J Bus Ethics (2017) 140:369–380
DOI 10.1007/s10551-015-2693-2

The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context

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Received: 20 May 2013 / Accepted: 12 May 2015 / Published online: 22 May 2015

Abstract There have long been calls from industry for guidance in implementing strategies for sustainable development. The *Circular Economy* represents the most recent attempt to conceptualize the integration of economic activity and environmental wellbeing in a sustainable way. This set of ideas has been adopted by China as the basis of their economic development (included in both the 11th and the 12th 'Five Year Plan'), escalating the concept in minds of western policymakers and NGOs. This paper traces the conceptualisations and origins of the Circular Economy, tracing its meanings, and exploring its antecedents in economics and ecology, and discusses how the Circular Economy has been operationalized in business and policy. The paper finds that while the Circular Economy places emphasis on the redesign of processes and cycling of materials, which may contribute to more sustainable business models, it also encapsulates tensions and limitations. These include an absence of the social dimension inherent in sustainable development that limits its ethical dimensions, and some unintended consequences. This leads us to propose a revised definition of the Circular Economy as "an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being".

Keywords Circular Economy · Closed-loop economy · Sustainability · Sustainable development

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Introduction

In 1983, Gro Harlem Brundtland was asked to head a Commission, independent of the UN, to explore 'a global agenda for change' with the intention of formulating '… long-term environmental strategies for achieving sustainable development by the year 2000 and beyond' (WCED 1987, p. ix). In hindsight, we can see that this was an overly ambitious target. By sad irony, the report's publication coincided with the period in history where we witnessed the adoption of neo-liberal economic policies by most western governments. In contrast to heeding the call for reduced consumption, the effect of deregulation in banking, globalisation of capital markets, improvements in IT, off-shoring production, etc., the outcome of these policies led to markedly increased consumption, especially in electronics, clothing, and consumer goods, exacerbated (at least until 2007/8) by the longest period of uninterrupted growth with low inflation since the Great Crash in the 1920s.

It also led to widespread and continuing anxiety that business is failing to address the critical concerns relating to sustainability: over-use of natural resources; ineffectual responses to global warming; and a lack of focus on social justice. Whether it is lack of guidance, the general complexity of the problems presented, or the fact that

alternative business models fail to offer sufficient confidence in their application, there seems to be little urgency in many quarters to respond to the challenges we face in the twenty first century. Despite the evidence that businesses, especially large corporations, have steadily increased the volume of corporate responsibility and sustainability information in their corporate reports (Gray et al. 1995; KPMG 2005, 2008, 2011, 2013), concerns endure that for many, corporate responsibility reporting remains a mask behind which 'business as usual' continues, unreconstructed (Christian Aid 2004; Gray 2006). Some organizations have attempted to capture the agenda and redefine the terminology to make it appear that sustainability is easily managed and delivered (Ball et al. 2000; Muir et al. Muiret al. 2002; O'Dwyer 2003; Gray 2006), and others have challenged its usefulness as a concept (Lélé 1991; Robinson 2004) .

Yet while business appears to drag its feet, the peoples of the world look on at successive sustainability conferences and wonder when any of Brundtland's recommendations might be properly adopted. At two of the recent UN conferences, the 2011 Climate Change Conference (COP17) at Durban in November 2011 and Rio +20 in Rio de Janeiro in June 2012, the consensus seemed to be, despite the view of many delegates, that change is overdue and indeed that time to make changes is running out, that governments seem unable to instigate change against the will of the corporate world, cloaked under the perceived threat to continuing economic growth (see, for example, Banerjee 2012).

If, however, we accede to the view that a lack of alternative business models may constrain the transition to a sustainable future, then there seems to be some urgency in identifying the most prospective of the alternatives. It is in this context that we examine a new approach to sustainability, the 'Circular Economy', which is emerging as a possible strategy that companies of all sizes might adopt to allow them to engage with such challenges. Despite the Circular Economy growing as a business construct, there is yet little formal academic debate on it within the business and sustainability literature. Yet, the Circular Economy is a highly relevant concept to examine given the plethora of academic debates on sustainable and socially responsible business (Russo and Tencati 2009; Junior et al. 2014; Dossa and Kaeufer 2014), in which economic sustainability is often found to be privileged over environmental and social (Schneider 2015) and over moral and ethical values (Besio and Pronzini 2014).

The purpose of this paper is twofold: first to trace the conceptualisation and origins of the Circular Economy, bringing to bear theoretical concepts from environmental economics, ecological economics, and industrial ecology to the business and sustainability relationship. Since sustainability requires systems thinking, the paper explains the inter- and trans-disciplinary perspectives inherent in concepts of the Circular Economy that apply to the implementation of sustainable business. The second purpose is to critically evaluate the potential of a circular economy for an improved and applied conceptualisation of sustainable business. Indeed, the Circular Economy has featured in the last two 'Five Year Plans' drawn up by the Chinese government (Zhijun and Nailing 2007), and is being operationalized in China. The concept is now being explored in the West and championed by a number of NGOs, with positional papers being presented by consultancies and 'think tanks' (Ellen Macarthur Foundation 2012; Preston 2012). However, as the Circular Economy is relatively new in its conceptualisation and implementation, there may also be tensions and limitations inherent in its appropriation and application.

In this regard, the paper addresses the following research questions: What are the theoretical origins of the Circular Economy in its application to sustainable business? How is the Circular Economy being operationalized in sustainable business? What tensions and limitations are inherent in the conceptualisation and application of the Circular Economy?

The paper is structured as follows: in the following section, the relationship with previous research is examined as a context within which to explore current thinking in this area. We then examine conceptualisations and definitions that are ascribed to the Circular Economy, but widen our study to include issues of biogeochemistry and resource cycling. We then trace the origins of the 'Circular Economy' term and explore antecedents of the concept in economics and ecology. The paper considers the relationship of the Circular Economy to sustainable business and applications of the concept to business practice and policy. We offer a discussion and critique of some tension and limitations with in the Circular Economy and conclude with a revised definition under which future analysis and academic research might be undertaken.

Relationships with Previous Research

A feature of the analysis in The Brundtland Report (WCED 1987) is the call for a holistic approach to be taken by societies (including businesses) toward issues of consumption in general. That aspect is largely ignored in the response of researchers who still tend to look at individual companies, and their immediate stakeholders, by taking an 'entity' focus, and often a (sometimes implied) economic focus. Sustainability consultancies, more predictably, stress bottom line effects of effective sustainability policies. This type of reductionism, studying single aspects of a system in

isolation, is a feature of much management research that is both difficult to recognize and to avoid (Von Bertalanffy 1950; Gray et al. 1996), representing a missed opportunity to advance the development of a more systemic approach.

This journal has been in the forefront, and led many of the contemporary debates relating to theoretical issues of sustainability, stakeholders, legitimacy, the social performance/financial performance link, sustainable production, etc. It is not our intention to revisit this body of literature which has been reviewed in detail in other places; rather we wish to examine the literature on the circular economy, surveying the current range of definitions, and exploring the potential for adding something of substance to the debate.

Conceptualisations and Definitions of the Circular Economy

The term *circular economy* has both a linguistic and a descriptive meaning. Linguistically it is an antonym of a *linear economy.* A linear economy is one defined as converting natural resources into waste, via production. Such production of waste leads to the deterioration of the environment in two ways: by the removal of natural capital from the environment (through mining/unsustainable harvesting) and by the reduction of the value of natural capital caused by pollution from waste. Pollution can also occur at the resource acquisition stage. This is a one-way system and an economy based on such a system has been referred to as a *cowboy economy* by Boulding (1966).

The term *linear economy* was brought into popular use by those writing on the Circular Economy and related concepts. Thus, in many ways, the origin has been deliberately set, in framing the antonym, to promote the term *circular economy*. By circular, an economy is envisaged as having no net effect on the environment; rather it restores any damage done in resource acquisition, while ensuring little waste is generated throughout the production process and in the life history of the product.

The word *circular* has a second, inferred, descriptive meaning, which relates to the concept of the cycle. There are two cycles of particular importance here: the biogeochemical cycles and the idea of recycling of products.

The Biogeochemical Cycles

Many basic molecules and atoms pass through cycles on the planet. For example, a simple yet fundamental cycle for life is that of water: water evaporates from the oceans forms rain clouds, falls on land as rain, runs into rivers, and flows back to the ocean. In fact, the planet has many such cycles. The length of time that it takes to complete a lap of a cycle varies. For example, it takes 9 days for water to cycle through the atmosphere, while it takes 37,000 years for the oceans to complete a cycle (Murray 1992). Phosphorus takes 2000 years to cycle through the soil (Jahnke 1992) as does nitrogen (Jaffe 1992). Carbon dioxide takes 4 years to cycle through the atmosphere (Siegenthaler and Sarmiento 1993) while atmospheric oxygen takes 3.7 million years (Keeling et al. 1993). Faster turnover times mean greater susceptibility to change, and so atmospheric carbon dioxide is much more sensitive than atmospheric oxygen, partly due to the size of the pool, which is small (0.039 % of the atmosphere) compared to oxygen (20.95 % of the atmosphere). Thus, flux is a very important issue in biogeochemical cycles (Schlesinger 1993).

Almost every biogeochemical cycle has been altered by human activity. If such a concept as a circular economy is a viable proposition, it would seek to restore fluxes to their natural levels, reducing the excessive removal of material from a cycle, and the excessive release of materials into a cycle. Cycles can cope with change, but it is the rate of change that is the important issue. Thus the Circular Economy is concerned with slowing or managing flux, a challenge we return to below.

Recycling

Recycling has been a significant part of sustainable practice for many years, and it is fundamental to the Circular Economy. Indeed, the Chinese transformation was significantly informed by several recycling laws in Japan (*The Basic Law for Establishing a Sound Material-cycle Society, 2002*) and Germany (*The Waste Avoidance and Management Act, 2002*). The Circular Economy is ultimately linked to resource cycling. These ideas are further developed in industrial symbiosis, where firms use each other's waste as resources, and in the service economy, where work is done to slow down cycles of use, in order to delay waste output. By increasing longevity of products through better manufacturing and maintenance, the rate of replacement decreases, and so resource use is reduced. Thus the 'waste-as-food concept', wherein unwanted outputs of one industrial process are used as raw materials in another industrial process, and the three Rs of Reduce, Reuse, and Recycle have become central to the concept of the Circular Economy.

The Origin of the Circular Economy term

The origin of the term 'Circular Economy' itself is debated. Certainly, the idea behind a circular economy has existed for a long time. As early as 1848, Hofman, the first President of the Royal Society of Chemistry, stated "…in an ideal chemical factory there is, strictly speaking, no waste

but only products. The better a real factory makes use of its waste, the closer it gets to its ideal, the bigger is the profit" (Lancaster 2002).

Greyson (2007) claims that Kenneth Boulding (1966) was the originator of the term when he wrote: "Man must find his place in a cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy" (pp. 7–8). Liu et al. (2009) claim it was originally a Chinese concept. Yuan et al. (2006) also claim the first use of a circular economy concept was in China and occurred in an unreferenced 1998 paper by Zhu, inspired by German and Swedish loop-closing, and arising from the Industrial Ecology paradigm which models industrial processes using the flow of material and energy through them. The inclusion of Sweden is interesting here, as most literature attributes the inspirations as stemming from Germany and Japan.

Pearce and Turner (1990) claim that the term 'circular economy' was first used in western literature in the 1980s, to describe a closed system of economy-environment interactions. It was Stahel and Reday-Mulvey (1976) who first referred to a closed-loop economy. Stahel's idea of improved durability actually was drawn directly from Boulding (1966, p. 12) who wrote: "I suspect that we have underestimated, even in our spendthrift society, the gains of increased durability". Another interesting claim for early use is by Robèrt (1991, p. 1) who stated: ''Most environmental problems are based on the same systemic error, linear processing of material. Until resources are processed in cycles, either by society or by biogeochemical processes, the global economy and public health will continue to deteriorate". More recently, Mathews and Tan (2011, p. 436) suggested that "the goal of the eco-initiatives is to eventually establish a so-called circular economy, or what is otherwise known as a 'closed-loop' economy", while Yang and Feng (2008, p. 813) called the Circular Economy an "abbreviation of Closed Materials Cycle Economy or Resources Circulated Economy".

The term 'Circular Economy' has therefore been linked with a range of meanings and associations by different authors, but what they generally have in common is the concept of cyclical closed-loop system.

Antecedents of the Concept in Economics and Ecology

The Circular Economy as a concept has its antecedents in broader historical, economic, and ecological fields. Examination of these supports understanding of the subsequent application of the concept in practice.

In one of the early theories of economics, the *physiocrats* (meaning literally *government of nature*) held that agriculture was the source of all wealth, and François Quesnay first set out the concept of a *circular flow of income*, in his book, *Tableau Économique,* in 1758 (Quesney 1972). This circular flow was inspired by the work of William Harvey (in 1628) and Marcello Malpighi (in 1661) on blood circulation. The circular flow of blood around the body was viewed as a useful metaphor for the flow of money through an economy. Of course, in terms of etymology, the word *economy* (οἰκονομία —household management), comes from the same ancient Greek origin as *ecology* (οἶκος, house -λογία, study of) meaning study of the household. This makes it all the more fitting that these concepts should come together. Indeed, the Circular Economy has, as its main concern, the management of the economy in such a way as to leave the *house* undamaged.

In the nineteenth century, industrialists had already developed the idea of industrial metabolism, wherein industry operates not as a set of independent inputs and outputs, but as a unified larger 'organism', and waste-is-food (Simmonds 1862), both of which would inform Circular Economy thinking. By 1930, industrial symbiosis had appeared in the literature (Fischer-Kowalski and Haberl 1998; Parkins 1930). The largest recent sustainable economics movement, *Industrial Ecology*, brought together these ideas and gathered considerable interest.

It was the advent of the closed-loop economy, first presented in the *Spaceship Earth* analogy of Boulding (1966), and later developed by Stahel and Reday-Mulvey (1976), that became influential upon German and Japanese policy of the 1980s and 1990s (Triebswetter and Hitchens 2005; Moriguchi 2007; Bilitewski 2007). These policies, in turn, inspired China to install the Circular Economy as its major framework for delivery of increased growth but with decreased environmental damage.

The Circular Economy has been framed in an almost identical way as Industrial Ecology, with three levels of initiatives:

Single enterprise, involving a firm-level study of cleaner production, such as the work of Yuan and Shi (2009) on eco-industrial initiatives at a smelter;
Inter-firm clusters at supply chain level, represented by eco-industrial parks (EIPs) and involving industrial symbiosis;
Entire cities/municipalities, incorporating industrial metabolism (Chertow and Lombardi 2005; Zhang et al. 2008; H. Zhang et al. 2009; L. Zhang et al. 2010)

Thus, Industrial Ecology and the Circular Economy have a shared lineage, with much overlap. A separate line of thinking began in the early 1970s, inspired by the OPEC oil crisis: *Environmental Economics* (Cropper and Oates 1992; Dorfman 1993) with its emphasis very much on economics, sought to examine how the environment could

be managed in order to allow economic growth to continue. By the 1980s, frustration with progress led to a second school of thought, *Ecological Economics*, separating itself and developing a more ecologically centered approach (Daly and Farley 2004). From this group emerged a third school, who felt that the social aspects of sustainability were not sufficiently recognized. They called it *Socio-ecological Economics* (Jacobs 1996; Cameron 1997). One interesting difference between Circular Economy and most of the other schools of sustainable thought is that it has largely emerged from legislation (at least in the Chinese context), rather than from a group of academics who have split from one field and have started a new one (exemplified by the emergence of Ecological Economics from Environmental Economics, as described by Røpke (2004; 2005)). This may explain why the Circular Economy has not yet acquired a journal, editorial board, and group of faculties of its own, as these are the normal territorial markings of a group of academics.

The relationship of the Circular Economy to Sustainable Business

The notion of systems thinking and the need to consider a business entity as part of a wider system of stakeholders and the environment in which it operates has long been discussed in the business literature (Pauchant and Mitroff 1990; Mason and Mitroff 1981; Hester and Adams 2014). Moreover, the need to consider the role of wider of systems in business and accounting decisions has become prevalent within environmental management and sustainability reporting (Gray 2002; Gray and Bebbington 2001). The widely accepted Brundtland definition of sustainable development as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987, p. 43) has the underpinning assumption that resources are not finite and have to be managed to sustain future generations. This is also recognized within the definition of the Circular Economy:

> "The model of a linear economy, in which it is assumed that there is an unlimited supply of natural resources and that the environment has an unlimited capacity to absorb waste and pollution, is dismissed. Instead, a circular economy is proposed, in which the throughput of energy and raw materials is reduced"(Cooper 1999a, b, p. 10).

In its most basic form, a circular economy can be loosely defined as one which balances economic development with environmental and resource protection (UNEP 2006) and in this form, it appears to be inseparable from industrial ecology, and close to the three pillars (economic, environmental and social) of sustainable development, although we critique the social aspect below.

However, the uniqueness of the Circular Economy comes from two interconnected ideas, the closed-loop economy and 'design to re-design' thinking. The UNEP report suggests that features of the Circular Economy include 'low consumption of energy', 'low emission of pollutants' and 'high efficiency', using it as a generic term for an industrial economy which is, by design or intention, restorative and in which material flows are of two types—those which are biological nutrients, designed to re-enter the biosphere safely, and technical nutrients, which are designed to circulate at high quality without entering the biosphere. The aims are to 'design out' waste, return nutrients, and recycle durables, using renewable energy to power the economy (UNEP 2006).

The use of the word 'restorative' is important, as the Circular Economy is not merely a preventative approach, reducing pollution, but also aims to repair previous damage by designing better systems within the entity of the industry itself. Drawing on concepts such as 'cradle-to-cradle™', where industry operates with no impact upon the environment by being waste-free (McDonough 2002); biomimetics, wherein the structure and function of natural systems informs industrial processes; and industrial ecology, the Circular Economy focuses on optimizing systems rather than components. Furthermore, it goes beyond traditional notions of sustainability by focusing on the positive restoration of the environment within the industry (Nakajima 2000; Pitt 2011; Cooper 1999a, b). Its concept of redesigning systems of manufacture and service supply focuses on achieving value from such redesign rather than simply improving resource utilization.

A true circular economy would demonstrate new concepts of system, economy, value, production, and consumption (Wu 2005), leading to sustainable development of the economy, environment and society (Wu 2005; Shen 2007). The ultimate objective of this approach would be to achieve the decoupling of economic growth from natural resource depletion and environmental degradation (Liu et al. 2009; Xue et al. 2010). As such, the Circular Economy might be thought of as a general term covering all activities that reduce, reuse, and recycle materials in production, distribution, and consumption processes (Cooper 1999a, b). Feng et al. (2007) describe the Circular Economy as a mode of economic development based on ecological circulation of natural materials, requiring compliance with ecological laws and sound utilization of natural resources to achieve economic development. Feng (2004) explains that there is a feedback process of *resource—product—renewed resource*, and that the ultimate objectives of optimum production, optimized consumption, and minimum waste can be achieved in production. Hu

et al. (2011) stress that the focus of the Circular Economy is on resource productivity and eco-efficiency improvement, and they adopt the 4R approach: **r**educe, **r**euse, **r**ecycle, and **r**ecover.

Applications of the concept of Circular Economy in Practice and Policy

The nation that has most fully embraced the implementation and development of circular economy concepts thus far is China, having developed an ambitious program of applying the concept (Zhou et al. 2014). Given its estimated population of 1.4 billion people in 2015, around 19 % of the global figure (UN 2014) the economic and sustainable business practices of China are of vital interest worldwide. Skene and Murray (2015) trace the development of the adoption of the Circular Economy in China to 1973, when the first National Environmental Protection Conference formulated environmental protection policies and guidelines. They suggest that by 2002 when the 16th National Congress of the Communist Party of China set out an ambitious development plan, involving economic growth, social equality, and environmental protection, known as a 'circular economy', the term was defined in legislation in China as a means of reducing, reusing, and recycling activities conducted in the process of production, circulation, and consumption (see also Xue et al. 2010; Geng et al. 2012). The incorporation of a circular economy into the Outline of the 11th and 12th five-year plans for National Economic and Social Development was an important step, allowing much greater support and focus on sustainability (Wu et al. 2014; Su et al. 2013) This inclusion is significant as the five-year plan cycle forms the medium term focus for government policy in China. It is backed up by a series of statutes designed to promote cleaner production, pollution prevention, and waste control. In 2009 the 'Circular Economy Promotion Law 'took effect, with the aim of 'improving resource utilization efficiency, protecting the natural environment and realizing sustainable development' (Geng et al. 2012 p. 216).

This enactment is designed to influence behavior at all levels of business activity from the micro, or individual firm level, where companies are encouraged to engage in eco-design and cleaner production approaches, through meso- or the eco-industrial park level designed to promote regional development and the natural environment (Yuan et al. 2006; Geng et al. 2008) to the macro or national level, promoting eco-cities, and sustainable production and consumption, ultimately with the intention of promoting a 'recycling orientated society' (Geng et al. 2012 p. 217). Geng et al. go on to explain that the government department with responsibility for implementing and monitoring Circular Economy activity is the National Development and Reform Commission (NDRC) which has already instigated pilot circular economy projects including participation by 178 entities including 109 enterprises, 33 industrial parks, seven provinces, and nineteen cities (p. 217).

To monitor the development of the process, the NDRC invited academic and policy 'experts' to develop a set of circular economy indicators broadly based on the principles of 'reduction, reuse and recycling'. This led to the development of two separate sets of indicators, one aimed at the macro or regional and national level, and the other at the meso- or industrial park level, both measuring resource output, consumption, and utilization, as well as waste, pollution and emissions (Geng et al. 2012 p. 218).

While it is acknowledged that in the context of a population of 1.4 billion, these steps may seem small and somewhat faltering, it is clear that Circular Economy activity in China is of growing interest to researchers (cf. Ghisellini et al. 2014). It is equally likely that, as data from the monitoring and evaluation process become more readily available, this research activity will further increase, and become of greater interest to policymakers in other countries.

While China may have taken the lead in implementing the concept of the Circular Economy in practice, its application has also been seen in western economies. Hill (2014) argues that what started as a theoretical construct is gradually becoming an idea accepted by some businesses and policymakers within Europe as conveying an aspiration to keep resources in economic use for as long as possible.

A leading proponent of the Circular Economy in the UK is the Isle of Wight based NGO, the Ellen Macarthur Foundation, who have to date commissioned McKinsey and Company to produce three reports on the concept (Ellen Macarthur Foundation 2012, 2013, 2014). The first report begins by emphasising the limits of a linear economy, focusing on resource losses, the erosion of ecosystem services, and the threat to continued economic prosperity. It then examines the potential of circular business models to drive value creation and identifies four sources of value creation within a circular economy: the power of the inner circle (less cost in production); the power of circling longer (lengthening lifetime of products); the power of cascading use (waste-is-food); and the power of pure circles (where source material remains uncontaminated, thus improving redistribution efficiency and material productivity) (Ellen Macarthur Foundation 2012). These concepts are then applied to a series of case studies taken from a broad spectrum of industries, including mobile phone technology and washing machine manufacture. For example, using a detailed example of smart phone manufacture it demonstrates how with some alteration to the design, the cost of remanufacturing mobile phones could be reduced by 50 %

per device, if the industry made phones easier to take apart, improved the reverse cycle, and offered incentives to return phones. This enables reduced material inputs and associated labor and energy costs, as well as reduced carbon emissions along the entire supply chain. Subsequent reports (Ellen Macarthur Foundation 2014) identify materials inputs into manufacturing processes that can be treated differently depending on whether they have high recycling potential (e.g., cardboard); lack systematic reuse (e.g., polymers); are by-products that can displace virgin material intake (e.g., bitumen made into carpets); or potentially innovative products that are fully restorative by design and intention (bio-based materials that can be returned to the biosphere). All of these give specific examples of how they can be implemented by business.

From a policy perspective, in December 2014, the European Parliament adopted the communication from the European Commission, 'Towards a Circular Economy: a zero waste programme for Europe' and although there was resistance from some business lobbies the adoption was carried. The intention is that such an approach would, *inter alia*:

> 'boost recycling and preventing the loss of valuable materials;
> create jobs and economic growth;
> show how new business models, eco-design and industrial symbiosis can move us towards zero-waste;
> reduce greenhouse emissions and environmental impacts.'
> (European Commission 2014, p. 4).

Initiatives in the UK, most notably evident in the Ellen Macarthur Foundation reports, were followed by a study undertaken by the Royal Institute of International Affairs (Chatham House), an independent policy institute (Preston 2012), and in July 2014, a committee of UK Members of Parliament published a report, entitled, *Growing a circular economy: Ending the throwaway society,* after taking evidence from numerous witnesses from private, public, and third sector organizations (House of Commons Environmental Audit Committee 2014). In this, they called for the government to take action on a number of fronts to facilitate the transition to a circular economy. In turn, The UK Government responded in November 2014, offering encouragement on the principle of a circular economy, but in line with its position in similar such matters declined to go further than endorsing Circular Economy initiatives (HM Government 2014).

In France, in the same timeframe, parliamentarians took upon themselves to form a 'circular economy club',[1] and in an interview in June 2014, during France's 'Green Week' Jean-Paul Albertini, the French Executive Commissioner for Sustainable Development affirmed France's commitment to 'turn France into a leading company, when it comes to the circular economy'.[2] France has also seen leadership initiatives from the NGO sector with organizations like l'institut economie circulaire campaigning and organizing events and initiatives. French companies like SNCF, Orange France, Capenergies and La Poste have partnered with a French Business School in a Research Chair researching the circular economy.[3] In the Netherlands, a similar impetus is being developed with the NGO 'Circle Economy' working to the same ends in partnership with public and private enterprises. There are similar initiatives are developing in many other European countries also, as interest grows.

It is clear that, faced with evidence that finite resources are being depleted (WWF 2010, 2012); that we are using more than we can replace (D. Meadows et al. 2004; Meadows et al. 1992); that things do not look like they will improve (UNEP 2012); and that climate change is likely to worsen the situation for many peoples of the world (IPCC 2007; Stott et al. 2010), business models have to change toward to a more sustainable way of living, manufacturing and consuming. In the face of this evidence, any initiative that might make the transition should be welcomed. The Circular Economy represents one way of conceptualizing and operationalizing this process; however, there are tensions and limitations in the application of the circular economy in contemporary business practice.

Tensions and Limitations Within the Circular Economy

In this section, we evaluate and discuss some of the aspects missing from definitions and concepts of the circular economy, including confusion with semantics, and a lack of focus on social issues, followed by a critique of the Circular Economy's potentially un-intended consequences and over-simplistic goals.

Confusion with Semantics

The uses of the words "*circular*" and "*linear"*, in association with the word "*economy"* are potentially confusing as both links have been made in completely different contexts.

The *linear–stages-of-growth model* is set out by Rostow in his book *A Non-Communist Manifesto* (1960), wherein

[1] http://www.euractiv.com/sustainability/french-parliamentarians-launch-c-news-530901

[2] http://www.energypost.eu/video-circular-economy-france-aims-lead-example-stresses-french-sustainable-development-official/

[3] http://www.kedgebs.com/en/chairs/business-unusual-chair

he describes five successional stages that developing nations all pass through: the traditional society, the preconditions for take-off, the take-off, the drive to maturity and the age of high mass-consumption. Other examples include *linear economic models*, which are mathematical tools used to analyze economic behavior, be it in closed or open systems (Gale 1989).

Furthermore there is the concept of *circular flow of income,* as mentioned above, dating back to 1758 (Quesney 1972). Here, income, production and expenditure cycle through consumers and producers. Thus the uses of *linear* and *circular*, in conjunction with *economics*, is potentially confusing, as both combinations already exist, but in very different contexts.

The Missing Social Dimension

The three pillars of sustainability (economic, environment and social) explicitly include the social dimension, in terms of human stakeholders, human well-being, and human rights. At times, these may stand in tension with environmental and economic pillars (Gray et al. 2014; Mathews 1995), but the social is explicit as a dimension. Moreover, the concept of sustainable development previously defined as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987, p. 43), introduces the notion that development ought to aim at delivering some form of equity across and through the generations of people who presently, and who will in the future, populate our planet. As such it raises issues of inter-generational equity, between present and future generations, and intra-generational equity, between different peoples within the current generation, i.e., the developed and developing worlds, and peoples within these worlds. Equity and social justice can be said to be at the heart of the concept of sustainability (Haynes and Murray 2015)

The Circular Economy, however, is virtually silent on the social dimension, concentrating on the redesign of manufacturing and service systems to benefit the biosphere. While ecological renewal and survival, and reduction of finite resource use clearly benefits humankind, there is no explicit recognition of the social aspects inherent in other conceptualisations of sustainable development. It is unclear how the concept of the Circular Economy will lead to greater social equality, in terms of inter- and intra-generational equity, gender, racial and religious equality and other diversity, financial equality, or in terms of equality of social opportunity. These are important moral and ethical issues which are missing from the construct. Only if societal needs are defined and included in the basic formulation, can we hope to build on all three pillars of sustainability. This needs urgent attention in the Circular Economy conceptual framework.

Unintended Consequences and Over-simplistic Goals

The Circular Economy approach can also be critiqued for having unintended consequences and over-simplistic goals. For example, many apparently positive sustainable activities have very negative environmental outcomes. The green fuel drive has led to large areas in Borneo being cleared of forest in order to plant oil palm. This has led to devastation of crucial habitat for cloud leopards and orang-utans, among many other species (Fitzherbert et al. 2008). Another issue is the reliance of much green technology upon rare earth metals, such as neodymium, which is mined at considerable environmental cost (Zhang et al. 2000). Ethanol production requires more fossil fuel than it produces, while biofuels use the equivalent of ten acres for every car per year (Pimentel 1998). Moreover, demand for biofuel has contributed directly to the loss of millions of acres of tropical forest which are replaced by soy fields for biofuel production (Farigone et al. 2008). Even without forest destruction, essential farmland is being displaced for green energy production, putting huge pressure on food production in poor countries (Gardner 1997).

The anthropomorphism of nature is another worrying trend. For example, Smart (1992) writes that "Nature's rule book has no moral or ethical ingredient beyond self-interest. Corporate metabolisms are remarkably similar to those of nature". There is no evidence whatsoever to point to self-interest being a meaningful concept within nature. By imbuing nature with our own traits, we risk auto-referencing. Over-simplification arises both from reductionist thinking and from mathematical modeling, wherein we remove most variables in order to produce manageable concepts. However, nature is holistic, and operates in a highly conversant way between its levels of organization (Skene 2011).

Furthermore, the idea that we can design much longer-lasting products appears useful, but design may be compromised and, in nature, appropriate flow is important. Longevity in product design is not always efficient ecologically. Many long-lasting products which do not break down quickly consume more useful energy and release more entropy than those designed towards a more natural outcome, likely with shorter life. For example, a bamboo chopstick would be better than a highly specialized plastic fork, as it could easily be recycled and would only briefly be removed from the Biosphere. Furthermore, the bamboo chopstick uses only natural nutrients, not technical nutrients, and therefore is more easily re-assimilated back into the environment. By building long-lasting materials, we

will be likely to make their ultimate breakdown more difficult and energetically expensive. Indeed much of our green technologies, from wind farms to solar panels, rely on technological nutrients that are very difficult to recycle. Yet the structures that contain these technological nutrients will invariably need significant, energy-expensive servicing and replacement, as nothing lasts forever in an entropic universe. The issue of flux should be central to all of this, and delaying the cycle through exotic chemistry or prolonged servicing may well not be an appropriate strategy. This brings us to the concept of appropriate technology, developed by Schumacher (1973), wherein smaller scale, locally adaptive solutions have less environmental impact than large scale global solutions.

The Circular Economy has embraced biomimetics as an important principle. However, mimicry itself may not go far enough and implies that we need to pretend to be biological, rather than actually *being* biological. It is very much a *weak sustainability* argument, where technology is intended to achieve what nature achieves. A different approach would be *bio-participation*, where we learn to play our role in the existent biosphere, rather than mimic aspects of that biosphere, while still existing in technological seclusion. Moreover, bio-mimicry is a reductionist approach, and since all natural processes emerge due to holistic interactions, then mimicking nature in isolation is unlikely to work [for example, the introduction of the cane toad to Queensland as a biological control (Smith and Phillips 2006)]. The dependence upon technology for environmental progress risks privileging it over nature in the sustainable tripartite bottom line.

Conclusion

The intention of this paper was to bring the debates surrounding the Circular Economy to a wider audience and increase its impact within the business ethics literature, where despite corporate engagement with the concept, there has been little theoretical development. A sustainable future for the human race will demand system-based thinking that involves, in equal measure, society, environment, and economics. It is the re-knitting together of these pillars of sustainability that must happen if we are to rediscover a balanced existence with the rest of the biosphere. Of the three pillars of sustainability (social, economic, and environmental) it is the former that is least expanded in most of the conceptualisations and applications of the Circular Economy, and yet the social, with an emphasis on intra and inter-generational equity is underpinned by ethical concepts, just as much as the environmental, in relation to the moral imperative of business to sustain the natural environment.

The Circular Economy is an important and significant new school of thought in sustainable development, having been adopted by the largest nation on the planet, China, as its main framework for environmental change and economic development over the next 10 years. It is a young field, and this paper suggests that it needs careful definition, in order to provide a meaning that will allow real benefit to emerge for both environment and society. Without this, there may well be insufficient structure to adequately address the serious issues facing us and the biosphere in which we live over the coming years. Oversimplified goals, based on weak foundations, may pose significant risks to the usefulness of the Circular Economy.

Given these issues mentioned above, it may be necessary to re-evaluate how the circular economy should actually be defined. The following definition is suggested:

> The Circular Economy is an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being.

Humans, their activities and their environment are all loci on the one circle, thus a circular economy recognizes this relationship. A circular economy involves entire networks of production, and there is a diffusion of responsibility throughout these networks, with the producer and consumer not remaining ethically neutral. Future research should begin to incorporate the latest ecological knowledge into our understanding of naturalistic economical models and systems, without silencing the social and human dimension. This may require significant re-examination of much of current theory, and lead to new practice. The implications of re-aligning economic and management practice with properly formulated ecological and social models can only contribute positively to the development of ethical and sustainable business practice.

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