H2020 MSCA-ITN-2018

ReTraCE Project

Realising the Transition to the Circular Economy

Report on Milestone 8 (M3.2)

Identification of critical factors, assumptions and constraints in determining economic efficiency of the CE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Introduction

Transition toward Circular Economy (CE) has drawn increasing attention from scholars as a solution for sustainable development to take on environmental and social challenges in tandem with extant economic priorities (Korhonen *et al.*, 2018). Several studies have indicated that shifting from linear models to circular ones will not only contribute to positive impacts on environment but also have an insignificant/positive impact on aggregate economic outcomes (McCarthy, Dellink and Bibas, 2018). The problem with these studies is that they offer customized economic models in general which do not comprise a holistic analysis of economic efficiency of transition toward CE. Although CE is a popular notion among the scholars with different expertise, there is no consensus about its definition, critical assumptions and constraints about transition toward it. It is because of the fact that CE is a multi-disciplinary concept and is rooted in on a collection of ideas from a wide range of disciplines including ecological economics, recycling and related topics, sustainable supply chain management, etc. Therefore, this report intends to review the concept rigorously and to identify the critical factors, assumptions and constraints in determining economic efficiency of the CE.

Efficiency is a broad term that can be conceptualized in many ways including technical efficiency, productive efficiency, and allocative efficiency which have their own advantages and disadvantages than need to be considered carefully when implemented in a particular framework (Murillo-Zamorano, 2004) . In general, for policymakers and economists, achieving efficiency is a top priority to be able to make an optimal use of available resources to develop policies and strategies (Palmer and Torgerson, 1999). In particular, economic efficiency is a term that receives multiple definitions depending on the context where this is being applied but most economists agree that it is a situation in which it is impossible to improve the situation of one party without imposing a cost on another (Markovits, 2008).

After an initial scanning on the existing literature about economic efficiency in the context of a circular economy, evidently there is a research gap in this very specific field, however, it is worth mentioning that there exist a broad body of literature on the topic of resource efficiency, however, when the term "economic efficiency" is used in multi-disciplinary contexts which comprise other topics in addition to economics, there is no consensus in definition. Depending on the context, economic efficiency is usually translated into productive efficiency or allocative efficiency which will be discussed further.

Productive Efficiency

Productive efficiency is more related to the technical side of efficiency definition in which the production capacity is maximized. It is to the level of production where the output levels are optimally high with production costs are at the lowest possible level. Productive efficiency can be identified in a context where all the industries in a market use best-practice technological and managerial processes and the economy is on its production possibility frontier in which there is no further reallocation that bring more output with the same inputs and the same production technology (Rodriguez, 2019). It is worth noting that, productive efficiency definition is highly similar to resource efficiency since the latter focuses on using given set of resources in the most technologically efficient manner to obtain maximum output. The current economic development model is a major driver for the current situation of environmental crisis, climate emergency, and resource depletion. Within this context, a growing world economy and the further industrialization

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of big countries as China, India, Brazil, Ethiopia or Indonesia among others, is very likely to cause a significant rise of resource demand (ALCAMO, FLÖRKE and MÄRKER, 2007; Lambin and Meyfroidt, 2011; Schimpf *et al.*, 2017), a further increase of greenhouse gases (GHGs), and an increase of pollution, among others (Fisher and Marrewijk, 1998; Victor, 2017). Within the scenario of a rising resource demand and a declining resource availability, prices of raw materials are expected to grow significantly, increasing the production costs of the industrial activities and consequently, the overall prices of products. Therefore, to build a competitive productive sector prepared for this future scenario of resource scarcity, it will be critical to develop production methods and technologies that are resource efficient. Or in other words, resource efficiency is expected to be a major driver of economic efficiency in near future. Although other elements that determine economic efficiency exist, according to the existing predictions on a growing resource demand and simultaneous decreasing supply, it can be hypothesised that resource efficiency will be a major driver for economic efficiency in the near future. European Commission has proposed that resource efficiency can be achieved by promoting reuse or recycling (Commission, 2008).
Also, the resource productivity has been taken up as the lead indicator for measuring resource efficiency by the European Commission. The indicator quantifies the relation between economic growth and the consumption of materials through the ratio between Gross Domestic Product (GDP) over the amount of materials used by an economy (Domestic material consumption - DMC). The consumption of material is quantitative and does not reflect what kind of materials are consumed and also the qualitative aspect of inputs is disregarded. Difficulties in assessing economic efficiency for example, the durability of UPVC weatherboard homes (greater maintenance efficiency) may be greater than wooden cladding for houses (renewable resources). Therefore, the efficiency approach alone cannot help distinguish between sustainable and unsustainable resource allocations and prevent absolute exhaustion of the limited physical resources from the environment (Jollands, 2006). Also, the GDP as indicator is contested as a measure of "economic growth", which does not separate costs from benefits, where also remedial and defensive expenditures induced by the economic growth, the depletion of life-sustaining natural capital, the depreciation and replacement of existing manmade capital, are all added to GDP as income in dollars' worth, not subtracted and alienated from its physical dimension. Moreover, as GDP flow consists mainly of throughput (resources - physical quantities) expressed in value units, the greater the flow of throughput (the faster the depletion) the higher is efficiency (Daly, 2014).

Allocative Efficiency

Allocative efficiency is another aspect of the economic efficiency concepts. Contrary to the productive efficiency, allocative efficiency deals with scarce resources as inputs and allocates optimal combination of them to society to achieve production of the products most wanted by consumers at minimal cost, and it is based on input prices. This refers to efficient distribution of productive resources among alternative uses to produce optimal mix of output (Brewer and Rabin, 2003). This is assumed under perfect market competition that the consumers will respond to prices that reflect the true costs of production or "marginal costs". But, allocative efficient economy does not necessarily lead to a just economy. Allocative efficiency means maximum benefits are yielded from scarce resources for the society at lowest cost, but equality means that those benefits are

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distributed uniformly among the society. Economic efficiency does not always bring equality in free markets.

Regarding the lowest costs, the environmental economists propose that the ecological degradation is not accounted in the traditional costs of production. They advocate for pollution charges which would increase economic efficiency of the circular economy expecting that it would encourage more uptake and scale up of the resource efficiency technology, policies and practices (Sauvé, Bernard and Sloan, 2016; Di Maio *et al.*, 2017; Brears, 2018). For example, ecological economists propose shifting the tax base from value added (earned income) and on to that to which value is added (natural resource throughput) to enable counting of all costs and minimizing depletion and pollution (Daly, 2014). This would work toward increasing the price of the raw material supply and therefore equalization with the cost for recycling and reusing secondary materials in the circular economy.

Critical Factors, Constraints and Assumptions

In economic efficiency terms, the limited resource factor and diminishing returns (true costs of production or in other words the marginal costs) are the most important. The limited resources can be in the form of raw materials (resources, water and energy), labour and man-made capital (machines or technology). Thus in the aspect of circular economy, the true costs of production should be reflected in the price/cost of raw materials versus recycled materials. Therefore, if prices of raw materials increase, then the use of secondary materials and recycling will increase the economic efficiency, but the products must be designed for recovery materials. However, limits to material recycling exist, as downcycling cause recycling materials to lose value and lower the product quality. Also, the collection waste system and recycling process requires intensive application of manual labour, which also can affect the economic efficiency in the circular economy. The development of technology for waste separation and introducing better collection systems, such as reverse logistics, can increase the economic efficiency of the circular economy. In this light, the efficiency should be multi-dimensional space where different interrelated perspectives of efficiency can be analysed, although in practice, efficiency is often narrowly conceived within disciplinary boundaries.

In addition to productive efficiency and allocative efficiency, there are other terms that can also be used depending on the context when it comes to economic efficiency such as energy efficiency, social efficiency, etc. All these terms have a set of implicit priorities, namely the optimal allocation of financial resources, of energy, of materials, of techniques to maximize production, or the impact to the environment. Thus, to craft a definition of economic efficiency of the circular economy means not only a mere measurement of the still abstract idea of circularity, but the definition of a set of priorities that have a political implication per se.

During the next months, the discussion among ESRs of WP3 will be dealing with these issues, in order to determine a first identification of critical factors, assumptions and constraints in determining a working definition for the concept of economic efficiency within the transition to a Circular Economy.

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The Circular Economy at a crossroad: Technocratic Eco-Modernism or Convivial Technology for Social Revolution?

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Abstract

In the last decade, the concept of 'Circular Economy' (CE) has gained prominence in the political and corporate discourse around the world. According to its proponents, CE represents a new paradigm that will push the frontiers of environmental sustainability by transforming the relationships between ecological systems and economic activities. In this paper we discuss how this idea is problematic for a number of physical, economic and political reasons, claiming that the biggest shortcoming of the CE discourse is represented by its apolitical framing. We call for opening up a debate to deconstruct the increasingly hegemonic discourse of CE based on a technocratic approach and reconstruct it by embedding normative and political dimensions. Finally, we propose a countervailing discourse of CE based on the idea of convivial technology.

Key-Words: Circular Economy, Sustainability, Eco-Modernism, Convivial Technology

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Abstract

In the last decade, the concept of 'Circular Economy' (CE) has gained prominence in the political and corporate discourse around the world. According to its proponents, CE represents a new paradigm that will push the frontiers of environmental sustainability by transforming the relationships between ecological systems and economic activities. In this paper we discuss how this idea is problematic for a number of physical, economic and political reasons, claiming that the biggest shortcoming of the CE discourse is represented by its apolitical framing. We call for opening up a debate to deconstruct the increasingly hegemonic discourse of CE based on a technocratic approach and reconstruct it by embedding normative and political dimensions. Finally, we propose a countervailing discourse of CE based on the idea of convivial technology.

1. Introduction

> "Today a lack of realism no longer consists in advocating greater well-being through the inversion of growth and the subversion of the prevailing way of life. Lack of realism consists in imagining that economic growth can still bring about increased human welfare, and indeed that it is still physically possible."

André Gorz (1980)

> "What continues to strike me, is that the 'environmental issue' necessarily means such different things to different people, that in aggregate it encompasses quite literally everything there is."

David Harvey (1993)

In the last decade, 'Circular Economy' (CE) has surged as a prominent concept in the political and corporate discourse around the world. The notion, which, thanks to its immediacy, can be easily communicated and employed to coin slogans and mottos, is the most probable candidate to replace the outdated 'sustainable development' imaginary that dominated the post-Brundtland era. Although its origin can be located in a specific academic tradition (i.e. the one linked to the Industrial Ecology field of study), CE has become an 'umbrella term' - i.e. an empty *buzzword* that can shelter different meanings (Rip and Voß, 2013) - whose flexibility and haziness is a potential battle ground for competing ideological agendas (Homrich et al., 2018; Korhonen et al., 2018b). In the views of its promoters, CE represents a new paradigm that will push the frontiers of environmental sustainability by transforming the relationships between ecological systems and economic activities (Ghisellini et al., 2016). This is supposed to happen through a shift in the design of socioeconomic metabolism from a linear model based on 'extraction-production-consumption' towards a circular model in which waste, by-products and end-of-life products are ideally totally reused, recycled or remanufactured (Genovese et al., 2017). CE proponents are not just concerned with the reduction of the use of the environment as a sink for residuals or with the delay of cradle-to-grave material flows (as a simplistic view of sustainable supply chain

management strategies may suggest), but rather with a thorough rethinking of production methods, which also involves a reduction of resource use and the implementation of advanced planning approaches (Genovese et al., 2017). For their capacity to mobilise different and complementary imaginaries (i.e. the technical, the environmental and the commercial/economic) CE principles represent the new political frontier to the achievement of environmental sustainability (Winans et al., 2017).

In this paper, as postulated by Korhonen et al. (2018a, 2018b), we argue that, although presented in a neutral, apolitical fashion, the CE agenda represents a highly contested political project. By recognising the existence of alternative and competing CE narratives, we recognise that, in its currently hegemonic formulation, CE is very much aligned to a technocratic, eco-modernist agenda. The dominant discourse of CE, indeed, essentially draws on a refurbished new version of 'circular' market-oriented capitalism that look at industrial wastes and environmental degradation not as 'system failures' but as opportunity to relaunch a new season of - this time sustainable and possibly 'green' - economic growth (European Commission, 2017). We discuss how this idea is problematic for a number of physical, economic and political reasons and then focus on what in our view is the biggest shortcoming of the CE discourse: its apolitical framing. We call for opening up a debate (Stirling, 2008) to deconstruct the increasingly hegemonic discourse of CE based on a technocratic approach and reconstruct it by embedding normative and political dimensions. Finally, we propose a countervailing discourse of CE based on the idea of convivial technology (Illich, 1973) that not only would enable an environmentally sustainable society but also a social transformation towards a more just and classless society. The paper is organised as follows: first we discuss the intrinsic contradictions of market capitalism that contributed to the emergence of the CE paradigm; second, we suggest that CE present all the features of an 'eco-modernist' project; third, we argue that in its present form proposed by the European institutions the CE paradigm is apolitically framed; we then have a look at the alternative CE framing provided by the Chinese government; finally we conclude with a call to repoliticise the concept.

2. The inevitability of waste in a capitalist system

The fundamental contribution of Karl Marx to the economic thought is the theorisation that capitalism presents a number of intrinsic contradictions. One of the most compelling ones is the fact that, whereas capitalists aspire to increasing returns, sooner or later the average rate of profit will decline. In other words, the more and longer capital is used to produce a given set and volume of commodities, the less the profit that can be obtained. This is, in a way, consistent with the neoclassical view stating that, under the theoretical assumption of perfect competition and *completely* free markets, firms can only experience profits or losses in the short run (see Wallerstein, 2004, pp. 25-26).

This *diminishing returns* law can be explained by at least three mechanisms, as posited by Harvey (2014). First, returns can diminish because of the tensions between labour and capital. Workers organised in trade unions can request and obtain better salaries and conditions at expenses of profits. Under certain conditions increasing purchasing power is beneficial for capitalism because it fuels demands. At the same time, more money in the pockets of the working class equals less profits for the capitalists. Second, returns are bounded to decline because of the access to technology (e.g. through diffusion of innovation) by competitors lowers the barriers to entry in a

specific market and causes the appearance on the market of new processes and products by competitors. Third, there are intrinsic limits to consumption. Markets saturate and demand declines. For instance, a consumer can buy a car for commuting to work; her might need a second car for social purposes; after that, the marginal satisfaction he can get from such products sharply declines. The decline in profit rates also causes the inability of firms to replace machineries and equipment at the same rate as before. Companies, as a result, might lose market shares to their competitors; as such, this also causes deterioration of production means, which can in turn cause further decline in production (Gorz, 1980). In this situation, capital cannot reproduce itself at the desired rate; its productivity sharply decreases, with obsolete and not properly maintained machines which need to be decommissioned, stocks and inventories to be alienated or destroyed, plants downsized, and workers laid off. The system is in crisis; such a crisis generates enormous amounts of waste, both in physical (raw materials, stocks, and machineries which need to be disposed of) and metaphorical (unutilised capacities) senses.

In order to avoid such vicious circle, and the associated waste, capitalist elites need to fight a day-to-day battle against the phenomena described by Karl Marx. They need, in some way, to fight the tendency of the rate of profit to fall off. This can be done in a number of ways. They can increase production volumes or increase the exchange value (and, consequently, the price) of their products (Gorz, 1980). They can move production in countries where labour protection is looser or fight back trade unions. Both strategies have been successfully implemented in most of industrialised countries in the last three decades as documented by Piketty (2014). As a result, the income of capital has been constantly rising from the 1980s whereas labour income has stagnated, along with aggregated demand. That basically means that returns decline has been merely postponed.
Another way of avoiding diminishing returns is through innovation. As Schumpeter (1934) has shown in the 1930s, innovation is the very engine of capitalist economies and is able to constantly transform production functions by increasing productivity and maintaining acceptable profits. Further research was carried out by Arrow (1962), Lucas (1988) and Romer (1994), in order to explain how technical change is able to counterbalance the law of '*diminishing returns*'. This faith in the salvific effects of innovation, however, is being increasingly questioned from many fronts (see, for instance, Strand et al., 2018). The fields of political ecology and ecological economics have shown that innovation can stretch the limits of the law of diminishing return, but only until a certain point. For instance, profits increases remain limited by energy availability (Bonaiuti 2018), raw material access (Hickel and Kallis, 2019), social unrest (Hirsch, 1977), environmental degradation (Kallis et al., 2010).

The presence of social and physical limits to the expansion of capitalism does not prevent capital to explore new ways of overcoming the problem of diminishing returns. These include all possible combinations of the mechanism illustrated above. One of the most effective strategy that includes technological, marketing and political mechanism is the so called *planned obsolescence* i.e. firms increase sales by making products less durable, thus forcing people to change them more often; at the same time, these products can be made more complicated and expensive (through innovation). We could even dare to say that this mechanism has become the basis of production organisation in modern societies. It is a mechanism that does not attempt to satisfy the specific needs of the people, but rather to keep profits at required levels, while keeping users' unsatisfaction constant, through planned obsolescence of products. In order to do so, increasing amounts of energy,

labour, raw materials, natural resources and of capital are 'consumed' without any positive impact on social welfare. In order to escape from the fall in the average rate of profit, and its associated wastes, the system needs to generate more waste. This demonstrates, as also affirmed by Gorz (1980) that *waste* is an intrinsically built-in and inevitable feature of capitalist economies, and a much-needed fuel to keep profit at the required level at the individual firm level.

3. The Circular Economy as an eco-modernist project

It can be said, thus, that capitalism in order to expand requires an increasing (or at least a steady) production of waste. However, it became evident that the production of waste has unbearable environmental and human implications. The emerging field of CE is an attempt to address from within the capitalism discourse, we argue, the consequences of an economic system based on the irrational creation of waste. The theoretical foundation of the CE concept is rooted in a wide array of academic disciplines and fields. Notwithstanding the significant contribution of certain elements of the latter, including *industrial symbiosis*, *cradle-to-cradle design* and *cleaner production*, the absence of clear boundaries with reference to relative school of thoughts such as *Bioeconomics* or *Green Economy* has hampered the development of a well-defined CE identity (Merli et al., 2018). Therefore, authors are orienting towards the conceptualisation of circular economy through an 'umbrella' concept framework, facilitating the identification of synergies and limits among related concepts (D'Amato et al., 2017; Homrich et al., 2018). As Korhonen et al. (2018b) point out, the circular economy concept has been led and promoted mainly by practitioners (Ellen MacArthur Foundation, 2015; WRAP, 2015; McKinsey, 2016) and governing bodies (McDowall et al., 2017). Nevertheless, the most influential field to the formulation of CE paradigm is *industrial ecology* which established the concept of *industrial metabolism* (Blomsma and Brennan, 2017).

The idea of a closed-loop system between rural and urban areas can be traced back to the Marxist tradition. Karl Marx introduced the notion of a metabolic rift as the irreparable fracture in the interdependent process of social metabolism, providing an interpretation of the tendency to ecological crisis under capitalism (Foster, 1999). In particular, Marx emphasised the emergence of a rupture in the metabolic interaction between humanity and the rest of nature caused by capitalist production and the growing division between town and country. In detail, Engels (1877) set as the starting point of the failure of the linear production model the decoupling between the point of agricultural production and consumption. Marx and Engels (1894) envisioned an ideal society free of class conflicts, where the working class (farmers) will harmonically regulate the circular flow between economic activity and nature. Starting from different theoretical premises, the heterodox non-Marxist economist Kenneth Boulding (1966) pointed out the transition towards a closed-loop system as a precondition for the preservation of human life.

In terms of contemporary applications of CE to industrial systems, the starting point of such a narrative can be traced back to Frosch and Gallopoulos (1989) seminal paper which redefined industrial operations by introducing the idea of a circular flow of materials where the by-products of one industrial process are used as an input for another in order to achieve higher environmental performance. The term 'Circular Economy' was first introduced by environmental economists Pearce and Turner (1989). Authors designed a materials balance model in which environment is defined in terms of three economic functions, namely resource supply, waste assimilation and source of utility. Recent literature accredits the theoretical underpinning of this model to the

heterodox school of thought known as *Bioeconomics* or *Thermoeconomics*, which reconceptualised economics through the principles of thermodynamic laws (Lieder and Rashid, 2016). Interpreting the first law of thermodynamics (FLT) with respect to energy/matter constant in the context of an isolated system where raw materials are extracted, turned into final products and eventually discarded, the quantity of waste generated in any period should be equal to the quantity of raw materials extracted in the same period. However, according to Georgescu-Roegen's (1971) interpretation of the second law of thermodynamics (SLT), the transition to a state of complete recycling is impossible since economic process flow of used raw materials is characterised by low entropy whereas the waste materials by high entropy. Despite the wide recognition to Georgescu-Roegen's contribution to the field of Ecological Economics, the use of thermodynamic concepts, particularly entropy, has been fiercely critiqued due to fact that it ignores the potential to harness solar energy (Schwartzman, 2008).

Given the diverse disciplinary and conceptual underpinnings as well as the absence of well-defined theoretical boundaries, there is a lack of consensus on a specific definition regarding CE (Kircherr et al., 2017). Nevertheless, despite diverse and heterogenous, the present constellation of definitions of CE share, we argue, most of the features (and ideology) of the so-called ecomodernism i.e. a strong emphasis of the roles of technology and economic growth in meeting the world's social, economic, and ecological challenges (Caradonna et al., 2015). The ecomodernists question the idea that market capitalism must be called into question to avoid economic and ecological collapse and instead argue that what is needed is a reliance on technologies, from nuclear power to carbon capture and storage, that allow for a 'decoupling [of] human development from environmental impacts' (Asafu-Adjaye et al., 2015). It is not surprising that a vast majority of CE definition are tech-driven or techno-optimistic. The most prominent definition of CE appears to be the one provided by Ellen MacArthur Foundation (2013a, p. 7), according to which *'a circular economy is an industrial system that is restorative or regenerative by intention and design'*. This system corresponds to an idealistic state where waste virtually ceases to exist, as materials are re-used and recycled indefinitely in a closed-loop (Ellen MacArthur Foundation, 2013a). Nonetheless, acknowledging the reality of material leakages due to lost opportunities or technological restrictions, CE aims at extending the life-cycle of materials pursuant to an *Inertia Principle* (Stahel, 2010). This can be achieved through minimising the material and energy leakages by either slowing, narrowing or closing the resource loops by following the '3R' value retention options of *reducing*, *reusing* and *recycling* (Geissdoerfer et al., 2017).

4. The apolitical framing of a "Circular Economy in a Weak Form"

Similar techno-driven visions have been embraced by the European institutions. The European Union has initiated many strategies aimed at delivering *smart, sustainable and inclusive growth*, all of them pervaded by a techno-optimistic credo. One such strategy is the Resource Efficient Europe flagship initiative, based on a CE paradigm and aimed at identifying and tackling the trade-offs between economic development and environmental protection. Furthermore, the European Commission has announced and implemented an ambitious CE Package and Action Plan; the proposed directives are aimed at *closing the loop* of product lifecycles through greater recycling and re-use, with the objective of benefiting both the environment (by promoting energy savings, reductions in Greenhouse Gas Emissions and resource efficiency) and the economy by creating –

of course – "green" jobs. Also, some initial financial mechanisms have been put in place in order to foster and support initiatives aimed at the implementation of CE practices in several industrial sectors. This timidly suggest that policy interventions are also required alongside innovative business models currently adopted by companies; bottom-up initiatives at a supply chain level might need to be incentivised through some form of top-down governmental support (for instance, by rewarding positive externalities). However, EU interventions have been, at their best, a form of *nudging*, without any planning effort.

But is this form of CE viable in practice? Although multiple and contested, this CE framing is highly problematic for a number of reasons (Korhonen et al., 2018a) that we can classify for the sake of simplicity in three main categories.

The first set of criticisms has a physical basis. If we assume an economic system totally based on solar energy – i.e. an abundant source of low entropy energy - a complete circularity of material flow, and thus an indefinite reutilization of material resources, in the system is in theory possible i.e. this is the so-called 'energetic dogma' (Ayres, 2007). After all, this is how nature has functioned for millions of years. However, in the present industrial society this is in practice virtually impossible. Even considering illimited availability of solar energy, the dissipation of minerals in distributed sinks all over the planet in high entropy state (minuscule concentration) makes in practice their recuperation virtually impossible (Kerschner, 2010). Similarly, the recuperation of tons of microplastic in the ocean even in the presence of revolutionary cleaning technology powered by solar energy is a highly improbable task. Secondly, whether or not the material structures necessary to harvest solar energy can be maintained over the long run just by the energy produced by them remains to be demonstrated. In a nutshell, there is an increasing evidence that question the practical possibility of a total and perpetual recycling of all material resources in any type of economic system, regardless of the amount of energy to be assigned to the recycling activities (Burkett, 2006; Kallis, 2018; Rammelt and Crisp, 2014; Washida, 1998). Another physical limitation is the vulnerability of CE to rebound effects e.g. the fact that it has been empirically observed that increased efficiency eventually lead a faster and greater use of natural resources (Korhonen et al., 2018a; Polimeni et al., 2008). According to Zink and Geyer (2017), such effects can be either direct or indirect and are attributed to price and substitution effects respectively. The aforementioned fact justifies the shift of interest towards eco-industrial parks as the participating network of firms operates on the basis of collaboration and not competition, thus developing the ability to reduce externalities (Bellantuono et al., 2017); also, the localised nature of such entities allows the reduction of logistical complexities and inefficiencies, which are one of the main obstacles to the development of CE-inspired production systems.

The second line of criticisms is based on the economic feasibility of CE in the present system of market capitalism, which the dominant economic model in the European Union. In the 1980s Schnaiberg (1980) famously introduced the 'treadmill of production theory' that hypothesised that class relations within Capitalism continually undermine any effort towards sustainability. Both capitalists and the workers reproduce the illusion that technology will make production greener, but this actually never happens. The only thing that makes the system functioning is increasing production and disposal of waste elsewhere. It's not hard to see that such a system is bound to collapse eventually. This would, at least in part, explain why, regardless of its evident environmental

benefits, the economic viability of the CE paradigm is questioned by market dynamics and regulatory inefficiencies which potentially can lead to higher production costs (Genovese et al., 2017). While environmental benefits may be obvious, in fact, the implementation of circular production systems and supply chains is often challenging in the current economic systems, as market dynamics and the lack of incentives may lead to higher cost of production. Companies rely on the need to maintain economic profitability of their activities and investments while market mechanisms (e.g. increase of prices of by-products provided by a company to another) may strongly discourage the adoption of CE strategies. As such, the applicability of CE in free-market and growth-oriented economic systems characterised by free-market policies has been questioned by many scholars, arguing that the implementation of such policies may be easier in contexts of economic de-growth/steady-state or in presence of central planning tools.
Many scholars have argued that in the European context, mainly dominated by free-market ideologies, companies are already capturing most of the economically attractive opportunities to recycle, remanufacture and reuse (de Man and Freige, 2016). This leads them to claim that reaching higher levels of circularity may involve an economic cost that European economies cannot cope with, especially as companies are already struggling with high resource prices. Indeed, benefits from recycling of materials tend to decrease until a cut-off point is reached where recycling could be economically too expensive to provide a net benefit. Such a situation has recently become apparent also to the public opinion, due to the ban imposed on imported waste by Chinese public authorities, which has revealed the unpreparedness of recycling networks and CE-related infrastructures in the European Union that have been relying extensively on export of waste rather than investing in CE-related infrastructures (Cole, 2017).

Finally, a third argument is political and is related to the self-perpetuation of neoliberal capitalism itself. It's been observed that capitalism escapes regulation and tends to expand by removing state regulation or by moving to new unregulated virgin territories. In other words, capitalism survival depends on its capacity to expand through new ways of commodification and appropriation. If this is true, a transition towards an ideal CE paradigm, in which economic transactions are necessarily bounded by the circularity of the system, would seriously undermine a further expansion of capitalism (and economic growth itself). On the other hand, a technocratic authoritative version of CE, in which resource access are denied to the vast majority of humanity, could be totally compatible with a 'capitalism without growth' which elites maintain its privileges through the impoverishment and exploitation of subaltern classes (Kallis, 2017, 2018). The transition to a CE could indeed lead to further concentration of capital, in which larger and more technologically advanced firms can take advantage of the fact that many competitors would not be able to upgrade their means of the production as required by more stringent legislation, being actually forced to exit the market. As a consequence, oligopolistic structures could emerge, and control entire value chains. In this sense, the idea of CE could open the door to unexpected dystopian futures.

Nevertheless, despite the above-mentioned issues, what's worrying about the dominant ways of presenting CE is its apolitical essence (Valenzuela and Böhm, 2017). According to EU institutions, CE is supposed to happen automatically in Western market economies. The role of people, class relations and power asymmetries, indigenous people, women, plants and animals are generally overlooked. The details about how such a Copernican revolution in the way we produce and

consume would happen are generally vague and, probably intentionally, underspecified. Who, where and how is going to decide where and how to implement closed-loop production and consumption systems? Since CE doesn't question class structures and power relations – it seems the whole debate about CE totally overlooks this aspect – the societal implications (e.g. the levels of freedom and democracy) of such a transition to the new paradigm are not explicit. This seems to suggest that a critical evaluation of the CE paradigm, of its economic, societal and policy implications, and of the outcomes of its implementation (which industrial sectors will benefit the most? Which stakeholder groups can be classified as winners and which one as losers) has not been conducted yet (Korhonen et al., 2018a; Murray et al., 2017).

Moreover, the global implications of a CE transition are not discussed enough in the European context. Given the planetary outreach of global value chains, how CE proponents expect to restructure colonial and postcolonial links between rich and poor countries is a totally neglected topic. Is CE applicable to global value chains that base their viability and profitability of the immense disparity of labour and environmental regulations across the Global North and South? And what about the immense reservoir of traditional agro-ecological practices that are already sustainable and sustain the majority of people living in the Global South? Are they going to be replaced in the name of eco-efficiency and circularity?

5. The Chinese Way to a Circular Economy

An alternative to the "weak form" (market-driven) approach to CE that characterises the EU is the Chinese way to CE. Compared to the EU version, the Chinese attempt to implement a Circular Economy is characterised by a more coordinated and planned approach (Mathews and Tan, 2016). A an entire section of the 11th Five-Year Plan (for 2006–10) was devoted to CE. In 2008, a CE 'promotion law' asked local and provincial governments to integrate CE objectives in their investment and development strategies. Targets were enacted for the coal, steel, electronics, chemical and petrochemical industries. The circular economy was upgraded to a national development strategy in the 12th Five-Year Plan (2011–15).

Such strategy is widely based on the concept of Eco-Industrial parks (McDowall et al., 2017). Concentrated to specific geographical areas, they are aimed at generating substantial benefits for local communities through job creation and (allegedly) inclusive growth, while preserving the nutrient cycle in the ecosystem (Zhao et al., 2017). In these establishments, companies that traditionally work as separate entities and belong to different supply chains become engaged in complex interplays of resource exchange (material, water, energy and by-products) according to an *Industrial Symbiosis* mechanism for achieving economic and environmental gains and social co-benefits. An optimal mix of production units can result in the minimisation of waste, emissions and environmental externalities, while realising direct (e.g. revenues from selling by-products, reduced costs from avoided discharge fees or disposal costs, reduced costs deriving from substituting virgin energy and materials with alternative feedstock obtained at lower prices) and indirect (e.g., avoidance of investments, increase of supply security and flexibility, better reputation, innovation, operational resiliency, ability to retain employees) economic advantages.

Such strategy, based on active governmental intervention and encouragement and engagement of leading private sector actors (McDowall et al., 2017), goes beyond the mere nudging approach provided by EU institutions (such as the large-scale pilot and demonstration facilities funded,

through competitive awards, by Europe's Horizon 2020 program) and has been deemed to have similar characteristics to the ones of a true *transition management* programme (McDowall et al., 2017). Although the Chinese way to CE can address successfully some of the limits of the market-driven approach through central planning, the Industrial Symbiosis programmes implemented to date by the Chinese government could still be affected by the eco-modernist spirit that characterises the European version of CE. This is testified by the fact that most of the indicators employed for keeping track of the implementation of CE measures are based on *efficiency* concepts (as reported by Mathews and Tan, 2016); as such, this could be still seen as an attempt to combine CE concepts with more traditional productivist views.

Central planning tools appear promising in forcing a transition paradigm in the Chinese productive system, but should be carefully adapted in order to address the physical limits to CE viability discussed above. Moreover, since a vast majority of the information available on the Chinese way to CE is essentially technical, uncertainty remains about how issues of participation, power and class relationships are considered and debated in the Chinese internal political debate.

6. Circular Economy for social revolution

The depoliticisation of CE, as many other similar process (Hartley et al., 2017), often underpins one or more political agendas but it not, at least in its early stages, irreversible. We think that there is the opportunity (even the imperative) for us to reshape the debate about the transition towards a new economic paradigm that takes into account the environmental and social limits to growth. The technocratic project that the ecomodernist vision of the CE underlies – a 'weak formulation' of CE we might argue - is questionable from a scientific perspective, but it's also undesirable for other non-technical reasons (Crist, 2016). We don't oppose the core ideas of industrial ecology on which CE draws its theoretical basis, but we think they are totally insufficient to promote a radical transition towards a society that is not only environmentally sustainable but also just and egalitarian (Ede, 2016). Even in the Chinese case, which, thanks to economic central planning tools, allows a better coordination of supply chains and related feedback loops, has not, so far, questioned technological determinism and productivism. For these reasons we put forward two critical reflections that, in our view, should be the base for reframing the present debate and promote the theorization of a '*strong formulation*' of CE, which could be embraced by the labour movement as a social transformation programme.

The first point consists in questioning the ownership of production units. The CE agenda (both under market capitalism and planned economies) takes for granted that the basic production unit is localised either in private or state-owned enterprise. Democracy in the decision making about what processes, what products and how profits are distributed is a topic which is totally absent in CE literature. We believe that a genuine transformative transition towards a CE can't occur without questioning hierarchies in the workplaces, production management and planning. Such a reasoning also includes all the possible forms of 'alternative organizations' (self-managed enterprises; reclaimed factories; co-operatives) that function outside the logic of market economy (Parker et al., 2014). This could be then implemented in the planning of circular chains of 'liberated' units of production. This includes all possible policies and incentives that can possibly lead to the creation of networks or value-chains based not only on circularity but also on the two previous principles.

Second, we think it is absolutely crucial to question how science, technology and innovation are governed. CE promoters call for rethinking how we produce but do not question *why we produce what we produce*. Rather than being left to the *invisible hand* of the market or to the paternalistic role of a technocratic state, innovation should be governed in order to be aligned to social desirable goals (Owen and Pansera, 2019a, 2019b). This also implies to open the space of decision-making to multiple stakeholders and social classes, alternative voices, minorities (Stilgoe et al., 2013). In the context of the global South this certainly implies taking account different epistemologies, worldviews and value systems (de Sousa Santos, 2015). The goal is to produce technologies that can be embedded in closed-loop supply chains but that can also enable new and fairer ways of living. We think of the notions of the 'ecology of tools' of A. Gorz (1980) or 'convivial technologies' as proposed by Ivan Illich (1973). Ivan Illich (1975) adopted the term in his book 'Tools for Conviviality'. His emphasis was on sociability and co-feeling, conviviality as 'individual freedom realized in personal interdependence'. We suggest that Illich and Gorz's (Gorz, 1980; Illich, 1973; Vetter, 2018) ideas of 'convivial tools' may be useful in building an (or more) alternative framing for CE. 'Convivial Tools' are tools, technologies & infrastructures for enacting the commons in open, enlivening ways. They foster relations within and beyond the human world and bring about small, slow and beautifully simple energy-efficient solutions. They are accessible to everybody and easy to use. Tools for conviviality invite such convivial cultures through creative adaptation to one's own context and a stress on interdependences. The notion of conviviality is not a Luddite slogan or an anti-technology position. The essential message of conviviality resides in the awareness that there is a point after which technological development becomes anti-economic and anti-human, its damages overcome its benefits. In Illich's (1975) words, "productivity backfires into counter-productivity". Our overcrowded and polluted cities are an emblematic example of this phenomenon. Different forms of technology and different levels of complexity are compatible with conviviality. The point is not the level of sophistication of a given technology, but rather how this is designed and how it shapes people's lives. The idea of interdependence is central to both: interdependence between human beings and interdependence between human beings and technology. Conviviality literature suggests that there is a need for creativity and autonomy "for and through" the use of convivial tools and technologies. Using convivial tools helps make a given commons structurally independent from proprietorial "closed" tools and contributes to commoning as a creatively adaptive process. Societal choices are often being imposed upon people under the guise of technical choices. The struggle for different technologies is essential to the struggle for visions of a different society. The inversion of tools (conviviality), thus, is a fundamental condition of the transformation of society (Gorz, 1980). Convivial technology are socio-technical solutions that satisfy 5 core dimensions: Relatedness, Accessibility, Adaptability, Bio-interaction, Appropriateness (Vetter, 2018).

Relatedness means to "be part of an ecological cycle and to be able to directly see this relatedness on their own ground, in their own garden". The central question for the dimension of relatedness is then: what does technology bring about between people? Convivialists assume that human beings are not just capable of relating to others, but dependent on relationships to others. Tools, technologies and infrastructures are crucial for enacting and maintaining these relations. Therefore, developing and using convivial technology implies the activation and expansion of human relationships and capacities. In the context of CE, relatedness in technology refers to technical

solutions that create, enhance or improve human relationships opposed to technologies that divide and isolate people.

Accessibility refers to the possibility of laypeople to access and manage technology. Do people have access to the design and knowledge needed to create convivial technologies? This could be a matter of open source licenses, adequate documentation and standards, and cultural barriers (such as gender norms or discrimination). Ownership of a technology can matter as well in terms of long-term control, access and use. The central question is who can build or use it where and how. As regards CE, accessibility implies that all the stakeholders involved in specific production/consumption activities should be able to freely access and use the technology proposed and also be able to manipulate, modify, repair, reuse it. This also include the possibility to control how their own data are used and by whom.

Adaptability refers to the independence from state-owned or private-owned infrastructures allowing for the use of everyday tools in order to follow own purposes, train skills and empower people. It also refers to the need to be able to decide whether one wants to be independent or linked. The central question is therefor: How independent and linkable is a tool? As regards CE, adaptable technology implies the possibility to 'disconnect' or to use alternatives whenever one desires. In other words, an adaptable convivial technology does not imply the exclusion from a given community of those individuals who are not willing to accept it.

Bio-interaction refers to the idea to not only be less harmful to the environment, but to be useful in an ecological cycle. Bio-interaction is a Care-Honouring notion aiming at co-productivity. The central question is: How does it interact with living organisms? Care in this sense means to contribute beneficially to ecosystems, not only to "produce no waste", but also to "obtain a yield" (David Holmgren, 2013). In the case of CE, bio-interaction might refer to those technological solutions that, apart from being environmentally friendly, create spaces and opportunities for animals and plants to flourish and prosper in the urban space.

Appropriateness refers to the need to reflect about the context. A convivial technology must take account of the entire context, local circumstances (are suitable materials and skills available?) Efficiency and time-saving features must be balanced against the need for time for socially enlivening activity. This greatly varies along cultures, time and space. Convivial technologies are contextual and dependent on local knowledge, values, purposes and worldviews. They can rely on their own epistemologies i.e. their specific forms of generating knowledge about a given context (de Sousa Santos, 2015).

7. Conclusion

> "A term, a phrase, a formula, which gains currency or acceptance because one of its meanings, or of the thoughts which it suggests, is congenial to the prevalent beliefs, the standards of value, the tastes of a certain age, may help to alter beliefs, standards of value, and tastes, because other meanings or suggested implications, not clearly distinguished by those who employ it, gradually become the dominant elements of signification."

A.O. Lovejoy (1936).

In the last decade, the concept of 'Circular Economy' (CE) has gained prominence in the political and corporate discourse around the world. According to its proponents, CE represents a new paradigm that will push the frontiers of environmental sustainability by transforming the relationships between ecological systems and economic activities. In this paper, we have discussed how this idea, in the version proposed by European institutions and think tanks is problematic for a number of physical, economic and political reasons, claiming that the biggest shortcoming of the current CE discourse is represented by its apolitical framing, which has inherently twisted the meaning of the CE concept. While recognising some positive and encouraging characteristics in the Chinese way to the CE, we call for opening up a debate to deconstruct the increasingly hegemonic discourse of CE based on technocratic and productivist approaches and reconstruct it by embedding normative and political dimensions.
We have proposed a countervailing discourse of CE based on the idea of convivial technology, which could stimulate researchers and scientists to think about different ways of framing CE that take into account power, normative aspects, cultural diversity. The re-appropriation, on these bases, of the Circular Economy idea could be a tool for social transformation which could be embraced by the labour movement.

Acknowledgements
This research has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE project).

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