Institute
and Faculty
of Actuaries

Sustainability and the Financial System

Review of literature 2015

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Presented to the Institute and Faculty of Actuaries, London, 11 May 2015

May 2015

Abstract

Much actuarial work is underpinned by the use of economic models derived from mainstream academic theories of finance and economics which treat money as being a neutral medium of exchange. The sustainability of a financial system whose understanding is based on a limited view of the role of money has increasingly been subject to criticism. In order to identify needed research programmes to address such criticisms and improve these disciplines, we sought to understand the current state of knowledge in economics and finance concerning the link between monetary and financial factors and sustainability.

We have approached this through a search for relevant literature published in the highest-rated academic journals in economics, finance and the social sciences for titles and abstracts containing both references to the financial system on the one hand and sustainability and environmental factors on the other.

The systematic search of a universe of 125 journals and 355,000 articles yielded the finding that surprisingly few research papers jointly address these concepts. Nevertheless, we find that current research shares a broad consensus that the implications of the growth-oriented economic model results in an increasingly interconnected and fragile financial system whose participants are not incentivised to fully recognise the natural environment and resource constraints. We further observe that the prescriptions offered are relatively limited and small-scale in their outlook and that there is a vital need for further research, particularly for actuaries who are required to take a longer term outlook.

The Resource and Environment Board has supported this work with two key objectives: first to identify research that may have direct application to actuarial work and, second, to identify gaps in academic research that would help drive the IFoA's own research agenda. With this in mind there are three further areas of potential actuarial research. These are the policy aim of pursuing growth without limit within a finite ecosystem; discount factors as the primary means of capital allocation and investment decisions; and the use of GDP as the key metric of economic activity and success. We also conclude that further academic research is urgently needed to understand the sustainability of the banking and monetary system.

Keywords

Literature review; Banking; Finance; Monetary policy; Sustainability; Green economy; Actuarial science

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Acknowledgements

The Authors would like to thank the following for their contributions to this review:

- The Institute and Faculty of Actuaries and The University of Southampton for their institutional support;
- Members of the Resource & Environment Board for their support and comments during the work undertaken;
- Volunteers who undertook reviews of individual papers; and
- All those who commented on the exposure draft or provided peer reviews.

1 Introduction

1.1 Much actuarial work is underpinned by the use of economic models derived from academic theories in economics and finance. The sustainability of a financial system whose understanding is based on a limited view of the role of money has increasingly been subject to criticism. In order to identify needed research programmes to improve these disciplines, we sought to understand the current state of knowledge in economics, finance and the social sciences concerning the link between monetary and financial factors and sustainability.

1.2 This literature review is a first major output of the Resource and Environment Board (R and E Board) of the Institute and Faculty of Actuaries (IFoA). The R and E Board was formed in 2014, reflecting the desire of the IFoA to understand the long-term nature of many environmental risks and to encourage the profession to be forward looking in reflecting these risks in its work.

1.3 The IFoA has previously undertaken research into several related areas. The IFoA Resource and Environment Member Interest Group, being the entity that preceded the formation of the R and E Board, undertook two prior literature reviews focusing on Climate Change (Baxter et al, 2010) and Energy (Allen et al, 2011). This work led the IFoA to commission research on the implications of resource constraints and climate change on actuarial advice (Jones et al, 2013).

1.4 The R and E Board recognises that debate on environmental risks extends well beyond the boundaries of the IFoA. Whilst the R and E Board is engaging across various actuarial disciplines, it is also seeking to engage with a far wider community.

1.5 A number of bodies – including policy institutions, commentators and think tanks – have offered increasingly detailed challenges to the sustainability of banking and finance as currently practiced. These include a growing awareness that critical features of the fractional reserve banking system are omitted from mainstream economic theory. These include, for example, the ability of retail banks to create new purchasing power through lending. Certainly, the global financial crisis appears to provide evidence that our financial system contains significant and hidden dangers, but the unsustainable effects of the current system are also alleged to include pro-cyclicality, systemic wealth concentration and acceleration of the depletion of natural capital. These bodies identify causes of unsustainability in the structure of modern finance and money creation including critiques of fractional reserve banking and the globalisation of capital. They offer various reforms aimed at improving the sustainability of the financial system and by extension the global economy as a whole.

1.6 The Authors consider that many of these arguments may be valid. Consequently, the aim of our review was to obtain an understanding of how far these criticisms have been addressed in academic literature. To the extent they have been addressed, we have investigated whether new insights are being integrated into revised theories of the functioning of the macroeconomy

and what implications these insights may have in relation to understanding the sustainability or otherwise of the way the financial economy operates.

1.7 Actuaries work throughout the financial services sector supporting institutional decision-making on risk and returns, thereby influencing the flows of financial capital in the economy. To do this work, actuaries routinely use economic models derived from academic theories of finance, models which are both implicit and explicit in the financial system we operate within. Given the range of criticisms made of the financial system from the perspective of sustainability, we also wished to understand the progress academics might be making to synthesise financial theory with sustainability topics, to see if some results might apply to actuarial work.

1.8 Given the centrality of the financial system to these aims, and in particular of the banks to the monetary system, our selection criteria for papers was constructed in order to filter the possible universe of literature in a way that would capture those papers most relevant to achieving these aims. Our search was for papers, published in the highest-rated academic journals in the disciplines of economics, finance and the social sciences, as ranked in the 2010 Association of Business Schools Journal Quality Guide, linking broad concepts of Banking, Finance and Monetary Policy with broad concepts of Sustainability, the Green Economy and Ecology.

1.9 The results have surprised us. We had hoped that academia might be developing new models which could enhance current actuarial practice and that our review might identify areas where new approaches could give different insights into our work. Instead we have found that the highest-rated journals have only a fraction of their papers on these cross-disciplinary topics.

1.10 There is an extensive breadth of topics and research techniques falling into these papers and they identify and work on several areas of environmental and social risks not normally associated with the financial system. There is a broad consensus amongst the papers that the implications of the growth paradigm, the functions of debt and interest, and the globalisation of the economy result in an increasingly interconnected, fragile financial system, with an economy where agents are not incentivised to recognise the natural environment. The approaches the papers offer to reduce these harms are generally incremental and small scale (although admittedly some are much more radical). There is little analysis of the wider impact of the natural environment on the financial system and economy.

1.11 As actuaries serving both our clients and the public good, it is vital that we understand whether the financial system does create or contribute to the additional environmental and social risks highlighted in the papers considered in this review, and form a consensus on whether reform is needed and how reform might be approached. Of all professionals in the financial services, only actuaries advise on events far enough into the future to be seriously concerned by the long-term challenge these risks pose to the sustainability of our clients' objectives.

1.12 However interesting, there are few analyses in the papers reviewed which are directly applicable to actuarial work as it stands today. Whilst broadening the scope of our search may be appropriate to identify areas where relevant research is being done, more detailed study is required to assess some of these ideas empirically before they may be incorporated into actuarial work. While our review has identified some interesting papers which offer genuine insights into the interrelated topics of sustainability and of the financial system, to us it has more urgently highlighted the need for further work on this relationship.

2 Overview of Review Process

2.1 The principal focus of this paper is to consider academic research examining the impact of the current financial system on the sustainability of the real economy. This review has two key objectives: first to identify research that may have direct application to actuarial work and which may lead to refinement of the models presently used; and second, to identify gaps in academic research that would help drive the IFoA's own research agenda. These efforts are ultimately aimed at assisting with the work of managing the resources on our planet wisely, improving standards of human welfare and having a financial system that supports these objectives.

2.2 The review seeks to achieve this objective by means of a survey and assessment of academic literature focused on the connection between the financial sector and the issue of environmental sustainability.

2.3 The review has been focused on literature published in 125 recognised peer-reviewed journals that were identified as ‘leading journals’. Specifically, the Association of Business School’s Academic Journal Quality Guide, in its latest version available as of October 2014 (Version 4 of November 2010) was used to obtain a list of all journals in the sections ‘economics’, ‘finance’ and ‘social sciences’ that were top ranked (by being marked 4 or 3) under the assumption that this is where leading thinking will be published. This represented 48% of all journals in these sections.

2.4 Each of these journals was accessed electronically to search for articles that covered or touched upon the link between the financial sector and sustainability. Since many of the journals concerned are many decades old, it is estimated that the universe comprised some 355,000 individual articles.

2.5 In searching this universe for articles on finance and sustainability, some 673 papers were flagged by searching both for papers that contained terms from an environmental perspective as well as terms related to financial and monetary systems. The search terms used are noted below:

Financial and Monetary System	Environment
Financial sector, Financial system, Banking sector, Banking system, Financial markets, Monetary system, Monetary policy, Banking policy, Bank regulation, Financial regulation, Financial architecture, Financial institutions, Financial intermediaries, Shareholders, Deregulation, Liberalisation	Sustainability, Environment, Ecology, Green economy, Climate change

2.6 As is usual in such a process, the number of articles initially identified by the search process was significantly larger than ultimately found relevant. Thus a major task – admirably and successfully completed by Tracey Zalk – was to manually consider all 673 papers in order to judge whether they actually covered the topic. The majority were not considered relevant.

2.7 In the end, 40 articles were deemed relevant; these are the subject of this survey and are listed in Section 13. Even these 40 articles were not all a close fit. The papers could be classified by the degree of granularity concerning the institutional detail understood by the papers, in particular, the role of different actors, the monetary operations of banks and of the financial sector.

2.7.1 Category A papers did not directly mention the financial sector, but could be interpreted as indirectly referring to it. A total of 18 papers were classified as such.

2.7.2 Category B papers were those that included reference to the financial sector, but without any institutional detail or directly covering the topic of money. There were only 2 papers in this category.

2.7.3 Category C papers were those that demonstrated awareness of money, and included a financial sector, but without institutional detail. With 12 papers, this was the second most numerous category.

2.7.4 Finally, Category D papers included reference to the financial sector, including money, and with institutional detail. There were 8 such papers, although only two actually identified banks as specific players.

2.7.5 Ideally, a Category E should exist, which includes a financial sector with institutional detail and recognises banks as special and separate from other financial sector firms for their role in the creation and allocation of money. However, no such papers were found in the universe considered.

2.8 Table 1 summarises this categorisation:

Topic Included in Paper	A	B	C	D	E
Inferred financial sector	✓	✓	✓	✓	✓
Direct mention of financial sector	×	✓	✓	✓	✓
Explicitly included money	×	×	✓	✓	✓
Included institutional detail	×	×	×	✓	✓
Banks recognised for role in creating money	×	×	×	×	✓
Number of papers identified	18	2	12	8	0

2.9 In total, papers included in the review were drawn from 13 separate journals. The two most cited journals were *Ecological Economics* (10 papers) and *Cambridge Journal of Economics* (6 papers).

3 Limitations of the review

3.1 There is a range of literature not published in academic journals, but which is potentially relevant to this review such as books, online journals, papers or comment. In these cases, quality assurance criteria would require consideration and an allocation of resources for a search, selection and review would also be required. Given the availability of resource, the Authors concluded that the approach followed, focusing on the leading peer reviewed journals in economics, social science and finance was most appropriate and that the 40 papers ultimately selected for this literature review fairly represent the range of areas of relevant research in the past. The peer review process of these journals provides a rigorous basis for future research and they have provided much of the foundation of actuarial science, banking regulation, practice and theory and the globalisation of international trade.

3.2 The 40 papers that were identified as covering, to some extent, the link between the financial sector and the economy, were diverse. Whilst the individual reviews are set out in a separately published document, we summarise some of the key themes arising below.

4 Common ground

4.1 The papers considered include a sole and heroic observer arguing that the future is bright, since there will be "fewer, richer, greener" people. Virtually unique in its optimism, this argument by Siegel (2012) in the *Financial Analysts Journal* is predicated on an approaching peak in population growth. But such optimism is the exception. Pessimism of the type invoked by Chichilnisky (2012) was more common. Chichilnisky (2012) argues that "it could be said that the role of economics is now to focus somewhat less on profits and more on the long-run survival of our species".

4.2 Chichilnisky (2012) identifies the discount factor as one of the problems. The criticism of the discount factor or interest as time preference is a recurring theme in the papers reviewed. Robinson (1996) asks whether we can reconcile finance with nature, and points out that the main way of addressing both investments and environmental issues by large firms is to deploy discounting of future cash flows to arrive at present values. However, for this to be valid, it is necessary that maximising the value of the firm maximises every owner's wealth, and thus their consumption opportunities and utility, a condition referred to as unanimity. The paper shows that the assumptions required for unanimity do not hold when the environment is taken into account. Robinson (1996) also argues that the net present value method is ethically unacceptable.

4.3 The remaining papers had much in common, revealing a kind of perceived current wisdom of the researchers covering this topic.

4.4 Firstly, there was a majority (though not unanimous) sense that the dominant conventional approach in economics and finance – usually referred to as 'neoclassical economics' by authors – was either incapable of addressing the issue of resource constraints and environmental sustainability, did so insufficiently, or failed to accord it sufficient importance. An important concrete argument is made by Foxon et al. (2012) who, citing Sraffa (1926), points at the emphasis on marginal changes in conventional economics and its obvious shortcomings when it is necessary to look beyond marginal tinkering.

4.5 Secondly, another almost unanimous tenet is that the concept of GDP (and thus the current methods of national income accounting) is inadequate to address environmental concerns, since GDP excludes key environmental dimensions.

4.6 Daly (1994) recommends ending the practice of counting the consumption of natural capital as income, thus misleadingly inflating GDP growth. Moreover, economists appear uncertain about the causes of growth and its link to social welfare. Specifically, it is argued that the almost exclusive focus of national income accounting on monetary transactions results in biases against valuable contributions to society and the economy that happen not to be transacted via financial markets. Concrete cases that are discussed in the papers include the role of caring, which is performed to a disproportionate extent by the female population (Jochimsen & Knobloch 1997). It is also argued that market transactions emphasise a competitive concept of the

economy and society, while diminishing the contribution by co-operative arrangements that may be based on non-competitive modes of conduct, and motivations other than profit maximisation.

4.7 Ekins (2009) is cited by Foxon et al (2012) as distinguishing between three types of growth, namely:

"(i) Physical growth: growth in the amount of matter and energy mobilised by the economy—indefinite growth of this kind is impossible in a finite physical system.

(ii) Economic (GDP) growth: growth in money flows, incomes, value added and expenditure—there is no theoretical limit on this kind of growth.

(iii) Growth in human welfare: this is dependent on sustaining environmental functions, has a complex relationship to economic growth (though, ceteris paribus, more money is better than less) and is dependent on many other factors (employment, working conditions, leisure inequality/income distribution, relationships and the security/safety of the future)."

4.8 Many writers refer to a rapidly accumulating body of scientific evidence of the detrimental impact that ever-increasing rates of production and consumption have on individuals, communities and the environment. Some writers (such as Smart, 2011) argue that global free-market capitalism is systemically prone to increased inequality, poverty, unemployment, depletion of scarce natural resources, environmental destruction, pollution, waste and major recurring crises. Furthermore, the standard response to the recurring crises is also predictable – and wrong, since it ameliorates symptoms, while the underlying problems get larger. By responding to recessions with policies to stimulate economic growth, increased production and consumption will exacerbate rather than solve the aforementioned problems and eventually lead to 'common ruin'.

4.9 Foxon et al. (2012) cite the 'GDP paradox', namely that the "shortcomings of GDP as an indicator of social welfare or progress are well known amongst economists, but its role in economics, public policy, politics and society remains influential". The reason for this is thought to be the fact that the growth aim, although ignoring all non-market activity, including unpaid childcare, is politically dominant. As a consequence, economic cost–benefit analyses of climate change mitigation policies are often biased against environmentally sound policies, as these may result in less GDP growth in the short term.

4.10 Foxon et al. (2012) – like most of the papers surveyed – do not explore just why GDP growth is such an important and persistent political goal. Although research has been undertaken on this subject, what may be needed is for this research to be more broadly published and recognised by both academics and policy makers alike. In justifying the inclusion of equality as a measure of happiness Foxon et al. (2012) does not directly address the link between greater inequality and deteriorating indicators of health, or the risk implications of inequality. However the authors propose a shift from GDP as a

progress indicator to measuring “happiness”, noting that the link between GDP growth and well-being is stronger at low income levels.

4.11 Greenhalgh (2005) argues that the market system primarily focuses on the needs of the wealthy and overlooks the needs of the poor, because only consumers with income can exert effective demand in a market-driven capitalist economy. So who gains from innovation? The paper argues that the demand for luxuries competes with demand for necessities. So technology tends to disproportionately benefit the wealthy, as they are the ones most able to afford access to new innovations. This results in the productive system focussing too much on the wants of the rich rather than the needs of the poor leading to reductions in social welfare. The issue of inequality raises the need to address political issues of how power in society is distributed. It should be noted that in the decade since Greenhalgh (2005) there is anecdotal evidence of increasing benefit to the lower-paid due to technology in developing countries.

4.12 Moreover, connected to inequality, many writers agree that the question of how full employment, being one of the factors influencing human needs, can be achieved without growth maximisation is an important one. Foxon et al. (2012) argue that “In a dynamic analysis with increasing returns to scale through learning by doing and economies of scale in new technologies, there will be opportunities for increased economic activity in new [climate change] mitigation technologies”. More radically, there are many proposals as to how to reorient society and economic activity, such that human needs are satisfied without requiring (conventional) economic growth.

4.13 A significant number of writers argue – or present analysis sympathetic to the idea – that as long as policy-makers focus on maximising GDP growth, valuable contributions to the economy, society and the environment may be discouraged. The reason for this is they might even result in a negative impact on GDP, despite potentially producing larger benefits that are however not reflected in national income accounts. A number of authors state more or less explicitly that sustainable development cannot be achieved without a shift in priorities from consumption and the GDP growth agenda to quality of life as a target.

5 Debate among researchers

5.1 Many papers were concerned with identifying the different approaches that broadly address the environment and resource constraints and/or sustainability issues. Within the papers, the disciplines of ‘environmental economics’, ‘ecological economics’ and ‘green economics’ were particularly identified. Our broad categorisation of these disciplines is as follows:

5.1.1 *Environmental economics* is seen as largely adhering to the tenets of neoclassical economics, and thus is identified as more oriented towards ‘business as usual’. An example is the attempt to deploy theoretical models far removed from observed reality, such as the Solow growth models (Martinet & Rotillon, 2001) and to couch

sustainability into neoclassical concepts such as dynamic efficiency, while using equilibrium approaches and Pareto efficiency. Solutions often involve market mechanisms, proposals such as 'carbon trading' and attempts to value and price the 'assets, goods and services' provided by nature through markets. An example of the few relevant environmental economics papers identified is Weitzman (1999), who deploys green accounting, in particular the attempt to price mineral depletion, to estimate the value of lost global welfare from depletion of non-renewable resources, such as oil. The paper argues that using market prices as indicators of scarcity is justified, since ''the market'' may be giving the best judgment of the overall welfare loss from running out of minerals.

5.1.2 *Ecological economics* is described by Gowdy & Erickson (2005) as the only heterodox school of economics focusing systematically on the human economy both as a social system and as one embedded in the biophysical universe. They maintain that ecological economics can be seen as providing a serious challenge to neoclassical economics, rejecting Walrasian equilibrium and Pareto efficiency, being cautious about using market mechanisms as the default policy, while trying to engage mainly the community of researchers and academics.

5.1.3 *Green economics* is described as rejecting the "commodification" of the natural world within the concept of ecosystem services, as placing greater value on fairness and equality issues, and as being more open to 'radical' analyses and measures. It focuses on policy advocacy and activism. An advocate of green economics (Scott-Cato, 2012) identifies four key issues central to a green study of the economy: (1) the need to end economic growth; (2) the importance of equality and questions of the just distribution of resources; (3) the requirement to consider appropriate local scale in economic decision-making; and (4) the need for multiple perspectives and diversity in the study of economics.

5.2 Doual et al. (2012) argue that, in fact, the main divisions within the economics of the environment and sustainability are *inside* ecological economics. These divisions arise between neo-classically minded economists, natural and social scientists with a strong policy focus and 'social ecological economists' rejecting neoclassical principles.

5.3 By its nature, green economics is not dealt with in neoclassical economics. It has emerged more through social political activity amongst think tanks, environmentalists, political groups and the like. Green economists share with ecological economists a commitment to a sustainable, steady state economy, emphasis on ecological balance, representation of the rights of future generations and other species and rejection of growth as an objective. But they are also committed to societal change, equality and practical application of their ideas, rejecting mathematics in favour of empirical evidence and "common sense".

5.4 Within each of these schools of thought, researchers can also be classified as defining their goals differently. While far from absolute, these goals can be broadly characterised as either focusing more on actually solving the environmental challenges ('strong sustainability') or being willing to compromise and not disrupt present structures and policies ('weak sustainability').

5.5 Dietz & Neumayer (2007) note that a key difference between weak sustainability and strong sustainability is that the former allows for a substitution of all natural capital for other forms of capital (economic, social, manufactured etc.) as long as total net capital remains constant whereas strong sustainability assumes that critical natural capital is non-substitutable.

5.6 The 'weak sustainability' camp is seen by some researchers as too quick to compromise. It is not far from here to the idea that 'green capitalism' is espoused by cynical firms only as a way to improve their PR, as some researchers argued. Prudham (2009) feels that free market capitalism cannot, by its nature, be 'green'. The idea is that high-profile private sector investments into 'green' research or activities – particularly those that seek to substitute one form of resource consumption for another – may not succeed simultaneously in their profit motive and in achieving the ostensible environmental benefits.

5.7 Spash (2013) distinguishes between "shallow" and "deep" ecological economists. Social Ecological Economists are identified as "deep" ecological economists, whose objective is to fundamentally change the way in which the subject of ecological economics is approached. Few 'deep' ecological papers were found in this literature survey, especially ones that incorporate the role of the financial sector.

5.8 Bina (2013) surveys the results of international events focusing on sustainability such as 2012 Rio UN Conference on Sustainable Development (UNCSD), and concludes that the outcome was a compromise which failed to address the real issues needed to achieve sustainable development. Linner & Selin (2013) conducted an empirical study of the effectiveness of sustainable development conferences in the last 40 years, from the 1972 Stockholm UN Conference on the Human Environment (UNCHE) to the 2012 Rio UNCSD. The assessment is that little has been done to achieve much in "greening" the agenda of states or international economic organisations such as the IMF, the World Trade Organisation and World Bank. Status quo rules because of conflicts between countries, in particular the North-South politics between industrialised and developing countries.

5.9 This chimes with the findings by Cimoli & Katz (2003), who question the success of 'market oriented' development based on structural reform, such as deregulation, liberalisation and privatisation based on consideration of the economies of Latin America. Such policies have rendered economies dependent on industries with minimal domestic knowledge generation or value-added content – a drastic reversal of the early post-war policies pursued in several major Latin American economies. As a result, many economies are said to have fallen into a 'development trap' where countries

either become natural resource-processing industries (southern Latin American countries) or assembly manufacturing industries (central American countries) with little prospect of developing out of these areas.

6 Improved measurements and methods

6.1 Many papers addressed improving measurements and research methods in order to further scientific knowledge in the pursuit of more sustainable human activity on the planet. The disciplines and approaches employed among ecology and sustainability researchers varies widely, and includes mathematical approaches, such as complexity research and agent-based modelling; sociology-based approaches; behavioural economics; endogenous preferences; socially correct discount rates; complex adaptive systems; extended input-output analysis; the precautionary principle and co-evolution.

6.2 Dietz & Neumayer (2007) explore current best practice for the measurement of weak and strong sustainability. This draws on the key issues of monetised resource depletion and environmental degradation that are deliberated in the System of Integrated Environmental and Economic Accounting (SEEA), launched at the Earth Summit in 1992. They indicate how SEEA data can be used to measure weak and strong sustainability whilst also considering the key benefits and shortcomings of each approach.

6.3 Bartelmus (2013) updates the discussion of the SEEA and the subsequent development of approaches to account for environment factors in official national income accounts. The author reports disappointing progress since the launch of SEEA, considering it a retrenchment from integrative environmental-economic accounting. However, accounting for environmental factors in the satellite national income accounts is increasingly being used. Moreover, the latest version of SEEA (2012) includes biophysical data but excludes data on environment degradation, albeit also including hybrid physical-monetary accounts which show discharges of wastes and pollutants next to economic indicators to compensate for this omission.

6.4 Robinson (1996) considers three different methods of making decisions that do take the environment into account: life cycle analysis, full cost accounting and non-quantitative accountability. The author concludes that an effective decision procedure would be to combine life cycle analysis with traditional net present values.

6.5 New indicators emphasising green growth as a subset of sustainable development that were suggested include: (i) environmental and resource productivity; (ii) physical evolution of natural assets; and (iii) environmental quality of life. Recommended tools include social accounting matrices and natural resource accounts.

6.6 Ang et al. (2011) propose the concept of ‘sustainable value’ and apply it empirically to the EU to measure performance as “return achieved per unit of resource used”. Such a measure is however found to be procyclical, due to its reliance on GDP, whereby GDP growth acts to mask resource use. For this method to drive policy decisions (or, in other contexts, investment decisions),

one would first need wide agreement on the various components: the measure of return (here GDP), of the resources being scrutinised (and the measurement thereof) and of the benchmark. As the authors note in the way they framed the exercise, “substantial economic growth may compensate for worse resource use”, a good example of ‘weak sustainability’. In addition, and again as the authors note, inefficient use of one resource (e.g. percentage output of carbon) might be compensated by an improvement in another (e.g. percentage change in landfill).

6.7 Common (2007), on the other hand argues that such attempts at improving on GDP, including the Index of Sustainable Economic Welfare and the Genuine Progress Index, are not likely to be useful, since they are still aggregates of monetary values. The paper proposes a family of indicators that are not based on monetary values, but instead provide partial information regarding the sustainability of current economic activity. These indicators could act as alternatives to national income for measuring national economic performance. Each indicator is a measure of environmental efficiency, calculated as the ratio of ‘satisfaction output’ to ‘environmental input’.

6.8 Common (2007) studies five indicators which each use a different environmental measure but the same satisfaction measure, ‘happy life years’. The environmental indicators are per capita measures of energy use (including and excluding non-commercial energy such as wood fuel), ecological footprint (the land and sea area required to produce what the country consumes and absorb its wastes) and greenhouse gas emissions (including and excluding emissions from land use changes). The paper presents values for the five environmental efficiency indicators for 75 countries for a single year (usually 2000). For each indicator, it investigates the relationship between efficiency and GDP per capita, finding similar results in each case. The efficiency indicators are described as measures of ‘national economic performance’, similar to the Happy Planet Index introduced by New Economics Foundation in 2006.

6.9 In a similar vein, Rennings & Wiggering (1997) advocate non-monetary indicators such as critical loads and levels – criteria for the environmental quality of complex ecosystems – as core indicators of ‘strong’ sustainable development. Critical levels are derived from experiments in laboratories and in the field and include SO_2, NO_2 and O_3 benchmarks. Specifically, they recommend ‘ecocapacity’ (quantifying the reduction in emissions and resource use required by 2040 to achieve a range in the assumed ecological carrying capacity); ‘material intensity per unit service’ (MIPS) – reflecting the eco-efficiency of products; pressure state response indicators – used by the OECD to allow international comparisons and thus dependent on the availability of data in all member countries; and AMOEBA (or spider) diagrams of sustainability indicators – selected environmental quality indicators that are related to sustainability standards being derived from historical precedents.

6.10 Hamilton & Clemens (1999) of the World Bank implement the theory of genuine savings, which are derived from traditional net savings. Net savings is identified as having been a first step towards incorporating a sustainability measure into national wealth, making allowance for the depreciation of produced assets. Genuine savings are calculated by deducting the value of resource depletion and environmental degradation from net savings and adding on the value of investment in human capital. This approach has been criticized by those classifying it as falling into the weak sustainability camp.

6.11 Several papers pointed out and made use of the World Bank's 'World Development Indicators' data on net national savings, which are adjusted for depreciation of produced capital and depletion of natural resources.

6.12 Daly (1994) recommends replacing GDP with a better income measure that accounts for resource depletion properly, revising the tax system to provide incentives to hire more labour and reduce resource throughput, and moving away from the ideology of global economic integration by free trade, free capital mobility and export-led growth towards the development of more local solutions within domestic internal markets.

7 Policy recommendations

7.1 Kallis (2011) argues that as economic 'degrowth' is inevitable, the challenge for policy makers is how it can become socially sustainable. The paper notes that policies that may lead to this such as a basic income, environmental and consumption taxes and controls on advertising are unlikely to be implemented given their perceived "harm" within a growth paradigm. The paper therefore argues that to embrace degrowth, radical social and political change will be necessary.

7.2 The pursuit of degrowth is supported by Smart (2011) who suggests that the transition to a sustainable economy could be achieved through a focus on localisation rather than globalisation. This would require a decrease in consumption, leading to a reduction in debt burdens and consequently in working hours. At the same time it was seen as necessary to promote altruism, cooperation, concern for community and social life, craftsmanship and manufacture of generally durable goods. It was, however, recognised that such a change would require significant political will. This suggests that, in the short-term, researchers would be well advised to build a strong scientific case for change, using appropriate tools and measurements.

7.3 Meanwhile, a number of activities were identified that individuals could already implement today. Scott-Cato (2012) notes that sustainability requires more localism and less global trade. This is supported by Smart (2011), who suggests that as the prospect of more radical change was currently remote, local decision-making and grass-root changes based on local self-administration, self-responsibility and self-determination seems most promising. Smart (2011) notes that self-determination could reflect a more "capitalistic" interpretation of community-oriented forms of social organisation, such as cooperative societies.

7.4 One paper (Emel, 2002) examines the success of NGOs in influencing major corporations. The case study is inconclusive, but the side-effect of raising the profile of environmental issues in the public debate may tip the balance in favour of such activism. The work by Clark & Hebb (2005) covers the topic of shareholder activism, noting that institutional investors can adopt and implement environmentally sound investment policies.

7.5 Local initiatives are worthwhile, we are reminded by Wallner et al. (1996), since 'islands of sustainability' can be created as areas of local or regional stability (the 'island'), and they may trigger or stimulate larger movements towards sustainability within the greater economic system.

8 Empirical evidence

8.1 Among the 40 papers, the majority were of a theoretical nature. Empirical papers were a clear minority. However those papers that were empirical usually delivered a strong message.

8.2 Meadowcroft (2013) provides a summary of what the past quarter century of research, policy advocacy and debate has achieved in terms of actual policies of sustainable development and impact on measures of sustainability or environmental performance. The author notes that the problem of an absolute limit of resources has been largely sidestepped in the policy debate and that there appears to be limited evidence of successful implementation of sustainable development strategies with few, if any, actual changes of significant proportion or with measurable and non-negligible positive impact.

8.3 Hamilton & Clemens (1999) provide a first set of calculations of genuine savings (see 6.10 above) from a consistently derived and reasonably comprehensive time series data set on resource depletion and carbon dioxide emissions. The data is mainly sourced from the World Bank. The conclusion from their empirical work is that many developing countries, particularly those in Sub-Saharan Africa, exhibit negative genuine savings and are consequently being progressively impoverished. This supports the proposition by previous authors (Hamilton & Clemens, 1999 cites Gelb, 1998 and Sachs & Warner, 1995) that the impact of relying on large natural resource endowments may be negative for many countries.

8.4 An empirical study based on 36 interviews with staff engaged in environmental or sustainability projects at 25 large Australian and global companies (Nyberg & Wright, 2013) found that those staff tasked with advancing the sustainability agenda – usually those most motivated to help address environmental issues – end up being the most willing to accept compromise. Although limited in its scope, the paper concludes that the sustainability agenda is seen to have been influenced by corporate interests, accepting an alteration of the definition of 'sustainability' to align it with the interests of the organisation rather than the environment or simply redefining it to refer to the long-term success of the organisation.

9 Evidence on the role of the financial sector

9.1 Huang (2012) found empirically that output volatility has a significant damaging effect on genuine savings, likely due to the positive impact economic output has on natural resource depletion. The paper shows that much of the link can be explained by the relative size of financial intermediaries compared to the rest of the economy which means that greater resilience to financial crises should also reduce resource depletion and increase overall sustainability.

9.2 Goldstein (2001) provides early empirical evidence from Costa Rica that sustainable development capabilities are impeded by the financial markets and financial institutions such as large banks. The reason identified is that lenders prefer to provide loans for high-end consumption and real estate investments. There is not much interest in either the capital markets or among banks in funding green practices and technologies. It is therefore argued that suitable reforms should lead to funding projects that reduce negative environmental impact, allow the private sector to benefit from such reductions, and build long-term organizational capabilities that render the economic activity complementary, rather than opposed to environmental goals. Four specific policies are proposed for Costa Rica: Green Banking, Green Group Lending, a Green Bond Market, and a Conservation Lending Certification Body.

9.3 The Authors note that it was hoped that this section would yield a larger number of papers for our review. The small number of papers in this section calls for further work to be done to research this topic. We discuss this further in the conclusion.

10 Local exchange trading systems and local currencies

10.1 Seyfang (2001) critically evaluates the impact and potential of a community currency known as the ‘local exchange trading scheme’ (LETS) to contribute to ‘sustainable local development’ (SLD). While most previous analyses of LETS used a ‘local economic development’ approach, the author focuses instead on an SLD perspective. Findings from a LETS case study indicate that this community currency is successful in allowing participants to make small changes in their lifestyles, consumption and employment patterns towards SLD. In general, the author concludes that community currencies have the potential to meet many of the objectives of the SLD model of local development. LETS schemes attract people on the margins of the conventional economy and provide informal employment opportunities for them.

10.2 Seyfang & Longhurst (2012) revisit the theme of local exchange and currency systems. These are parallel monetary systems designed to promote sustainable development in a variety of means. In theory, they promote localism in consumption and economic development; efficiency of resource use through recycling; social capital as a substitute for material consumption; and provide market incentives for investment and consumption of greener goods. Community currencies are designed to temper the money-creation elements of banking by offering a de-centralised community-directed function of money creation. They respond to challenges inherent in the debt-based system of money creation which relies on (1) an ever-expanding economic system to allow the repayment of loans with interest, and (2) conventional economics which implicitly claims money is a neutral technology and does not embody particular values, incentives, structures of consumption and cultural meanings.

10.3 The rationale behind community currencies is that money is a socially-constructed institution, so alternative systems of exchange, or financial services provision, can build in more sustainable incentives and structures than conventional money.

10.4 New empirical evidence from 3,418 community currency projects in 23 countries and across 6 continents is presented by Seyfang & Longhurst (2012). The differing schemes identified are classified as follows:

10.4.1 *Service credits*: The most common, accounting for more than half of the projects identified, these represent a radical rejection of market valuations of labour and adoption of the principle that everyone's time is worth the same. Examples include 'time banks', 'service credits' and 'time dollars'.

10.4.2 *Mutual exchange*: The second most common, accounting for around 40% of the projects, these are created by the act of spending whereby one person's credit always equals another's debit to the system so accounts always sum to zero. The value and utility of the currency is maintained by trust in other members to meet their commitments. Examples include LETS which generally emerge from civil society and have the greatest impact on local society and community building.

10.4.3 *Local currencies*: This category comprises only 7% of the projects identified. Cities and regions issue local currency to circulate within a geographically bounded region, increasing the local economic multiplier. This category includes Hours currencies founded in 1991 in Ithaca. The first wave of currencies appears to have plateaued but a new generation are experimenting with electronic payment mechanisms to increase uptake.

10.4.4 *Barter Market:* The smallest category, accounting for just 1.4% of the projects, Barter Markets are a hybrid of local currency and mutual exchange and offer a new infrastructure to enable people to exchange goods and services without the need for mainstream currency. In Latin America it has become closely associated with ideas of the solidarity economy. A variation in Quebec (Troc-tes-Trucs – "swap your stuff") has a stronger emphasis on supporting sustainable development through the reuse of goods.

10.5 Perhaps worthy of note is that none of the papers surveyed covered crypto-currencies (such as Bitcoin) and the potential for communities to deploy them.

11 Historical works

11.1 The oldest paper selected for inclusion in the review was Huntington (1917). A century ago, ecological economics did not exist. Yet, the paper is able to shed some light on the devastating impact of environmental damage on an entire society. Modern analysis may have moved past some of the specific analysis the paper offers. However, the paper deals with the fall of the Roman Empire, a civilisation extremely advanced technologically and boasting a sophisticated economy and financial sector with a banking system with strong parallels to the banking system of the time (i.e. 1917).

11.2 The author links the fall of this civilisation to climate change. Importantly, the causation chain starts with a reduction in agricultural yields, likely due to depletion of the soil and increased aridity. As a result, small tracts of land were no longer sufficient to sustain farmers. Farmers became indebted (indicating, albeit indirectly, the role of banks) and lands were gradually acquired by large landowners – increasing inequality and reducing social cohesion. As crop yields fell, land was instead used for grazing. This impeded the growth of new forests and resulted in soil washing away to leave hillsides barren and ruining lowland fields (reminiscent of today's problems of landslides and even desertification), further compounding the situation. The economic pressures had political results. Since taxation did not adjust to the increasing impoverishment of agricultural workers, power became increasingly concentrated in the hands of a few (in line with wealth concentration). Discontentment was an important element in the break-up of the Roman Empire.

11.3 Increasing aridity was due to streams drying up and resulted in a greater need for irrigation. As a result, there were more stagnant pools of water – ideal conditions for mosquitoes to flourish. Malaria may have been a factor in reducing the agricultural productivity of farmers. Huntington (1917) notes that climate change itself may have been the result of unsustainable agricultural or economic practices. While such issues are not explored directly in the paper, with the hindsight of a century, if not two millennia, it would appear that the endogeneity of environmental and resource problems is an important potential factor that requires further research. It is significant that this paper, unlike many contemporary ones, mentions debt and thus the financial sector as playing a prominent role.

12 Concluding remarks

12.1 Actuaries seek to advise clients on the risks of events that may lie many years in the future and the implications for their businesses. In building our understanding of what lies ahead, we inevitably look to the past for guidance although experience has taught us that what we perceive to be “normal” can be anything but.

12.2 A thorough understanding of the financial system is important to actuarial methodology and the clients our profession serves. Consequently, understanding the potential risks to this system, particularly from environmental and sustainability issues which may emerge over the longer term, should be an area of considerable interest.

12.3 In building this understanding, it is sensible to look first to academic research on the topic to assess whether the status quo is sustainable; whether it needs to be incrementally reformed to become sustainable; or whether it needs to be wholly reformed. That was the objective of this body of work and the results have been surprising. Relatively little research has been published in the top rated journals for researchers in economics, finance and social sciences on the topic of how the financial sector relates to the issue of sustainability.

12.4 We have identified various common themes amongst the 40 papers included in the review. Key amongst these themes is pessimism over the role of neo-classical economics in promoting behaviours which threaten the long-run survival of the species and a perceived inability to reform itself or these behaviours. This suggests that further research is needed, either by academics or by the IFoA, into the implications for actuaries of the following interlinked topics:

12.4.1 The policy aim of pursuing growth without limit within a finite ecosystem. There is a clear challenge between global, national, corporate and individual perspectives on the validity and use of growth. Current policies overlook these nuances.

12.4.2 Discount factors as the primary means of capital allocation and investment decisions. A number of important consequences stem from this approach such as that the far future may appear worthless (having negligible capital value); and that only financial capital may enter into our equations of value. We as actuaries need to recognise the limitations of discount rates for making financial decisions as it may have unintended consequences for sustainability.

12.4.3 The replacement of GDP as the key metric of economic activity and success. GDP does not capture the depletion of existing natural or human capital and so promotes capital erosion. For this purpose, measures of human welfare may better describe the role of the state but need to be both pluralistic and qualitative.

12.5 However, expanding work on these three topics would not be sufficient: the handful of papers that touched on these topics did so without going into any detail concerning the role of the banking and monetary system specifically around creating new purchasing power (e.g. money). This is a significant academic research gap.

12.6 The Authors recognise that the search process followed may have excluded papers of interest from lower-rated journals, think-tanks and private research institutions; and other publishing media such as books and online sources were also excluded. We recognise that the conclusion is not so much that limited research has been carried out, but rather that it is not published in the highly-rated journals that we searched.

12.7 There is therefore an urgent need for the IFoA to continue the engagement with the academic community looking at these topics and to promote research on the influence of the banking and monetary system on sustainability issues, either on the profession's own behalf or through forming research partnerships with the academic community.

12.8 There is no clear consensus on the way forward or whether, indeed, business as usual could work. However, we believe there are choices that can be made, particularly with reference to the mind-set adopted by actuaries as they seek to incorporate more sustainable practices into their work. These choices are to some extent articulated by a number of papers in our review, in particular by Doual et al. (2012).

12.9 The fundamental choice is between incorporating "green" factors into current actuarial models or a radical overhaul in the models actuaries use. Whilst the literature suggests that a more radical change is necessary, it may be that incremental change is more palatable to actuaries, their clients and regulators. It is important to determine whether incremental change will be sufficient.

12.10 Other issues that may follow as areas for future research include understanding the components of a sustainable financial infrastructure (including, for example, Green Banking, Green Group Lending, Green Bond Market, Conservation Lending Certification Body, Community Currencies); what the implications of a de-growth or steady state economy may be; and policy options such as sovereign money (e.g. a full reserve banking system); or a de-centralised banking system dominated by not-for-profit community banks. An area which has been the focus of UK government scrutiny (the Kay review, Law Commission 2014) has been understanding the impact of fiduciary duties on institutional decision making which may also act as a catalyst for progress on these topics.

12.11 For the Institute and Faculty of Actuaries' Resource and Environment Board, there is a clear opportunity to shape future research. This will be critical in achieving the long-term goal of the Board to make Resource and Environment issues mainstream in actuarial work.

13 Categorisation of the 40 selected papers

Category A papers: Inferred reference to the Financial Sector

Bina, O. (2013). The green economy and sustainable development: an uneasy balance? *Environment and Planning C: Government and policy,* **31**(6) 1023 - 1047

Cimoli, M & Katz, J. (2003). Structural reforms, technological gaps and economic development: a Latin American perspective. *Industrial and Corporate Change*, **Vol.12 (2)**, pp. 387-411

Daly, H. S. (1994). Fostering environmentally sustainable development: four parting suggestions for the World Bank. *Ecological Economics*, **10**, pp. 183-187

Doual, A., Mearman, A. & Negru, I. (2012) Prospects for a heterodox economics of the environment and sustainability. *Cambridge Journal of Economics*, **36** (5), 1019-1032. doi: 10.1093/cje/bes053

Ferreira, S., Hamilton, K . & Vincent, J. (2014). Comprehensive Wealth and Future Consumption: Accounting for Population Growth? *The World Bank Economic Review*, **22**, No 2, 233 – 248

Gowdy, J. & Erickson, J.D. (2005). The approach of ecological economics. *Cambridge Journal of Economics*, **29**, 207–222, doi:10.1093/cje/bei033

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Jochimsen, M. & Knobloch, U. (1997). Making the hidden visible: the importance of caring activities and their principles for any economy. *Ecological Economics*, **20**, pp. 107-112. doi.org/10.1016/S0921-8009(95)00099-2

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Martinet, V. & Rotillon, G. (2001). Invariance in growth theory and sustainable development. *Journal of Economic Dynamics and Control*, **31** (8)**,** pp. 2827-2846

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Ozkaynak, B., Adaman, F. & Devine, P. (2012). The identity of ecological economics: retrospects and prospects, *Cambridge Journal of Economics*, **vol.36**, pp. 1123 - 1142

Prudham, S. (2009). Pimping Climate Change: Richard Branson, global warming, and the performance of green capitalism. *Environment and Planning A*, **volume 41** pp. 1594-1613 doi:10.1068/a4071

Scott-Cato, M. (2012). . Green Economics: putting the planet and politics back into economics. *Cambridge Journal of Economics*, **36**(5) 1033-1049

Smart, B. (2011). Another 'Great Transformation' or Common Ruin? *Theory, Culture & Society*, **vol. 28, no. 2** , pp. 131-151. DOI

Stavins, R.N.; Wagner, A.F. & Wagner, G. (2003). . Interpreting sustainability in economic terms: dynamic efficiency plus intergenerational equity. *Economics Letters*, **79**, pp. 339-343. doi: 10.1093/cje/bes053

Weitzman, M. L. (1999). Pricing the Limits to Growth from Minerals Depletion *The Quarterly Journal of Economics*, **114**(2), pp. 691-706

Category B papers: Financial Sector without Institutional Detail and Unaware of Money

Clark, G.L. & Hebb, T. (2005). . Why should they care? The role of institutional investors in the market for corporate global responsibility. *Environment and Planning A*. **37**(11) 2015-2031 doi:10.1068/a38116

Emel, J. (2002). An inquiry into the green disciplining of capital. *Environment and Planning A*, **34**(5) 827-843. doi:10.1068/a3428

Category C Papers: Financial Sector included without Institutional Detail but with Awareness of Money

Ang, F., van Passel, S; Mathijs, E. (2011). An aggregate resource efficiency perspective on sustainability: A Sustainable Value application to the EU-15 countries. *Ecological Economics*. **71**, 99-110.doi.org/10.1016/j.ecolecon.2011.08.008

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Common, M. (2007). . Measuring National Economic Performance without using Prices. *Ecological Economics*, **64**, pp. 92-102. doi:10.1016/j.ecolecon.2007.07.017

Foxon, T., Kohler, J., Michie, J. & Oughton, C. (2012). Towards a new complexity economics for sustainability. *Cambridge Journal of Economics*. **37**, 187–208. doi: 10.1093/cje/bes022

Greenhalgh, C. (2005). Why does market capitalism fail to deliver a sustainable environment and greater equality of incomes? *Cambridge Journal of Economics*, **29**, 1091-1109

Hamilton, K. & Clemens, M. (1999). Genuine Savings Rates in Developing Countries. *The World Bank Economic Review*, **vol. 13**, no. 2 , pp. 333-356

Kallis, G. (2011). In defence of degrowth. *Ecological Economics*, **70** pp. 873 – 880.

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Rennings, K. & Wiggering, H. (1997). Steps towards indicators of sustainable development: Linking economic and ecological concepts. *Ecological Economics*. **20**, pp 25 – 36. . doi:10.1016/j.ecolecon.2007.07.017

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Wallner, H P., Narodoslawsky, M., & Moser, F. (1996). Islands of sustainability: A bottom-up approach towards sustainable development. *Environment and Planning A* **28**(10) 1763 – 1778. doi:10.1068/a281763

Category D Papers: Financial sector with Institutional Detail and Awareness of Money

Bartelmus, P. (2013). Environmental–Economic Accounting: Progress and Digression in the SEEA Revisions. *Review of Income and Wealth*. Online view published before inclusion in an issue. doi: 10.1111/roiw.12056

Dietz, S. & Neumayer, E. (2007). Weak and strong sustainability in the SEEA: Concepts and measurement. *Ecological Economics* **61**, 617–626

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