Ecological Macroeconomics: Introduction and Review

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1. Introduction

The Great Recession of the past years has brought macroeconomics back. Many of the recession's phenomena, causes and consequences alike, cannot be understood using solely microeconomic decision-making. Over the past decades the economics profession has pursued the implications of rational choices and enshrined them in so-called "micro-foundations" as a hallmark of modern economic theory. By focusing on the choices and actions of individual consumers, firms, or the government, however, one can easily miss important determinants of the economic system which only arise at the meso- or the macroeconomic levels where institutions, coordination, and complexity in general are important and sometimes even can take on a life of their own. To lesser extent, ecological economics has fallen prone to similar pitfalls by mostly focusing the unit of investigation on low-level, small-scale subsystems of the economy. There are, of course, notable exceptions including the early contributors Boulding and Georgescu-Roegen and the general interest of ecological economists in the field of (ecological) macroeconomics has been increasing.

We find the neglect of ecological macroeconomics, and ecological growth theory in particular, surprising since its need springs from the simple and most basic tenet of ecological economics: the world is finite. As the scale of the world economy continues to grow, humanity is increasingly confronted with the planet's biophysical limits. Ecological economics has been pointing to this unsustainability of economic growth incessantly. Progress on these questions of throughput and economic growth has been made in terms of collecting and implementing the necessary empirical data in input–output analysis and by pointing to unsustainable practices in the consumption and production of material goods. Ecological economists have also been successful in demonstrating the inadequacy of conventional macroeconomic thinking in addressing the fundamental social problems a transition to sustainability confronts. Neoclassical macroeconomics assumes that setting caps and price signals is sufficient to steer the market economy towards a sustainable pattern of growth and resource use. Others believe that a more far reaching transition is fundamental, requiring serious rethinking of the growth paradigm and the associated standard economic assumptions and the consideration of societal institutions and power relations.

Meanwhile projected growth rates of resource use remain positive and GDP growth remains an unquestioned imperative for macroeconomists throughout the world. This focus on rising consumption and material well-being is understandable in less developed countries where labor productivity growth is deemed a necessary condition for the alleviation of poverty and the advancement of development. However, even in OECD countries most macroeconomists continue to see growth as a socially stabilizing necessity in times of record unemployment (both in magnitude and duration) and faltering aggregate demand. The Great Recession painfully reminds us that reductions in economic activity, while providing breathing space for the biophysical system, bear socially unacceptable consequences. Social institutions do not have to rely on an expanding economic system and exactly how to reorganize our societies to cut the link between growth and welfare is central to ecological macroeconomics.

In order to formulate consistent policy proposals for the economy as a whole, ecological economic theories need to take in essential macroeconomic thinking. Dominant macroeconomic theory takes a supply-side approach, which implies full utilization of all resources by assuming rational behavior and well-functioning markets. Under omnipresent full employment, however, many of the social problems associated with the fundamental transformation to sustainability do not arise. Post-Keynesian growth theories have been applied to develop less-rigid macroeconomic frameworks to allow disentangling of the policy implications advocated by ecological economists for the economy as a whole. Sustainable consumption, reduced working time, and "green" investment are examples of such concepts. However, the macroeconomic implications of these policies are not immediately obvious: If consumption is reduced, saving increases. Higher saving can lead to lower output and employment due the Paradox of Thrift. An increased saving ratio can, however, also feed into higher investment and higher economic growth. Reducing working time can spur technological progress, because firms want to adopt labor-saving technologies, potentially leading to higher output due to higher labor productivity. "Green" investments can help to reduce the impact of economic activity on the environment, but they themselves can spur economic activity along the lines of a macroeconomic rebound effect.

There is encouraging progress on merging ecological with macroeconomic thinking. In this introduction we trace the origins and recent developments of this progress. We also highlight where we believe further steps need to be taken: growth and distribution, sustainable organization of real production and finance, and social well-being. Non-neoclassical economists have been developing theories on all of these issues without resorting to an optimizing, full-employment framework for a long time. Such theories include Marxist, neo-Ricardian, and evolutionary economics. Ecological economists should, by standing on their

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shoulders, strengthen their own theories and devise practical and comprehensive policy recommendations.

While not represented in this special section, it must be noted that, concurrently to ecological macroeconomics, the Degrowth movement has been evolving out of the political ecology school and asking many of the questions that are relevant to ecological macroeconomics. The focus of Degrowth has been less on the current economic structures and more on the societal transformation necessary for sustainability with a particular emphasis on power, the social relations of production, and conflict. While there exist differences in their normative approaches and their research focus, degrowth and ecological macroeconomics share many of the immediate policy proposals for sustainability.[1]

2. The Historical Origin and Evolution of Ecological Macroeconomics

The origins of ecological macroeconomics date back to the origins of economics itself. Given the importance of agricultural land in the feudal societies, the Physiocrats saw it as the predominant determinant of the wealth of nations. Even Adam Smith, who saw a nation's wealth in the potential of the division of labor in a country's rising manufacturing sector, recognized landed nobility as an important class in the distribution of income. In the theories of the Classical Political Economists David Ricardo and Thomas Malthus, the carrying capacity of land is the ultimate limiting factor of an economy's scale.

With the rise of industry and the continuous decline of agriculture's share in GDP, land fell by the wayside of macroeconomics. Questions of sustainability were reduced to scarcity considerations in neoclassical models (Dasgupta and Heal, 1974; Solow, 1974; Stiglitz, 1974) and less utilitarian analysis based on systems modeling (Meadows et al., 1972). Over the course of the 1980s, however, it became clear that the defining constraints for material throughput would also be the planet's sinks and not just its sources with the ecological economists' emphasis on throughput as an analytical link between the two. It was in this context that Daly introduced the concept of ecological macroeconomics as "[t]he physical exchanges crossing the boundary between system and subsystem constitute the subject matter of environmental macroeconomics" (Daly, 1991, p. 35). Daly also understood that limits to growth would conflict with other policy goals, most importantly an equitable distribution of income and outlined how such a joint solution for social and ecological sustainability could be achieved.[2] In terms of growth theory, ecological economists have been arguing that economic growth can only be understood in terms of material throughput and, in particular energy (Ayres and Warr, 2009).

The ideas, questions, and theories outlined by Ayres, Daly, and others were not taken up for a considerable length of time. Instead the debate within ecological economics focused on measuring and establishing indicators such as the "green" satellite accounts (in the form of green material flow accounting), the environmental Kuznets Curve, natural capital, and the application of moral philosophy to ethical judgments of resource use (Harris, 2001). Questions of scale were addressed using resulting indicators such as the footprint and Human Appropriation of Net Primary Production (HANPP) and entered only cursorily in discussions of the IPAT and Kaya identities where scale enters implicitly through affluence and population. The level and growth of productivity and income per person are, however, endogenous variables which macroeconomics with its many varieties tries to explain. A suite of papers has tried to approach the question of ecological macroeconomics, as defined by Daly, by introducing a notion of "optimal" scale in the simple textbook IS-LM. The carry capacity of the environment is represented as a stylized EE schedule which traces "the physical exchanges crossing the boundary between system and subsystem" in Daly's words and the IS-LM-EE model constitutes a model for ecological macroeconomics, albeit with the simple insight that higher levels of output have to be accompanied by higher levels of resource productivity and lower levels of waste in order to keep throughput constant (Heyes, 2000; Lawn, 2003; Sim, 2006).

The collapse of the world economy and the ongoing Great Recession revived the interest in economic growth and its social necessity and desirability, and alternatives. Recent contributions can be seen as distinct from the previous literature on the (optimal) scale of the economy in following the macroeconomic tradition and focusing on the (de-)growth rate rather than the absolute size of the economy. This refocusing of the debate is in part due to the recognition of growth as an endogenous variable and the effects of growth on policy- and welfare-relevant variables such as employment, income, and the stability of the economy and its financial system. Another reason for the growing interest in macroeconomics is the ecological economists' skepticism towards the power of innovation and technological fixes. Most (neoclassical) environmental economists would assume that the establishment of 'right' prices, i.e. those reflecting scarcity, through permits, taxes, or direct regulation, suffices for the invisible hand to direct resources towards energy- and resource-saving technologies and "green" growth. Ecological economists are closer to the Post-Keynesian economists in their understanding of deep, fundamental uncertainty and endorsement of the Precautionary Principle: as innovations can fail and have unintended consequences. The issue of scale remerges and needs to be understood at its root. Ecological macroeconomics, therefore, is necessarily concerned with growth theory although recent contributions discussed below also branch out into monetary, distributional, and welfare economics.

Given their methodological overlap, ecological economists reached into the (Post-)Keynesian growth toolbox early on.[3] Victor and Rosenbluth (2007), Victor (2008), Jackson (2009) are early contributions to this new variety of ecological macroeconomics trying to understand how throughput (usually with a focus on fossil fuel emissions) can be stabilized at sustainable levels in macroeconomic models of output and growth. Given that all components of aggregate demand (consumption, investment, government, and, where relevant, net exports) are considered simultaneously and that standard policy tools such as tax and employment policy are used as policy instruments, these contributions are using standard macroeconomic reasoning. At the same time, Post-Keynesian economists have been considering the question of resource use (mostly climate change) in their theoretical work and policy proposal. While some of this work viewed climate change as a welcome opportunity for public infrastructure expenditure during the recession (so-called "Green New Deals") and as means of restarting growth, there have been more earnest attempts to engage with the community of ecological economics.[4]

3. Current Frontiers in Ecological Macroeconomics

Ecological macroeconomics has made significant progress over the past years and it is rapidly expanding its understanding of current macroeconomics. Two of the most important developments in macroeconomics over the past decades have been the study of the connection between the distribution of income and the growth of the economy

[1] For an introduction to Degrowth see D'Alisa et al. (2014) and the special section on The Economics of Degrowth (Ecological Economics, 2012, vol.84) and Degrowth: Form Theory to Practice (Journal of Cleaner Production, 2013, vol. 38).

[2] Somewhat surprisingly, Daly (1991) approaches the policy problem from a market-based view, arguing that the questions of allocation, distribution, and size can be separated such that allocation can be left to the market and distribution and scale could be addressed through 'appropriate' instruments. See also the critical discussion on optimal scale and the inseparability of policy instruments in Lawn (2001).

[3] The common ground and 'visions' between economists of ecological and Post-Keynesian type have been long been argued for (Gowdy, 1991; Gowdy and Erickson, 2005; Spash and Schandl, 2009; Kronenberg, 2010). Concrete movements have only been undertaken more recently (Holt et al., 2009; Rezai et al, 2013). See also Fontana and Sawyer (2016), Jackson and Victor (2016), and Taylor et al. (2016) in this special issue.

[4] The work on the climate policy and the macroeconomy by Terry Barker and his associates from Cambridge Econometrics is the big exception and deserves special notice.

and the study of financial markets and their role in the non-financial sectors. The topics of income distribution and financialization have also gained the interest of the wider public in the wake of the Great Recession. Ecological macroeconomics needs an understanding of and the implications of a stabilization or reduction of scale on both aspects: In modern capitalist societies, the question of scale can, in fact, not even be asked without an understanding of the determination of the distribution of income and the importance of financial markets for firms and households. The Great Recession also renewed questions about the desirability of growth and its suitability as a welfare indicator. Ecological macroeconomics has avoided the shackles of utilitarianism and is able to accommodate alternative welfare measures readily.

3.1. Income Distribution

The Occupy Wall Street movement and the work by Piketty have put the distribution of income and wealth in more developed countries back on the policy agenda and gained the interest of the wider public. Since the 1970s the distribution of income has deteriorated in most OECD countries and reached its pre-WWII peak shortly before the Great Recession the most of the relative income gains concentrated in the top single-digit percentiles.

In the economic literature, there is a long empirical and theoretical tradition in studying the macroeconomic effects of changes in the functional distribution of income. Already Keynes (1936) was aware of distributive effects on demand, although his concerns focused on rentiers with high-saving rates vs. wage-earners with low-saving rates. Kalecki (1942) formalized the ideas of differential saving rates for the extreme case where profit earners save all their income and workers consume all of their income and Kaldor (1956) introduced an equilibrating feed-back mechanism from aggregate demand to the distribution income. These early contributions have been canonized in the so-called Neo-Kaleckian (or Kalecki–Steindl) model of income and distribution (Rowthorn, 1981; Dutt, 1984; Taylor, 1985; Bhaduri and Marglin, 1990). The functional distribution of income impacts aggregate demand in two important channels in these models: consumption falls and investment rises with a higher share of profit in aggregate income.[5]

Taylor et al. (2016, in this issue) draw on this literature to introduce the accumulation of Greenhouse Gases in a Post-Keynesian growth model and study the macroeconomic implications of global warming. In particular, the effects of rising levels of GHG on output and employment, offsets by mitigation, relationships among energy use and labor productivity, income distribution, and growth, and the economic significance of the Jevons and other paradoxes are studied. Using methods to study dynamical systems, the authors trace the potential sources of instability and cyclicality already arising in the two-dimensional dynamical system of capital and GHG accumulation. In this model, full abatement of emissions is possible but the authors also present scenarios in which the economy continues to increase fossil fuel use along a baseline emission trajectory to trace the potential implications of high levels of atmospheric carbon on macroeconomic variables such as output, capital depreciation and labor productivity. This would be necessary to curb capital accumulation and carbon emissions to reach a steady-state economy.

The distribution of income only captures how (un)equal income flows are distributed. The distribution of wealth which accumulates out of these income flows is often distributed even more unequally. The relationship between income and wealth distribution has been subject to increased scrutiny since the analysis of Piketty (2014) who posited that slower growth rates are causing a deterioration in the distribution of wealth. Jackson and Victor (2016, in this issue) use a simulation model to see how far Piketty's conjecture holds up in a low growth environment. While motivated by the problem of climate change, the authors bypass the accumulation of GHG in the atmosphere and take the policy objective of or prospects of lower or zero economic growth as given. Drawing on the earlier modeling framework of both authors, they incorporate the Neo-Kaleckian features of differential saving rates in their model. Calibrated simulations show that Piketty's conjecture is not necessarily true: slow growth does not necessarily lead to a worsening of inequality; in certain circumstances inequality falls as income growth is throttled. Jackson and Victor (2016-in this issue) also discuss how lower economic growth relates to the question of employment in the presence of labor productivity growth and various rates of substitution between capital and labor inputs.

3.2. Finance and Financialization

Since the 1980s financial markets have been liberalized under the promise of efficiency, faster growth, and more stability. Critics have been arguing the opposite: financial liberalization leads to more risk and more risk-taking, faster but unsustainable growth and more fragility. It seems that the collapse of the world's financial system in 2007–08 vindicated these critics. Finance and the process of financial liberalization, often called "financialization," are defining aspects of modern capitalist economies which have to be included in any macroeconomic analysis.[6] Ecological economists have been studying the financial system for its role in the facilitation of consumption through credit and debt creation. The financial system, however, bears the additional functions of facilitating investment in (sustainable) technologies which shape the future evolution of production and technology, transforming risk, and influencing labor relations and corporate governance (Epstein, 2005; Krippner, 2005). Piketty's analysis also demonstrates the importance of finance for the distribution of income and, more importantly, wealth. Given the importance of the financial sector in funding any transition of the economy and its potential to sustain consumption beyond income growth, it is surprising that many ecological economists have seen finance as secondary to the issue of material flow (Daly, 2014). Ecological macroeconomists have been trying to understand and incorporate financial flows into their analysis.

Macroeconomic theorists have been debating the nature of money and whether its supply is endogenous or exogenous for many centuries (Taylor, 2004). While Monetarists in the spirit of Wicksell or Friedman see money supply as a policy variable and inflation as the adjusting variable (with positive inflation if there is too much money chasing too few goods), Non-neoclassical economists seem to converge on the view that money supply is endogenous (Lavoie, 2014). This view is also consistent with the current practice of central banks to set interest rates rather than limit the supply of money. With money creation endogenous, the financial actors (commercial banks, stock markets, investment banks, etc.) take on an even more important role in the monetary system.

While some ecological economists have been arguing in Monetarist terms (Lawn, 2010), others see endogenous money creation through commercial banks as incommensurable with a steady-state economy (Daly, 2013), arguing for monetary reform in favor of local currency and time banks (Douthwaite, 2012; Seyfang and Longhurst, 2013). There has been argument about the feasibility, practicability, and desirability of such approaches and the academic rationale for such movements is weak (Dittmer, 2013, 2015). Recent contributions on the role of finance in a sustainable economy feature high resolution financial systems, incorporating central banks, corporate banks, and sometimes even bond and equity markets (Bernardo and Campiglio, 2014).

[5] Depending on which of the two dominates, the output of the economy can increase or decrease with a shift from wages to profits. In inundated jargon, the economy is "profit-led" in the former and "wage-led" in the latter. An expanding empirical literature has been debating which economy falls in which regime during what period of time (for an extended introduction to the topic see Carvalho and Rezai, 2016).

[6] Epstein (2001, p. 1) defines financialization as "refer[ing] to the increasing importance of financial markets, financial motives, financial institutions, and financial elites in the operation of the economy and its governing institutions, both at the national and international level."

Jackson and Victor (2015) present and calibrate a detailed model of the financial side. Naqvi (2015) presents a calibrated model of financial markets and the environment and explores the repercussions of policies for environmental sustainability for financial markets in various scenarios.

Fontana and Sawyer (2016, in this issue) present an analytical model of endogenous money creation and show that the rate of economic growth depends on the rate of investment which itself depends on monetary factors. Lower economic growth for environmental sustainability leads to lower profit rates, investment demand, capital accumulation, and, ultimately, employment. Fontana and Sawyer are careful in spelling out that lower economic growth is not a policy variable but a possible policy objective and that policy would have to find ways of directing the volume and composition of investment. To them, these ways have to include monetary policy through money creation and the regulation of lending behavior of private banks. Jackson (2009) has been very vocal in pointing to the importance of harnessing finance for sustainability and of policy finding ways of directing the volume and composition of investment. Campiglio (2014, this issue) discusses the effectiveness of some of these ways, which include monetary policy and the regulation of lending behavior of private banks, in addressing the financing gap for low-carbon technologies. In the context of climate change, policy proposals often end with the call for establishing a price for using the earth's atmosphere. However, in order to invest, low-carbon firms typically require credit from banks, which might not be convinced by carbon pricing in itself to lend to them, especially when climate policies are implemented timidly as they are now (Bowen et al., 2014). Campiglio thus explores how macro-prudential financial regulation could be augmented to prioritize such societal desirable investments.

3.3. Welfare Indicators

Ecological economics has a long tradition in criticizing GDP as the key economic performance indicator. In this context it is interesting to note that the OECD played a key role in the GDP's rise to prominence. Schmelzer (2016) tracks how the pursuit of economic growth emerged as a societal goal and the ways in which the methods employed to measure, model and prescribe growth resulted in statistical standards, international policy frameworks and widely accepted norms.

Present institutions do not secure long run increased well-being as they focus on economic growth as the primary goal pursued through policymaking. Decades ago, the presumed underlying link was criticized conceptually and empirically (Nordhaus, 1972; Daly and Cobb, 1990; Stockhammer et al., 1997; Castaneda, 1999; Jackson and Marks, 1999). These studies show is that the ISEW of a country has been growing much slower since 1945 than GDP and indeed has fallen since the early 1980s. Methodologically related yet conceptually broader is the use of the Human Development Index capturing life expectancy and literacy in addition to income (Steinberger and Roberts, 2010).

Instead of indices the statistics offices prefer multidimensional accounts of socio-economic and socio-ecological performance and by now collect a wealth of data. They reveal a more differentiated and critical perspective on human welfare, e.g. life satisfaction in almost all countries has also not improved significantly since 1975 (Kubiszewski et al., 2013). Addressing inequality of income, wealth and access to resources turns out to be key to increasing human wellbeing for everyone (Pickett and Wilkinson, 2009).

Accounting for multiple dimensions in economic policy such as employment, fair income and wealth distribution, quality of life, price stability, balance of payments, sound structure to public finances and care for the environment used to be the mainstream perspective in the 1970s. It was called the “magic polygon of economic policy” indicating that there were multiple and in part conflicting goals that policy tried to achieve. The conflicts require deliberation before decision-making. Addressing them all fully would be magic, i.e. impossible. Multicriteria methods can be used to help decision makers in systematic and transparent ways to structure the deliberations about policy options with conflicting performance schedules and to foster participation.

Howarth and Kennedy (2016, in this issue) take up the issue of growth, inequality and well-being. Reviewing the treatment of economic inequality in ISEW and the debate surrounding it, Howarth and Kennedy propose a solution of previous methodological critiques by motiving the treatment through a classical utilitarian ethical framework and empirical evidence on the wellbeing–income nexus. They then proceed by applying this method to data on the distribution of income per capita in the United States. Their findings show that the annual growth rate of after-tax per capita income between 1979 and 2011 has to be revised downward to 1.2% per year when accounting for rising inequality.

Developing macroeconomic models that more directly focus on the goals instead of the ends is still a task ahead for ecological economists. This is essential to move constructively and radically beyond the high-growth, low-growth or no-growth discourse.

4. Future Issues of Ecological Macroeconomics

The world and its societies are currently facing a triple crisis: ecologically, economically, and socially. The aim of ecological macroeconomics is to inform how these crises are interconnected, which crisis phenomena reduce to the same root cause, and how sustainable and equitable crisis responses could be formulated. The crises, however, are associated with particular socio-economic structures and practices and their solutions necessarily entail moral judgements which are beyond the limits of conventional macroeconomics. Røpke (2016, in this issue) discusses these limitations of current macroeconomics in understanding and guiding the transitions to sustainability and suggests a topological approach which runs from boundary considerations to the macroeconomic provision and distribution systems. Røpke argues that understanding macroeconomic relationships in themselves is insufficient and reifies current social relations of production. Zwickl et al. (2016, in this issue) discuss the option of work-sharing, mentioned by Røpke as one way of breaking free from current institutions, as a way of achieving a more equitable and sustainable society (Schor, 2005; Victor, 2008; Seidl and Zahrnt, 2010; Kallis et al., 2013). Reviewing historical incidences of reductions in working time and the academic (economic) debate on it, Zwickl et al. (2016-in this issue) argue that empirical studies provide no general, robust finding of negative macroeconomic effects of work-sharing and highlight the importance of institutional and political settings.

Røpke (2016-in this issue) describes ecological economics' pre-analytic vision of human society as a metabolism interacting with the environmental foundations and its goal to promote more equitable living conditions within ecological sustainability. In modern capitalist societies, societal relations are mediated to a large extent through market interactions and, as a consequence, ecological macroeconomics aims at highlighting this central element. The establishment of more equitable living conditions within biophysical limits, however, must go beyond understanding market relations. Creating a fruitful exchange with those members of the ecological economics community who research the broader questions of societal transformation will be the ongoing challenge for ecological macroeconomics.

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