



A new ecological macroeconomic model

Analysing the interactions between the ecosystem, the financial system and the macroeconomy

Our economy, environment and financial system cannot be viewed in isolation: each interacts with the other. However, the current models that inform policy making lack a clear understanding of the links between these systems. This is a significant gap. It's time to develop a new modelling framework that can analyse these links in an integrated way.

The three crises and the need for an integrated approach

In 2007–08 the global financial system was hit by a severe crisis: major financial institutions collapsed, the interbank market froze, the price of crucial financial assets fell sharply and default rates skyrocketed. The financial crisis has had a significant impact on the real economy: the unemployment rate has substantially increased in most major economies and slow or no growth has become the new norm in the global economy. At the same time – and despite the slowdown of economic activity – the environmental crisis is becoming more severe. The recent human made greenhouse gas emissions are the highest in history, the earth's temperature is increasing and natural resources are continuously deteriorating.¹

These crises have called into question the sustainability of our societies. They cannot be tackled in isolation, as has mostly been the case so far.

Any attempt to deal with the economic crisis by using the traditional growth policies will lead to more pollution and a higher use of natural resources, risking further economic and financial crises. Any attempt to deal with the environmental crisis by ignoring the potential adverse effects on unemployment and inequality will damage our societies and lead to more severe economic and financial crises. And any attempt to regulate the financial sector without transforming the way that it interacts with the ecosystem and the macroeconomy will fail to ensure financial stability in the long run. There is, therefore, a clear need for a new approach that will promote policies capable of dealing with all these crises simultaneously.

Can we use existing models?

There are already a large number of economy-environment models.² However, these models can only partially support the new approach that we need. The main reason is that finance and money are either absent in the analysis or are considered to play a neutral role, oiling the wheels of market exchange. The impact that the

Box 1: Types of thermodynamic systems

There are three types of thermodynamic systems. An open system is a system that exchanges both energy and matter with the surrounding environment: the economy is such a system. A closed system is a system that exchanges only energy, not matter: earth is such a system. An isolated system is a system that exchanges neither energy nor matter.

creation of money has on economic growth, the effects of debt and asset prices on investment and consumption, and the links between inequality and debt accumulation are not considered in these models. Current economy-environment models cannot, therefore, explain the interactions between the financial system and the macroeconomy. They do not also link the financial system and the ecosystem. This is a crucial missing element because the financing of various types of green investment is one of the factors that will affect future pollution levels and resource security.

Dominant economy-environment models also make questionable assumptions about how the ecosystem and the macroeconomy interact. The ecosystem in these models is generally considered as an extension of the macroeconomy. They do not take explicitly into account the fact that the macroeconomy is an open subsystem of the closed ecosystem, and that economic processes should respect the laws of thermodynamics (see Box 1 and Box 2³).

Furthermore, the prevailing economy-environment models analyse environmental issues by pricing the environmental externalities in order to incorporate them in the utility and profit maximisation of households and firms. This approach relies on the questionable assumption that a sufficient condition to save the planet is to incorporate ecological problems into the market price system.

Towards a new modelling framework

We recognise the weaknesses of the current models which have shaped the dominant theory and thinking on the three crises. Therefore, the

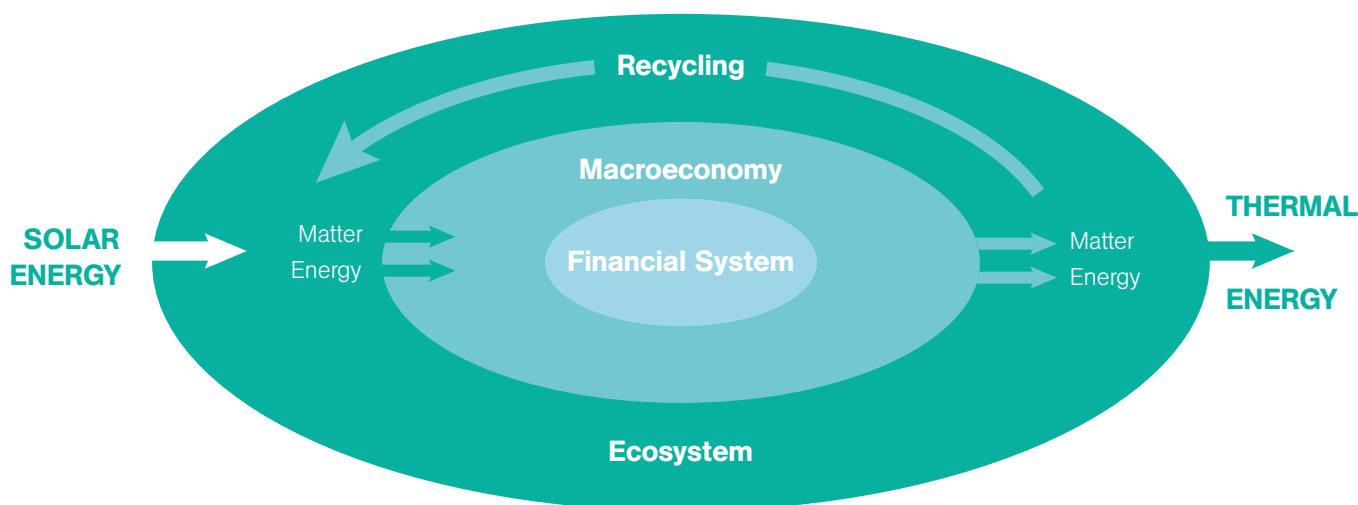
Box 2: The First and the Second Law of Thermodynamics

The *First Law of Thermodynamics* states that energy and matter cannot be created or destroyed. A straightforward implication of this law is that humans cannot create energy and matter and, therefore, economic activity unavoidably relies on resources that are available by nature. The *Second Law of Thermodynamics* states that within an isolated system entropy increases or remains constant when energy and matter are transformed. Entropy is a measure of unavailable energy and disorder. An implication of the Second Law of Thermodynamics is that by transforming energy and matter, economic processes tend to increase the entropy in the ecosystem reducing thereby the ability of the macroeconomy to reproduce itself in the future.

New Economics Foundation, in collaboration with the University of Greenwich and the University of the West of England, is developing a new modelling framework that can consistently analyse the interactions between the ecosystem, the financial system and the macroeconomy.

Using insights from various fields, such as post-Keynesian economics and industrial ecology, this modelling framework combines the following distinct features:

- i) *The economy is an open subsystem of the closed ecosystem (see Figure 1):* All processes in the macroeconomy, such as production of capital goods and consumption by households, employ useful energy and matter from the environment as inflows. The macroeconomy produces significant amounts of material waste, unavailable energy and greenhouse gas emissions that affect the stability of the ecosystem, having feedback effects on economic activity.
- ii) *The economy-environment interactions respect the laws of thermodynamics:* The restrictions that stem from the First and the Second Law of Thermodynamics are explicitly incorporated in the transformation of energy and matter.⁴

Figure 1. Ecosystem, financial system and macroeconomy in our new modelling framework

- iii) *There is a clear distinction between stock-flow and flow-fund resources:* The stock-flow resources (such as fossil fuels and minerals) are materially transformed into what they produce, can theoretically be used at any rate desired and can be stockpiled for future use. The fund-service resources (such as labour and capital) are those that are not embodied in the output produced, can be used only at specific rates and cannot be stockpiled for future use.

The distinction between these two types of resources is significant because it demonstrates that production needs both of them: there is no possibility to substitute the one for the other, as is the case in conventional presentations of the production function.⁵

- iv) *Output is demand-determined but the environment might impose supply constraints:* Following the post-Keynesian tradition, output is determined by the demand for consumption and investment products. However, supply constraints might arise because climate change can cause damage that affects capital and labour or because finite natural resources might be exhausted in the very long run.
- v) *The dynamic interaction between monetary stocks and flows is coherently analysed:* In

the macroeconomy and the financial system the monetary stocks are the assets and liabilities of households, firms, commercial banks, the central bank and the government. Examples of assets and liabilities include the deposits of households, government bonds and the loans of non-financial corporations. The monetary flows refer to various monetary transactions that take place in each month or year, such as the payment of wages, the repayment of debt, the collection of taxes by the government and the interest payments on loans. Using stock-flow consistent techniques,⁶ our modelling framework formalises the dynamic interaction between stocks and flows in an explicit and consistent way, following the rules of accounting.

- vi) *The financial system is an important integral part of the macroeconomy (see Figure 1):* The financial system and its functions (bank lending, equity emission, bond pricing etc.) affect macroeconomic activity and, hence, the pressures that the latter places on the environment. The financial system also has an important impact on the financial feasibility of various types of green investment plans. Simultaneously, the macroeconomy influences the stability of the financial system. Since a healthy ecosystem is a precondition for a sustainable macroeconomy, the ecosystem

indirectly determines the stability of the financial system.

vii) *Money is endogenous*: Drawing on the modern view, money is endogenously created within the economy when banks provide loans to households and firms. The central bank is not able to control the amount of money created in aggregate.⁷ The endogenously created money can support economic growth and green investment, but it can also lead to higher financial fragility and a more unequal distribution of income and wealth.

viii) *Income and wealth distribution matter*: The distribution of income and wealth affects consumption and investment expenditures and, therefore, economic growth, the use of natural resources and pollution. Moreover, the financial system affects the way that income and wealth are distributed, having feedback effects on debt accumulation.⁸

The new framework and policy

Our modelling framework can analyse many issues that will be at the heart of policy making in the 21st century. These include the following:

- To what extent can green taxes reduce pollution and what can be their effects on economic growth, public debt and inequality?
- How can financial regulation and central banks contribute to ecological sustainability?
- How can the regulation of energy efficiency and recycling affect the ecosystem and the financial performance of firms?
- How can slow or no growth, combined with a reduction in working hours and

other institutional changes, affect pollution, unemployment and financial stability?

- How can fiscal policy enhance ecological sustainability?

Conclusion

The simultaneous existence of the environmental crisis, the financial crisis and the economic crisis calls for a fundamentally different approach to policy making. No longer can policies be developed that focus on just one area – rather, they must take into account the dynamic interactions between these three crises.

Our new modelling framework can become the basis for developing this new approach by, for the first time, making clear the links between the ecosystem, the financial system and the macroeconomy.

Endnotes

- 1 See IPCC (2015). *Climate Change 2014: Synthesis Report*.
- 2 For a recent review of these models see Scricciu, S., Rezai, A. & Mechler, R. (2013). 'On the economic foundations of green growth discourses: The case of climate change mitigation and macroeconomic dynamics in economic modeling', *WIREs Energy and Environment*, 2 (3), pp. 251-268.
- 3 For a detailed analysis see Daly, H.E. & Farley, J. (2011). *Ecological Economics: Principles and Applications*, Washington, DC, US: Island Press, 2nd edition.
- 4 Our approach on this issue draws on the tradition of Georgescu-Roegen (see Georgescu-Roegen, N. (1971). *The Entropy Law and the Economic Process*, Cambridge, Massachusetts and London, England: Harvard University Press) and the recently developed material flow analysis and physical input-output tables (see, for example, Suh, S. (ed.) (2009). *Handbook of Input-Output Economics in Industrial Ecology*, Dordrecht, Netherlands: Springer).
- 5 See Georgescu-Roegen (1971). *Ibid* and Daly & Farley (2011). *Ibid*.
- 6 See Godley and Lavoie (2007). *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*, Basingstoke, UK: Palgrave Macmillan.
- 7 See Ryan-Collins, J., Greenham, T., Werner, R. & Jackson, A. (2012). *Where does Money Come from? A Guide to the UK Monetary and Banking System*, London, UK: New Economics Foundation, and McLeay, M., Radia, A. & Thomas, R. (2014). 'Money creation in the modern economy', *Bank of England Quarterly Bulletin Q1*, pp.14–27.
- 8 See NEF (2014). *Inequality and Financialisation: A Dangerous Mix*.

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Design: the Argument by Design – www.tabd.co.uk