An ecological stock-flow-fund modelling framework

Yannis Dafermos, University of the West of England
Giorgos Galanis, New Economic Foundation
Maria Nikolaidi, University of Greenwich

Extended abstract

Over the last years the synthesis of ecological and post-Keynesian economics has been identified as an important inquiry that can open the avenue for a fruitful combined examination of economic and ecological issues (e.g. Holt and Spash, 2009; Mearman, 2009; Kronenberg, 2010; Spash and Ryan, 2012; Fontana and Sawyer, 2013). Ecological economics provides a solid framework for the analysis of the economy-ecosystem interactions. This framework is based on the conceptualisation of the economy as an open subsystem of the closed ecosystem and the detailed analysis of the implications of the First and the Second Law of Thermodynamics. Post-Keynesian economics provides a quite rich explanation of the dynamics of modern capitalist economies by putting at the centre of its analysis the importance of aggregate demand, the non-neutral role of money and finance, the impact of fundamental uncertainty on economic decisions and the links between income distribution and economic activity. Ecological economics lacks the solid macroeconomic framework of post-Keynesian economics. Post-Keynesian economics almost totally ignores the ecological constraints of macroeconomic activity. Therefore, the synthesis of these two branches of economics would be a significant step forward.

Although the importance of this synthesis has been recognised by a plethora of scholars, only a few attempts have been made in developing an integrated approach in this direction and, particularly, in developing a modelling framework that combines ecological and post-Keynesian economics in a systematic way. The most important of these attempts can be found in Victor and Rosenbluth (2007), Victor (2012) and Barker et al. (2012) who have presented large-scale models with Keynesian features that take into account the energy sector and various environmental issues. Moreover, Jackson (2011), Fontana and Sawyer (2013) and Rezai et al. (2013) have put forward building blocks for modelling frameworks that could combine ecological economics with Keynesian (or post-Keynesian) insights. Although these contributions are very significant, they can only be considered as the first steps towards the integration of ecological with post-Keynesian economics. For example, in the aforementioned contributions the role of money and finance,

which is fundamental in post-Keynesian economics, is not explicitly incorporated. Moreover, the full implications of the fact that the macroeconomy is an open subsystem of the closed ecosystem are not analysed in an integrated way.

This paper develops a new modelling framework that synthesises post-Keynesian and ecological approaches. This framework integrates the post-Keynesian stock-flow consistent (SFC) modelling approach, developed by Godley and Lavoie (2007), with the flow-fund model of Georgescu-Roegen (1971, ch. 9; 1979). The stock-flow consistent approach makes a coherent analysis of the stocks and flows in the macroeconomy and the financial system allowing thereby a consistent formulation of the links between the real and the financial spheres of the economy. The flow-fund model of Georgescu-Roegen is an analytical framework that describes in detail the energy and matter flow interactions of the economy with the environment as well as the role of funds in the economic processes. The formulation of these interactions takes explicitly into account the First and the Second Law of Thermodynamics. By combining and extending these approaches, our ecological stock-flow-fund (ESFF) modelling framework incorporates fundamental features of both post-Keynesian and ecological economics, most notably the consideration of macroeconomy as an open subsystem of the closed ecosystem, the impact of aggregate demand on economic growth and employment, the biophysical limits to economic activity, the effects of finance on growth and the importance of the laws of thermodynamics.

The ESFF modelling framework relies on four matrices: 1) the ecosystem flow-fund matrix; 2) the ecosystem stock matrix; 3) the transactions flow matrix; 4) the balance sheet matrix. The first matrix is an extension of Georgescu-Roegen's (1979, p. 1042) flow-fund matrix and captures the energy and matter flows in the ecosystem as well as the funds that are necessary for the various economic and natural processes. The second matrix represents the stocks of matter and energy in the ecosystem. The third and the fourth matrix describe the changes in the stocks and flows of the macroeconomic and financial systems, following the traditional formulations in SFC literature.

The paper illustrates the ESFF framework by presenting a model with a simplified macroeconomy and a simplified ecosystem. The macroeconomy consists of households, firms and commercial banks. Firms make conventional and green investment by using their retained profits and by taking out loans from commercial banks. Commercial banks distribute all their profits to households. The ecosystem is affected by the following economic and natural processes:

(1) Production of controlled matter: It produces controlled matter using matter in situ and controlled energy.
(2) Production of controlled energy: It produces controlled energy using energy in situ.
(3) Production of capital goods: It produces capital goods using controlled energy, controlled matter and recycled matter.
(4) Production of consumption goods: It produces consumption goods using controlled energy, controlled matter and recycled matter.
(5) Recycling: It produces recycled matter using recyclable matter, controlled energy and controlled matter. This recycling is conducted by firms.
(6) Consumption by households.
(7) Natural recycling: It produces matter in situ using dissipated matter and controlled energy. This recycling stems from nature's waste absorption capacity.
(8) Energy exchange with the outer space: It captures the fact that the ecosystem exchanges energy with the outer space.

The paper discusses the various potential applications of the ESFF modelling framework and indicates how this framework can be used as a platform for the joint investigation of ecological sustainability, macroeconomic viability and financial stability.

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