economic problem as studying the ways in which human beings satisfy their unlimited wants with limited resources, neoclassical economics with its current methodological approach is not well suited to understand or analyse the problem of environmental sustainability. This paper finds the post-Keynesian approach to environmental sustainability more appropriate in understanding sustainability in its models. Though there are limitations with existing post-Keynesian models in understanding and dealing with sustainability, it also has elements within its theoretical base that allows it to incorporate sustainability by focusing on macroeconomic and policy outcomes, uncertainty, and historical time, which brings institutional analysis into its economic approach. This puts post-Keynesian economics in a better position to assimilate sustainability into its models than the neoclassical approach, providing the public with a more steady footing to deal with policy concerns of environmental sustainability than can be recommended by mainstream economics.

References and Note

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20 This section on historical time is based on a piece written by me and Mark Setterfield appearing the *Encyclopedia of Political Economy* (1999) edited by Phillip Anthony O’Hara, London: Routledge.


