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GUEST EDITORIAL

Ringing the changes: Ecological economics and actuarial science

1. INTRODUCTION

1.1 Actuarial science is arguably a sub-discipline of economics. And it's all about modelling the future. When the foundations of economics suffer a fundamental challenge, actuaries need to sit up and take note. When the challenge comes at a time of unprecedented global change we need to examine the way in which we define the structure, and estimate the parameters, of our models of the future.

1.2 Such a challenge comes from ecological economics. As Keen (2001) has it, the emperor of the social sciences is neoclassical economics, but the emperor has no clothes on. When the puzzles of a paradigm become overpowering, it's time for a paradigm shift (Kuhn, 1962). When the discourse continues regardless, it becomes an ideology.

1.3 In this editorial I first explore the points of departure of ecological economics from the mainstream neoclassical economics that currently informs both state policy and business strategy in many countries. Ecological economics, a major branch of new (or 'heterodox') economics, has been institutionalised since the late 1980s, with its own journal, its own societies at regional and international levels, and its own textbooks (Röpke, 2005). I would prefer to use the expression 'socio-ecological economics' because it better reflects the current discourse of the field, and members of the community involved have expressed themselves in favour of recognising the social domain in the rubric of the field. Ecological economics does not necessarily speak with one voice; though much of the founding literature dates from the 1990s, it is a rapidly developing field in which writers may disagree with each other. For example, some ecological economists prefer to avoid measures of the effects of entities' activities on the ecology, on society and on the economy. To my mind, the need for accountability demands measurement. In some places writers' arguments are weak. In this

editorial I have focused on what I consider to be sound, well-established arguments; space does not permit a more critical engagement with the literature. I then explore the implications of ecological economics for actuarial science.

1.4 This editorial is in effect a follow-on from Thomson (2013); whereas that editorial focused particularly on the non-ergodicity of the financial systems modelled by actuaries (i.e. on the prospect that the future will be substantively different from the past) and on the issue of sustainability, this focuses on the critique of neoclassical economics by ecological economists. There is, of course, some overlap, but together these editorials point towards a new paradigm for actuarial science. As regards the current paradigm of actuarial science, reference may be made to Thomson (2004; 2006).

2. POINTS OF DEPARTURE

2.1 The Orientation of Ecological Economics

2.1.1 THE PERSON-IN-COMMUNITY

> Perhaps the most important point of departure is captured in Daly & Farley (2004: 262): Man [*sic*] as atomistic individual is the *Homo economicus* of classical economics. Ecological economics' concept of the nature of man is 'person-in-community,' not isolated atom. Community here means community both with other humans and with the rest of the biosphere.

2.1.2 COLLECTIVE RESPONSIBILITY

2.1.2.1 Traditionally, neoclassical economics has had a strong ideological predisposition to individual liberty rather than collective responsibility (Hamilton 1997: 41).

2.1.2.2 Some authors (e.g. Keen, op. cit.: 19) refer to neoclassical economics as a 'religion', with the market as the object of worship (e.g. Beinhocker, 2007). Whilst that suggestion is debatable, the recognition of neoclassical economics as an ideology rests on firmer ground (Underwood & King, 1989: 106). Sterba (1995: 360) states that Marx used 'ideology' to signify "a false consciousness shared by members of a particular social class." He gave the example of the "capitalist class", which "shares the ideology that the laws of the competitive market are natural and impersonal, that workers in a competitive market are paid all that they can be paid, and that the institutions of private property in the means of production are natural and justified." As shown below, this accords remarkably well with ecological economists' critique of neoclassical economics.

2.1.2.3 In fact the problem is deeper; whilst neoclassical economics distinguishes between firms and households, it treats both as if they were individuals making rational self-interested decisions. It has no theory of economic power. The ecological and social licence to operate requires accountability for past activities and responsibility for the effects of future activities. Ecological economics recognises humankind as the responsible species.

2.1.2.4 Neoclassical economics tries to portray itself as objective and value-free, whereas in reality it is not and cannot be (Jones, C[1]). Economics cannot avoid

1 Correspondence with the author

being normative. Nature abhors a vacuum, and the vacuum created by the pretensions of conventional economics to be an objective, value-free science has been filled by values of power and greed (Robertson, 1998: 15). Ecological economics is unashamedly normative. As Cobb (1973: 317) points out, we are a product of the evolutionary process, and therefore indebted to it. We need to respond to the 'urge for life, for continued life, and for more and better life'. Lawn (2001: 69–70) argues for a 'principle of stewardship', which involves the "sustainability-based rule of right action" as a basis for the discharge of its "obligation to oversee and facilitate the continuation of the total evolutionary process."

2.1.3 TRANSDISCIPLINARITY

2.1.3.1 As Lawn (op. cit.: 150) states, it is because the neoclassical macroeconomic system is a complex evolving system embedded within a larger ecological and social ensemble that meaningful policy conclusions are unlikely to emerge while the economic process continues to be described as a process separated from history, culture, social structure and the greater ecosphere in which it is embedded. The biologist Marston Bates suggested that "ecologists pretend that man does not exist, and economists pretend that nature does not exist." (Daly, 1968: 139)

2.1.3.2 Ecological economics, on the other hand, is transdisciplinary (Daly & Farley, op. cit.; Röpke, op. cit.: 267) Ecology, sociology and economics transcend each other to form a new holistic approach. Whilst ecological economics draws on classical economics, it also embraces insights from ecology and other earth sciences, from sociology, health sciences and psychology, and from development studies. Other heterodox economics disciplines have also contributed, particularly institutional economics; unlike neoclassical economics, institutional economics looks beyond the individual, the household, the firm and the state to locate all these agents as part of a community with rules, norms and values.

2.1.3.3 Neoclassicists also tend to define very clear boundaries between the various sub-fields of economics. As Söderbaum (1992) observes, environmental economists are expected to take care of environmental problems and policies, while other economists can continue in their detached fields of study. Some of the problems with neoclassical economics have been raised by neoclassical environmental economists, but their treatment of those problems tends to be piecemeal. Ecological economists emphasise the integration of the whole.

2.2 Sustainability

2.2.1 RESOURCE AND ENVIRONMENTAL ECONOMICS AND WELFARE ECONOMICS

2.2.1.1 The environmental sub-discipline of neoclassical economics is generally referred to as 'environmental economics' or 'resource and environmental economics'. It treats the 'environment' as part of the economy.

2.2.1.2 The social sub-discipline of neoclassical economics is generally referred to as 'welfare economics'. It treats human 'welfare' as part of the economy.

2.2.1.3 The treatment of sustainability in ecological economics is quite different from that in neoclassical economics.

2.2.2 SUSTAINABILITY DEFINED

2.2.2.1 There are many definitions of 'sustainability'. Many don't distinguish between ecological, social and economic sustainability. Daly & Farley (op. cit.: 425–6) define ecological sustainability as follows: If the throughput remains within the natural capacity of the ecosystem to absorb wastes and regenerate resources, then the scale of the economy is considered [ecologically] sustainable. Similarly, social sustainability may be defined as follows: If the effects of future human activity on the needs of human society are positive then that activity is socially sustainable. And economic sustainability may be defined as follows: If, after allowing for externalities, the effects of future human activity on the production of goods and services are positive then that activity is economically sustainable. Here the effects of human activity need to be disaggregated to individual entities to establish each entity's ecological, social and economic sustainability. They also need to be disaggregated to individual products and to individual investors to establish each product's and each investor's ecological, social and economic sustainability.

2.2.2.2 As Common & Stagl (2005: 374) point out, when environmental and resource economists and welfare economists write about 'sustainability' they are primarily interested in what happens to 'human welfare' over time. Most simplify further by identifying welfare with consumption. The sustainability questions that most interest neoclassicists are about the time profile of consumption. Many economists wrongly believe that human welfare is a direct function of income, or of the quantity of goods produced and consumed (Lawn, op. cit.: 3).

2.2.2.3 In business, 'sustainability' may mean the sustainability of profits, or of shareholder value, over time. This places the interests of shareholders above those of other stakeholders. Whilst the development of stakeholder theory (Freeman et al., 2010) is not specifically within the ambit of ecological economics, it is of interest in the context of the responsibility of a company for the effects of its activities on society. In particular, shareholders do not 'own' a company; they merely own a share in its equity. So in its accountability for human well-being, a company must report to its stakeholders with regard to their respective fields of interest and concern. The move towards the stakeholder approach to strategic management requires abandoning the idea that shareholder value maximisation is the unique or predominant purpose of the corporation, and embracing the idea that the interests of specific stakeholder groups (including shareholders) have to be considered in defining the purpose of the corporation. (Freeman et al., op cit.: 242)

2.2.2.4 'Sustainability' is also often used in business to denote environmental sustainability. The use of the expressions 'ecological sustainability' in ecological economics and 'environmental sustainability' in resource and environmental economics is indicative; in the latter, the ecology is merely the environment in which business is done—the backdrop to the real action that takes place centre-stage.

2.2.2.5 Even in ecological economics there is some confusion about the meaning of 'sustainability'. In fact the definition is quite clear in most dictionaries. What is needed is clarification of the usage. In the first place we need to identify the agent and the agent's activity at issue: are we talking about the sustainability of a particular activity of a particular

agent during a particular period, or are we talking about all activities of all agents? And secondly we need to identify the affected domain; are we talking about ecological, social or economic effects as at a specified time horizon and therefore about ecological, social or economic sustainability up to that time horizon?

2.2.3 Sustainability vs. Efficiency

2.2.3.1 Current human activity is ecologically unsustainable (Daly & Farley, op. cit.: 34). Rockström et al. (2009), shows nine planetary boundaries that are essential for human survival. By 2019 three of them would have already been overshot—climate change, biodiversity loss and the biogeochemical circulation of nitrogen. Wackernagel & Rees (1995) chart the ecological footprint of humanity, in other words, the global hectares required per person to provide human resource consumption and waste production, compared with the capacity of the Earth to provide them sustainably. Since 1977 we have been overshooting the limit of sustainable biocapacity. By 2013 we were overshooting it by about 100%.

2.2.3.2 Climate change is particularly problematic. In October 2018 the Resources and Environment Working Group of the International Actuarial Association released a briefing for actuaries on decarbonisation (IAA, 2018). In 2015 the Paris Agreement on climate change was agreed to by 197 countries and organisations (like the EU) under the United Nations Framework Convention on Climate Change (UNFCCC). It will be legally binding from 2020 and has already been ratified. The Agreement does not include specific decarbonisation targets, but states the need for global emissions to peak as soon as possible (recognising that this will take longer for developing countries), and for rapid reductions thereafter in accordance with the best available science. The target is to limit the increase in global average temperature to well below 2.0°C, and pursue efforts to limit the temperature increase to 1.5°C, above pre-industrial levels. According to a UNFCCC report issued in 2015, the non-binding pledges then submitted by countries could still result in a 2.7°C global temperature increase by 2100, which means that additional efforts will be necessary to keep warming below 2°C. (IAA, op. cit.) In 2018 the United Nations issued a 'wake-up call' urging states to limit global warming to 1.5°C and to take "urgent and far more ambitious action to cut emissions by half by 2030, and reach net zero emissions by 2050" (United Nations, 2018).

2.2.3.3 Land degradation, apart from its effect on climate change through reduction in carbon capture, seriously affects not only the ecosystems involved through the loss of biomass and biodiversity, but also the integrity of the biosphere as a whole. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 75% of Earth's land is degraded, affecting the well-being of 3.2 billion people (IPBES, 2018).

2.2.3.4 For ecological economics, therefore, ecological sustainability is more important than efficiency, and, as Lawn (op. cit.: 5) argues, while markets are the most useful mechanisms at facilitating the efficient allocation of scarce resources, they are "woefully inadequate" at ensuring an ecologically sustainable rate of resource use and an equitable distribution of income and wealth. Daly (1992) suggests that economists who are obsessed with efficient allocation and the economies of scale deserve the environmentalists' criticism that they are busy rearranging the deck chairs on the *Titanic*.

2.2.4 LIMITS TO GROWTH

2.2.4.1 Material growth forever is ecologically unsustainable (Daly & Farley, op. cit.: xxi, xxiv) and because of our dependence on the biosphere, it is also socially unsustainable. We are already living in a "full-world economy" (Daly & Farley, op. cit.: 17). Ecological economists recognise the "limits to the material growth of the economy" (Röpke, op. cit.: 267; Goodland, 1992: 40–2).

2.2.4.2 Neoclassical economics has failed to distribute wealth. It continues to shift wealth from labour to capital, creating shareholder wealth in the rich countries that can ride the wave of technology, and creating unemployment in the poor countries that can't. The issue of a proper range of inequality in the distribution of income or wealth has not yet received due attention. The standard economist's effort to "keep distribution at bay forever by eternal growth" is not a satisfactory solution (Daly & Farley, op. cit.: 266).

2.2.4.3 And therefore, because of environmental limits, the poor cannot be cared for by continuing economic growth, so the ethical challenge to take care of other human beings calls for "an increased focus on redistribution" (Röpke, op. cit.: 267).

2.2.4.4 As Lawn (op. cit.: 5) states, whereas a maximised rate of growth constitutes the "primary macroeconomic objective" of mainstream economists, for ecological economists it is the attainment of an "optimal macroeconomic scale". In the assessment of the optimal scale, the precautionary principle, which calls for taking precautions (either by way of conservative assumptions or by way of risk aversion) in the face of uncertainty, must be adopted (ibid.: 5–7).

2.2.4.5 Strategies for attaining a steady state within the limits to growth include durability of products, reduction, reuse, repair and recycling. Institutions need to be created that will facilitate keeping stocks of wealth and people constant, while infringing as little as possible with individual freedom. (Daly, 1980: 119–20) Technology needs to be improved so as to minimise throughput and maintain stocks (Boulding, 1966: 130). Species conservation, as well as the continued co-evolution of cultural knowledge, local technologies, and unique forms of social organisation, all need more spatial diversity and temporal stability than neoclassical economics permits (Norgaard, 1987: 158). Schumacher (1993: 344) argues that a change of the aims and objectives of society necessitates a change of the production process, the prevailing technology, and the existing organisational framework.

2.3. Meaningful Measures

2.3.1 DOMAIN-SPECIFIC MEASURES

2.3.1.1 In ecological economics, distinctions between micro- and macroeconomics fall away. As Lawn (op. cit.: 78–9) argues, whereas neoclassical microeconomics maximises efficiency, neoclassical macroeconomics doesn't; it just assumes more is better. In ecological economics there is no such dichotomy.

2.3.1.2 The expression 'triple bottom line' was coined by Elkington (1997) to make the point that companies need to be accountable not only for their financial bottom line but for their environmental, social and economic bottom lines, i.e. for the effects of their activities on the environment, on society and on the economy. (I draw the distinction

between the 'financial bottom line' and the 'economic bottom line', the former disregarding externalities and the latter allowing for them.) However, the notion of a 'triple bottom line' has always been metaphoric; there has never been a triple bottom line in the same sense as in the financial bottom line. Furthermore, in the light of ¶2.2.2.3, whereas the bottom line merely reflects shareholders' interests, stakeholder theory requires responsibility for all stakeholders' interests, so 'value added' is preferable to 'bottom line'.

2.3.1.3 Ecological economics involves triple value added: ecological, social and economic. Whilst economic sustainability may be measured in terms of the production of goods and services, ecological and social sustainability need to be measured in terms of ecological and social well-being. Ecological economics recognises that the market economy is a subset of human society, which in turn is a subset of the biosphere (Brown et al., unpublished).

2.3.1.4 In the ecological domain, numerous measures are used. These include emissions of wastes and greenhouse gases and land-use changes. Companies are free to decide on the measures they consider important for reporting purposes. Greenwash prevails (Lyon & Montgomery, 2015). This makes it difficult to compare one company with another.

2.3.1.5 For the purposes of the assessment of human well-being, substantial progress has been made in the measurement of quality of life, particularly in the measurement of the satisfaction of human needs (e.g. Max-Neef, 1992; Doyal & Gough, 1991). This emphasises the importance of needs as against the wants and preferences on which neoclassical 'welfare economics' is based. It also recognises that, unlike wants, needs are finite. Ultimate universal needs can be categorised, weighted and scored. They can be expressed in terms of 'capabilities' (including states of being and opportunities for doing) (Sen, 1992). And they go beyond 'having' (the focus of welfare economics) to include 'being', 'doing' and '*estar*' (Spanish associated with being situated in time and space). This literature is largely ignored in the neoclassical economics literature. Companies' social responsibility reports do not always reflect the effects of their activities on stakeholders; until recently they have tended to be largely PR spin, but there are signs that, in some countries, things are changing.

2.3.1.6 It may be argued that in the ecological domain it's fine to be ecocentric, in the social domain it's fine to be anthropocentric, and in the economic domain it's fine to be economistic. That justifies using ecological, social and economic measures respectively. But then decision-makers must ensure the sustainability of their activities in each domain simultaneously. Appeals to a 'balance' between sustainability and efficiency are misdirected. Ecological economists stress the interdependence of all three domains (e.g. Lawn, op. cit.: 1).

2.3.1.7 At present, in South Africa, investment performance is measured in the financial domain, but efforts are being made by fund managers to facilitate 'ethical investment'. The King Commission has blazed the trail of corporate responsibility for the triple bottom line. The use of a separate measure in each domain will facilitate the measurement of investment performance in each domain. A colleague and I are currently working on the development of such measures. It will be possible to adjust financial returns to allow for externalities so as to give an economic return in monetary terms. It will also be possible to determine ecological and social returns in terms of the measures used in those domains. It will

be neither desirable nor possible to combine the measures across the three domains; it would in fact be invidious for an actuary to advise a decision-maker on the relevant importance of those domains. But the systemic aim will be to achieve sustainability of the world's economic activities in all three domains. And in order to do that it will be necessary to disaggregate worldwide effects to the individual entity, the individual product and the individual investor.

2.3.2 Problems with GDP

2.3.2.1 Neither human well-being nor the ecological sustainability of human activity is reflected by the state of the market economy. Although GDP was not originally intended to be used as a measure of human well-being, it tends to be treated as such. In rich countries, GDP growth focuses on the satisfaction of ever more trivial wants while simultaneously creating "ever more powerful externalities" which destroy "ever more important environmental amenities" (Daly, 1980: 121). In poor countries it draws people into market economies where they may be more easily exploited. GDP is indifferent between different types of economic activity (more activity, of any kind, is considered good) rather than recognising their different contributions to human needs (Jones, *supra*). It is also a poor measure of production as it excludes externalities or cost-shifting.

2.3.2.2 For the purpose of economic value added, some writers have proposed adjustments to GDP to allow for externalities, notably the Index of Sustainable Economic Welfare (ISEW) (Daly & Cobb, 1989) and its successors.

2.3.2.3 Söderbaum (1992: 154) argues, however, that attempts to modify measures of GDP by adding components that are judged valuable and subtracting others that are judged environmentally harmful may improve things somewhat (at least in measuring production), but it will not eliminate the dogma of thinking in terms of money values. This dogma must instead be replaced by a strategy of disaggregation, whereby monetary and non-monetary impacts are kept separate. This may be done by developing domain-specific measures as suggested above. Some countries have launched measures of human well-being, but they are not generally disaggregable so they cannot be used for accountability by individual entities.

2.3.3 Problems with the Pricing of Non-Market Goods

2.3.3.1 Ecological economists also criticise the assignment of monetary values to "nonmarket goods such as ecosystem services". The principal issues here are the problems with the use of "non-market valuation techniques" and the assumption of 'weak' or 'strong' sustainability.

2.3.3.2 Non-market valuation techniques include such methods as 'willingness to pay', which assesses the price affected people would be willing to pay for the preservation of a facility such as a wilderness area (e.g. Hamilton, op. cit.: 42). The 'price' of the facility is then used in cost–benefit analysis for the purposes of making decisions. These techniques are rejected by ecological economists. As Lawn (op. cit.: 105) argues, the majority of neoclassical economists believe a sustainable use of resources can be achieved by 'getting the prices right', that is, by ensuring that markets reflect the full marginal costs of resource use and waste generation. He points out that, without denying the allocative importance of full cost

pricing (i.e. pricing that allows for cost-shifting), ecological economists refute this claim. Part of the problem is that, whilst resources such as air or water generally have low marginal prices, they may have very high prices when they are in short supply and in the aggregate their prices become infinite. The institutional economist Söderbaum (2000: 11–12) observes that neoclassicists "regard as innovative and exciting" the idea of interpreting environmental problems in terms of markets and prices. But, he suggests, actors "not indoctrinated in this particular paradigm" may perceive the same idea as 'strange'.

2.3.3.3 The 'weak sustainability' assumption is that natural and manmade capital are perfect substitutes. Ecological economists (e.g. Daly & Farley, op. cit.: 236) reject this assumption. They generally argue in favour of 'strong sustainability', the assumption that natural and manmade capital are not substitutable. (The concept of natural, human and social capital is economistic, but ecological economists have sometimes uncritically adopted it in response to its use by neoclassicists.) Of course, when pressed, both sides concede that there is some substitutability and some limits to that substitutability, but they have very different views on where those limits lie. Ecological economists argue that "nature has value in itself" (Röpke, op. cit.: 267) and the acceptance of substitutability rides rough-shod over the intrinsic importance of the biosphere. The issue may be resolved by distinguishing between ecological sustainability, which rejects substitution as anthropocentric, and economic sustainability, which doesn't. And in between there's social sustainability, for which minimum levels of natural capital are required. But attempting to calculate an exchange value for every nonmarket good, and then using that value to decide what we will preserve and what we will destroy, is an example of "economic imperialism" (Daly & Farley, op. cit.: 411). Instead the decision-maker must weigh up the effects in each domain in terms of relevant norms and values and take responsibility, and be held accountable, for decisions.

2.3.3.4 The intrinsic importance of the biosphere can't be expressed in monetary measures or in measures of human well-being. It can only be expressed in terms of a proxy measure of the state of the biosphere. The basic position of ecological economics is that some effects simply cannot be compared using a common measuring unit. This is because some of the impacts of a decision are ecological, some are social and some are economic (Hamilton, op. cit.: 60).

2.3.4 Problems with Commodification

2.3.4.1 Because of the tendency of neoclassical economics to try and express everything in terms of prices, it promotes the commodification both of the biosphere and of people. The neoclassical theory of consumer choice rests on the idea that things, including the natural environment, only have value to the extent that they satisfy human desires (Hamilton, op. cit.: 39). In other words it's instrumentalist and anthropocentric. From a utilitarian perspective, resources are seen to be valuable because the use of them adds to human utility. Thus utilitarianism is closely related to the idea of instrumentalism.

2.3.4.2 Birkeland et al. (1997: 129) quite rightly label this "perverse". A resource allocation system that derives from a human-centred form of valuation is ultimately incompatible with the preservation of the biosphere (ibid.).

2.3.4.3 It is important to avoid commodification of all entities in the assessment of the intrinsic importance of the biosphere, because this tends to reduce both the complexity of the issue and the recognition of wider conceptions of value, including the intrinsic importance of nature, rights, justice and emotions. (Röpke op. cit.: 280–1)

2.4 Other Problems with Neoclassical Economics

2.4.1 Microeconomics: Supply and Demand Curves

2.4.1.1 Keen (op. cit.: 25) argues that, in a society consisting of many different individuals with many different commodities, the market demand curve is unlikely to be monotonically downward-sloping. It is "more probably jagged, and slopes every which way." One essential building block of the economic analysis of markets, the demand curve, therefore does not have the characteristics needed for the application of economic theory. The output level chosen by a market economy "may not, and probably does not, maximise social welfare"—even if social welfare is measurable in terms of the quantities and prices of commodities (ibid.: 40). Likewise, the concept of the "representative agent" is "a fudge devised to get around the failure to prove that society can be reduced to the sum of its constituent individuals." (ibid.: 47).

2.4.1.2 He does a similar hatchet job on supply curves. For the vast majority of manufactured goods the costs of production are normally either constant or falling, so that supply curves are normally either flat or downward sloping. "This causes manufacturers no difficulties," he writes, "but it makes life impossible for economists, since most of economic theory depends on supply curves sloping upwards." (ibid.: 54–5).

2.4.1.3 As if that were not enough, he explains the interdependence of supply and demand, which flies in the face of the standard assumption that they are independent. For every industry there will be a different demand curve for every different position along the supply curve (ibid.: 67–8).

2.4.1.4 He similarly critiques many of the other standard tools and assumptions of neoclassical economics. Though he is not an ecological economist, his arguments add grist to the mill of that discipline.

2.4.2 Problems with Banking and Interest and Discount Rates

2.4.2.1 Werner (2005: 174–8) also weighs in against the role of banks in the economy. Banks create credit, and therefore money. If they create credit for secondary investment (i.e. for the purchase of existing assets) they are fuelling a bubble. If they create credit for consumption they are fuelling inflation. If they create credit for productive purposes, further questions must be asked: will that credit be used to promote human well-being and ecological sustainability?

2.4.2.2 He also suggests (ibid.: 339–40) that interest rates should be "kept at low levels, or abolished entirely, since they create deadweight losses and lead to an inefficient concentration of wealth in the hands of a few." Piketty (2014) argues that, to avoid growing inequality, interest rates should be lower than output growth rates. Nevertheless, if growth rates are going to be substantially curtailed, this will mean that interest rates will need to

be even more strongly curtailed. Because of the dominance of debt-fuelled growth, it will not be possible to curtail growth suddenly; the transition to a steady state would have to be implemented gradually.

2.4.2.3 A related issue is the use of discount rates. Because economic value added reflects inter-temporal preferences of market participants, it's logical to use discount rates for future economic value added. But social value added needs to consider future generations, so it's questionable to use discount rates. And ecological value added includes the long-term future, so for that purpose discount rates are inappropriate (Daly & Farley, op. cit.: 272–3). For all three domains it is better to project effects up to a specified time horizon than to discount them.

2.4.3 Problems with International Trade

As Daly (1993: 304–6) argues, international trade is a major issue for sustainability. He discusses the following problems:

— The theory of comparative advantage, which is supposed to justify free trade, assumes that capital is not mobile.
— Specialisation locks countries into world trade, interfering with their independence.
— Transportation is energy-intensive, it emits greenhouse gases and it causes other damage to the biosphere.
— Free trade encourages trade with nations that do not internalise their externalities.
— Multinational companies tend to exploit low wage levels in poor countries.
— Free trade increases the scale of the market economy.

He could have added:

— Free trade undermines the ability of poor countries, which have been exploited for their natural resources, to become viable producers.

2.5 Other Insights from Ecological Economics

2.5.1 Thermodynamics

An important insight that ecological economics has brought to the table relates to the biophysical laws of thermodynamics and the conservation and entropy of energy and mass. Following these laws, all input of resources from the biosphere ultimately becomes output to waste. These laws are of importance to the economy, particularly in relation to the limits to growth (cf. Section 2.2.4 above), which lead to the concept of a 'steady state'. But neoclassical economics fails to take them into account. (Diesendorf & Hamilton, 1997: xviii; Lawn, op. cit.: 3; Martinez-Alier, 1987: 22; Underwood & King, 1989: 107; Daly, 1980: 119).

2.5.2 Resilience

2.5.2.1 As pointed out by Röpke (op. cit.: 277), another such insight is the concept of 'resilience', which Holling (cited in Common & Perrings, 1992: 110) defines as the propensity of a system to retain its organisational structure, without flipping into another

stability domain, following a perturbation. He distinguishes this from 'stability', which is the propensity of an element of a system to return to an equilibrium condition following a perturbation. Stability involves a micro-focus on an element of a system, whereas resilience involves a macro-focus on the system itself. Individual elements of a system can be stable only if the system is resilient, but resilience does not necessarily imply stability (ibid.).

2.5.2.2 Ecological, social and economic sustainability can be modelled with allowance for stresses and shocks. In the modelling of ecological sustainability, the distinction between resilience and stability needs to be recognised. This may also have effects on social and economic sustainability via effects on ecosystem services.

3. IMPLICATIONS FOR ACTUARIAL SCIENCE

3.1 Challenges to Actuarial Science

3.1.1 Elements of the outline of ecological economics in Section 2 constitute challenges to actuarial science. The identification of these challenges necessitates value judgements with which the reader might not concur. In my view, principal among these challenges are:

— the need to distance ourselves from the atomistic, individualistic ideology of neoclassical economics;
— the need to include in our models the effects on our clients' financial soundness of future changes in the state of the biosphere, human (particularly stakeholder) well-being and the economy (after adjustment for externalities);
— the need to include in our models the effects of our clients' activities (including their investments in other entities) on the state of the biosphere, on human well-being and the economy and hence to obtain ecological, social and economic investment returns (see explanation below);
— the need to communicate to stakeholders, or enable our clients to do so, with regard to modelling the future and informing decision-making;
— the need to build into our models the planetary limits to growth and the laws of thermodynamics;
— the need to contribute to the development of meaningful measures of the effects of entities' activities on the biosphere, on human well-being and on the economy, and to the development of models of those measures—models that reflect the interdependence of those three domains and that could be used to assess sustainability;
— the need to assume lower (or zero) interest and discount rates in the future; and
— the need to critique the role of the banks in creating money, especially in view of our increasing involvement in that sector.

In item (3), as contemplated in ¶2.3.1.7, an 'ecological investment return' is the measure of the effect of the entity's activities on the biosphere during a specified year divided by the amount invested. Similar concepts apply to social and economic investment returns.

3.1.2 The understanding that actuaries (or, at least, our professional body) have a duty to act in the public interest already necessitates our respect for social value added.

3.2 The Way Ahead

3.2.1 Our education curriculum currently includes the assessment of "the main strands of economic thinking". The strands included are:

— classical;
— Marxian socialism;
— neo-classical;
— Keynesian, neo-Keynesian and post-Keynesian;
— monetarist; and
— Austrian.

We need to include ecological economics as one of the main strands of economic thinking. In the assessment of ecological economics we need some critique of neoclassical economics from the perspective of ecological economics as outlined in Section 2.

3.2.2 It would be helpful to have a substantial number of members of the actuarial profession with knowledge and understanding of ecological economics.

3.2.3 It would be good for a number of actuaries to attend conferences of the European Society for Ecological Economics and of the International Society for Ecological Economics.

3.2.4 Whilst this editorial reflects my thinking on the way ahead as it has been influenced by the ecological-economics literature, there is a need for a broader and deeper conversation between ecological economists and actuaries with a view to assessing how best to bring ecological-economics thinking into the profession. At some stage it will be necessary to engage with neoclassicists (particularly resources and environmental economists and neoclassical welfare economists) in this regard as well.

RJ Thomson

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