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The potential of circular businesses in the post-COVID era: a system dynamics view

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Abstract

The last decade has witnessed the flourishing interest of scholars and policymakers to the application of Circular Economy (CE) principles, which has been pointed out as a compelling goal for business and society at current times of Coronavirus pandemic. This paper aims to describe the roles of companies and consumers in CE implementation, the basic mechanisms of circular business creation and diffusion, and their potential contribution to the recovery post-COVID. For the purpose, it has been adopted a system dynamics (SD) view to build an insight model integrating selected literature inputs.

Distinguishing between "born circular" and "converted circular" businesses, model dynamics highlight the interplay of circular businesses and responsible consumers, postulating key feedbacks able to affect, respectively, the conversion of companies and people to virtuous productive and consumption behaviours. Finally, the consolidation of such mechanisms contributes to the alleviation of specific socioeconomic and environmental issues ascribable to the Coronavirus spreading.

Keywords: circular economy; circular business; COVID; system dynamics.

1. Introduction

The Coronavirus pandemic has been challenging global health care, economy and society. In order to minimize the loss of human life "in the face of an invisible contagion" (Sarkis et al., 2020, p.1), previous life routines have been substituted or integrated by new ones (e.g. sanitation, social distancing, use of

disposable gloves and masks). The scenario observed in the early stage of COVID spreading (first half of 2020) included congestion of health facilities, national lockdowns and a generalized deceleration of production and trade, especially as far as the international commerce is concerned.

In this regard, the switch towards the Circular Economy (CE) principles, already felt as a compelling goal by policymakers in the pre-COVID era (e.g. European Commission, 2015, 2019; European Environment Agency, 2019), assumes a crucial importance at the time of writing this paper. In fact, once the initial shock was overcome, there is the need to cohabit with the virus in the medium term (until the development of a vaccine), balancing the urge to restore the economy with that of operating in safety conditions.

With a longer period orientation, to be proactive and to avoid being caught unprepared by potential system shocks, it is called for a general rethinking of production systems in terms of sustainability and resilience (Sneader & Singhal, 2020; Ellen MacArthur Foundation, 2020). Thus, national and local systems should accelerate the transition to Circular Economy (Blériot, 2020) attributing a central function to entrepreneurship, seen as a relevant change agent (Neumeyer et al., 2020). Indeed, the CE paradigm, subverting the traditional linear economy (summarized by the sequence of material extraction, transformation, disposal), introduces production and consumption practices devoted to resource recovery and re-circulation. This way, it promises to foster industrial efficiency and local supply resilience in an environmentally conscious way (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2018).

This paper seeks to address circular business generative paths and their impacts on Coronavirus challenges by wearing strategic management lens, meaning that circular business development will be intended as a process involving firms and their environment (Katz, 1970; Mintzberg, 1987). So far, even in presence of extant contributions from the practitioners world (e.g. Ellen MacArthur Foundation), some gaps have been identified in the strategic management research dealing with CE.

In first place, the scientific literature originating the topic is not ascribable to the managerial and organizational spheres (Korhonen et al., 2018), and only recently the strategic management domain started to pay attention to CE, conceiving it as a driving paradigm for product and business model innovations (Linder & Williander, 2017; Urbinati et al., 2017). As a result, the research field is still young and not fully explored. Referring to a systematic literature review recently conducted by Centobelli and colleagues (2020), it was detected a research lack in providing a systemic view of circular businesses, considering multiple-actor interrelations and the contextual factors able to boost the transition. In addition, managerial

contributions to CE conceptualizations are narrowly focused: they pay attention to just one side of the coin (companies), underestimating the crucial role of consumer acceptance of the new paradigm (Chamberlin & Boks, 2018).

This paper aims to concur in bridging the aforementioned gaps, seeking at the same time to make a contribution regarding some COVID related issues. Accordingly, three research questions have been formulated:

(1) What is the role of companies and consumers in the implementation of circular economy principles?

(2) What are the basic mechanisms of circular business creation and diffusion from a holistic perspective?

(3) In which ways the circular economy can contribute to the recovery post-COVID?

In order to address the above queries, it was adopted a system dynamics (SD) view (Forrester, 1961; Sterman, 2000; Wolstenholme, 1990) to build an insight model integrating relevant literature sources in a holistic and original manner. SD modelling approach was privileged because it provides visual and analytic tools to capture the feedback relationships among several variables.

The paper is organized as follows: after this introduction, it is proposed a literature review about Circular Economy and its potential links with COVID pandemic. Then, the methodology section describes SD features, together with the modelling approach for this study. It follows an illustration of research results, whereas core model dynamics are presented and described. Finally, the conclusion section summarizes the contents of the paper and the main contributions, highlighting limitations and future research avenues.

2. Literature review

The Coronavirus pandemic has caused health facilities overload, national lockdowns and a generalized deceleration of economic activities. The crisis has disclosed the fragility of many global supply chains and the need of more resilient supplies at a local level (Blériot, 2020). Moreover, the impact on business closures exacerbated social inequalities, whereas “minority groups and individuals living in poverty, including the elderly, are disproportionally affected by the resulting health and economic implications” (Neumeyer et al., 2020, p. 2). From the environmental perspective, together with a general call to preserve the environment as a precondition for public health (Wuyts et al., 2020, p. 2), the large-scale economic slowdown was claimed to bring more specific – and contrasting – effects.

On the one hand, it was registered an improvement of air and water quality (Saadat et al., 2020), especially in more polluted areas. However, such advancements are to be considered temporary and destined to gradually disappear with the necessary restart of economic activities. On the other side, there have been highlighted indirect negative effects, such as an increase of waste (in particular for disposable plastic goods and for protective equipments) and a reduction of recycling (Ragazzi et al. 2020).

In this context, sustainable development and CE are two related concepts (Geissdoerfer et al., 2017) assuming a crucial importance. Sustainable development, meaning to satisfy actual needs without compromising the satisfaction of future generations (World Commission on Environment and Development, 1987), is based on three pillars: economic growth, environmental protection and social inclusion (United Nations General Assembly, 2015). Entrepreneurships plays an essential role in pursuing sustainable development (Apostolopoulos et al. 2018), and, from a managerial perspective, the "triple bottom line" approach dictates for companies the joint consideration of economic, environmental and social performances (Tullberg, 2012).

Circular Economy, an approach postulating an economic system able to minimize resource exploitation, emissions and waste without compromising economic growth, is seen as a possible solution to address sustainable development (Geissdoerfer et al., 2018). CE mitigates the environmental externalities associated to economic activities, by providing guidelines to invert the logic of traditional, linear models where raw materials are extracted and transformed in finished products, consumed and finally routed to waste (landfilled or incinerated). Connaturated with this sequence are risks of material scarcity and negative environmental impacts: the CE paradigm overcomes such pitfalls by increasing product efficiency through new ways of production and consumption, where goods are conserved as long as possible and resources are iteratively circulated through closed loops (Guldman, 2016, pp. 9-11).

Accordingly, it proposes the redesign of products, services and business models, incorporating durability, re-use, repair, refurbishment, and recycling (Ellen MacArthur Foundation, 2013, 2015).

In spite of many Circular Economy applications from the practitioners world (e.g. Ellen MacArthur Foundation and Accenture), the scientific debate about CE appears dispersive. On the one hand, natural sciences and engineering fields have developed an ample body of research, routed in different research streams, such as: industrial ecology, acknowledging the need of operational learning from cyclical, renewable and cascading natural flows (Graedel, 1996); and cradle-to-cradle (McDonough & Braungart,

2003), a design strategy based on the consideration of products' entire value chains and life cycles, in search of eco-effectiveness (Braungart et al., 2007).

On the other side, conceptualizations in business, organization and management are still in an infant stage (Korhonen et al., 2018). Specifically, recent studies intersecting strategic management and CE only focus on circular business models (CBMs) (e.g. Linder & Williander, 2017; Crainer, 2013), i.e. business representations on how companies create, transfer and capture value relating internal and external relations (Zott & Amit, 2010; Osterwalder & Pigneur, 2010) suitable to put in practice CE principles by incorporating elements that slow, narrow, and close resource loops (Geissdoerfer et al., 2018).

Scholars contributions propose taxonomies of circular business models (Bocken et al., 2016; Urbinati et al., 2017), and highlight how CBMs are source of competitive advantage through the recovery of the so-called "uncaptured value" (Yang et al., 2016), that along linear business models is lost and not internalized. Circular business models allow to create and/or modify organizational and inter-organizational resource loops through three possible measures: (a) recycling, which allows to close loops instead of having open chains; (b) efficiency improvements (narrowing loops); and (c) use phase extensions, consenting to slow loops (Ellen MacArthur Foundation, 2013; Bocken et al., 2016).

So far, the strategic management studies have not addressed circular business development in a systemic way (Centobelli et al., 2020), i.e. taking into account factors affecting the circular business creation/conversion, and the relationships between differents actors, first of all the consumer, playing a crucial - and overlooked – role in the acceptance of CE (Chamberlin & Boks, 2018). Recently Geissdoerfer and others (2017, p. 765) reported that the typical subjects of Circular Economy's agency, i.e. entities needing to internalize and put in practice CE principles, are just government, companies and NGOs, thus underestimating the responsible consumer behaviour's role and its determinants.

3. Methodology

3.1 System dynamics modelling

The study addressed the research questions by adopting a qualitative system dynamics approach (SD) to create an insight model grounded in literature and representing a dynamic hypothesis about circular business spreading in relation to COVID related issues. Before illustrating modelling steps adopted for this research and describing the key model results, it is considered appropriate a brief introduction about system dynamics discipline and its building blocks.

System dynamics is a computational methodology grounded in cybernetics and system science, initiated at the MIT Institute (Boston) by Forrester (1961). In the context of this work, it was judged suitable to deal with Circular Economy issues, since it captures the behavioral dynamics of complex (social, economic and/or ecological) systems through the feedback relationships among the parts (Maier, 1998). The methodological choice was also supported by looking at numerous SD modelling efforts in the strategic minanagement field (e.g. Morecroft, 1984; Warren, 2005; Wang, 2011).

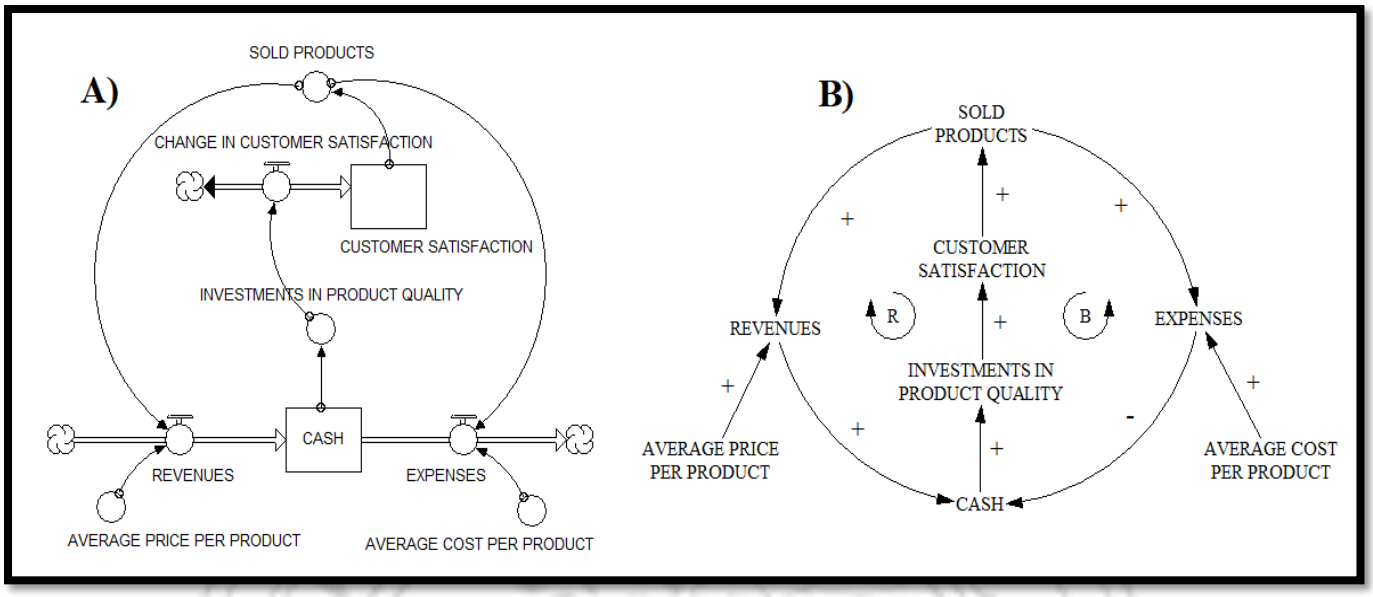
The SD modelling process (Sterman, 2000) involves the construction of stock-and-flow diagrams (SFDs) and causal loop diagrams (CLDs), paired with the formulation of differential equations allowing to simulate alternative policy scenarios.

In this regard, the phase of construction (and subsequent analysis) of SFDs and CLDs is acknowledged as a qualitative modelling branch of system dynamics (Wolstenholme, 1990), able to provide interesting results both as a stand-alone methodology or as preliminary step before mathematic formalization.

A stock-and-flow diagram is a map tracking networked processes of accumulation/depletion of material, information, and money (Sterman, 2000). It is made of stocks, flows and auxiliary variables. Stocks represent cumulated levels of resources or amount, are measured by quantities at a punctual time and are denoted by rectangles. Flows are the rates causing stocks to rise/exploit over the time, are measured by quantities per time unit and are graphically represented by mean of pipes inflowing or outflowing the stocks. Sometimes, especially in dealing with soft variables, modellers prefer to not keep inflows and outflows distinct, and to use bi-flow structures, expressive of stocks' net rates of change in term of difference between inflows and outflows (Sterman, 2000).

In the simplified shop economy of Figure 1, letter A), there are two stocks ('cash' and 'customer satisfaction'). The first is fed by the inflow 'revenues' and depleted by the outflow 'expenses' (assuming all the transactions taking place in cash); whilst the stock of 'customer satisfaction' is affected just by 'change in customer satisfaction' which is a bi-flow with its specific graphic.

Figure 1. Basic examples of stock-and-flow diagram (A) and causal loop diagram (B).



Source: Author's elaboration.

Auxiliaries, denoted by circles, are supplementary variables with various function: to help calculus through ratios and other formulas, to bring constant or exogenous parameters to the model, to synthesize system's partitions that the modellers decide not to focalize. Stocks and auxiliaries can impact on the flows related to other stocks, directly or through auxiliary variables. In the example, the stock of cash, ceteris paribus, impacts on the auxiliary 'investments in product quality', which in turn has a boosting effect on the 'change in customer satisfaction' and then on 'customer satisfaction'. The latter (together with other variables not included in this simple model), affects both 'revenues' and 'expenses' flows, and then the 'cash' stock.

On the right part of the figure above (letter B), it is shown a causal loop diagram. It consists on a network of interacting loops, synthesizing the model dynamics through a compact scheme which does not distinguish stocks, flows and auxiliaries, and isolates just some variables from the ones belonging to the stock-and-flow structure. In the example, the CLD shows the interplay of two loops, made of variables linked by arrowed polarities, whereas the positive and negative links mean that the cause-and-effect change goes respectively in the same and in the opposite direction.

Even loops have a polarity, resulting from multiplying all the links' signs. Loop R (positive polarity) is defined "reinforcing" because it shows virtuous or vicious mechanisms of continuous growth or decay: an increase of cash can induce new investments in product quality and thus sales, revenues, and ultimately

more cash. On the other side, a cash depletion frees up less resources for quality investments and thus reduces sales, revenues, and again cash. Loop B (negative polarity) is "balancing" since it counteracts the above dynamics of growth/decay: more 'sold products' cause 'expenses' to raise, which in turn reduce the 'cash' stock. Viceversa, a reduction in sales has a depleting effect on expenses and thus a boosting effect on cash.

3.2 Research process

The study was based on an iterative process of literature selection and analysis, accompanied by model building activities. The starting point was a literature research about topics directly descending from the research questions: Circular Economy, consumer's role in Circular Economy, Circular Economy and Coronavirus.

As mentioned in the introduction, in line with research aims the analysis adopted strategic management lens. This means that every source was evaluated for its potential contribution to the circular business development discourse, treated as an interdependent process involving firms and their environment.

However, the phase of literature search considered both the strategic management orientation and the novelty of CE topic for the field, whereas theoretical developments are far from being complete, and a systemic view is lacking. As a result, the searching approach was multidisciplinary to also explore candidate inputs from other fields, such as environmental sciences, industrial ecology and product design.

Scientific sources have been selected from Google Scholar (or GS) according to the following criteria: relevance to the study purpose, published in peer-reviewed international journals, written in english language. Beside boolean researches on the database, other sources were identified by looking at papers' references.

The decision to use GS (instead of a subscription-based scholarly database, such as Web of Science, or WoS) is due to the following reasons. First, like WoS, Scholar is multidisciplinary (De Winter et al., 2014; Mikki, 2009) and this fits the purpose to embrace publications from many research fields, with more direct links to open access publications.

Second, GS aggregates both academic and grey literature (Haddaway et al., 2015), and this is useful given the actuality of the research and the fact that Circular Economy issues produce diverse types of output knowledge than just research articles. Indeed, it was considered worth to review also non-scientific sources, such as best practice reports and other publications from practitioners and policy makers, when

considered coherent with the investigated objects and coming from authoritative and internationally recognized private/public institutions.

The documents (49 in total, published in the last decade) were analyzed in-depth, progressively identifying key concepts in relation to the research questions. Then, a series of candidate variables (retrieved from literature or elaborated by the author through inference from it) were listed, trying to hypothesize a modeling strategy for each, i.e. it was decided whether to represent every variable as a stock, a flow or an auxiliary, and key links have been identified. This phase was useful for a twofold reason: to create a preliminary understanding of the relevant system, and to drive the first modelling activity.

Afterwards, using a specific SD software, it was started the building of the stock-and-flow diagram. The modelling process was iterative and, starting from scratch, the model was continuously modified, adjusted and enriched in pace with new literature rounds and modeller's progressive undestanding of the investigated objects.

In the final version of the model (made of 31 variables: 5 stocks, 3 flows and 23 auxiliaries), it was decided to represent as stocks only variables ascribable to businesses and consumers, to remark accumulation/depletion processes regarding these key actors.

All the flows were modelled as bi-flows to make the qualitative model more immediate and compact. Auxiliary variables were used in two ways: to help in making feedback mechanisms explicit, and to show exogenous influences, i.e. not directly partecipating in any feedback circuit. Once the SFD was completed, it was outlined a comprehensive causal loop diagram made of 11 interacting loops, providing a holistic view of the model dynamics and allowing a better analysis, discussion and communication of research results.

4. Results

4.1 Stock-and-flow diagram

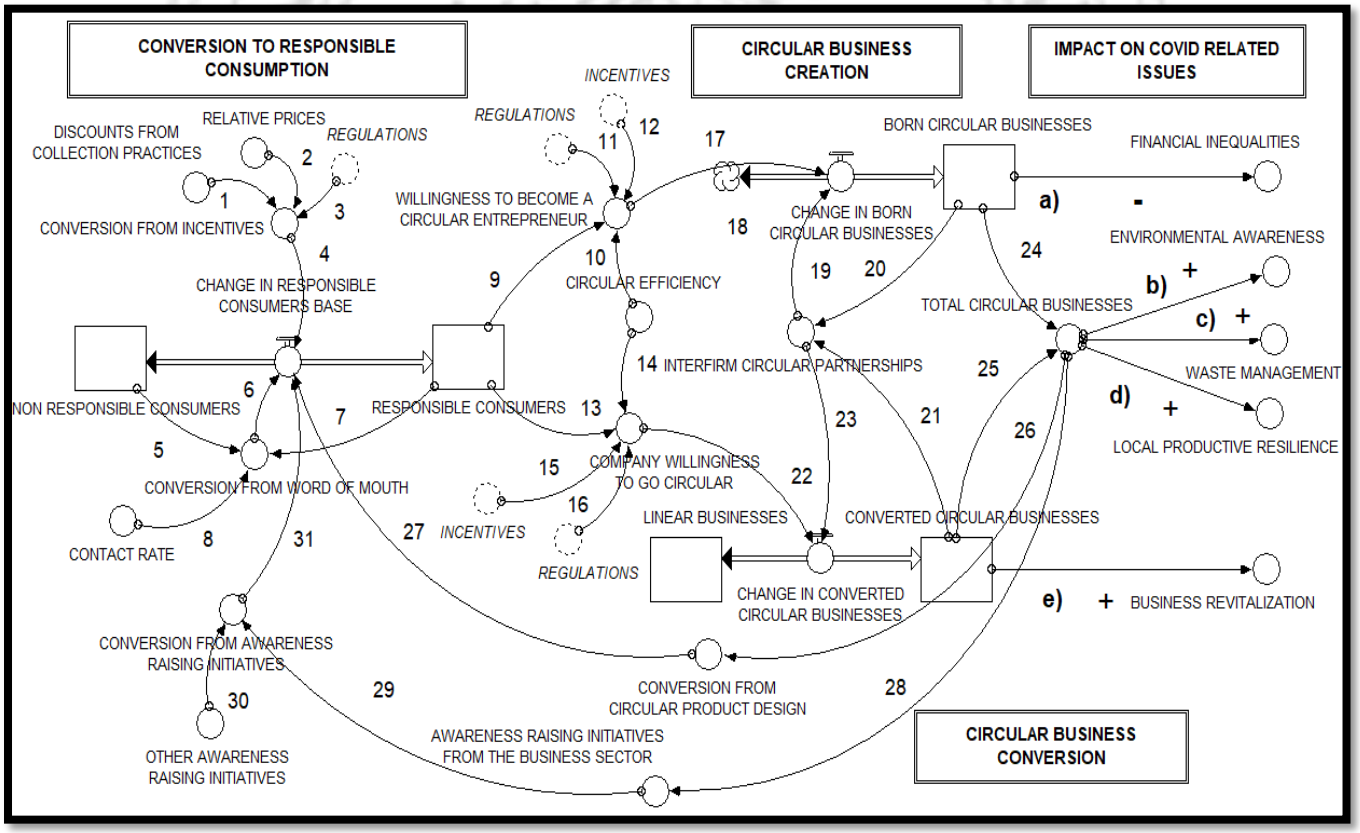
The first modelling output is the stock-and-flow diagram of Figure 2. Building on literature insights, the model postulates that the transition to CE is a process of "conversion" involving not only business companies, but also consumers. Therefore, the model mirrors changing processes occurring in both categories, their interactions and their contribution to post-Coronavirus recovery.

In first approximation, the model area is divided in four sub-areas, indicated by rectangular labels. On the left side, there are depicted processes of 'Conversion to responsible consumption', whilst the center of

the diagram is devoted to circular businesses and distinguishes two cases: the 'Circular business creation', taking place when the company starts up with a circular business model from its own origin; and the 'Circular business conversion', occurring whenever already existing companies decide to make investments to implement CE principles. On the right side, it is represented the 'Impact on COVID related issues': this part of the model infers on how circular business dynamics can help in alleviating some challenges deriving from the actual systemic crisis. In order to favor the model intelligibility, all the links connecting the variables are numbered, except for the ones pertaining to the 'Impact on COVID related issues', emphasized with letters.

The following paragraphs provide detailed descriptions of the model areas and their connections. For explanatory reasons 'Circular business creation' and 'Circular business conversion' are addressed together.

Figure 2. Model's stock-and-flow diagram.



Source: Author's elaboration.

4.1.1 Circular business creation and conversion

The model recognizes the role played by entrepreneurial action in reducing environmental degradation and fostering sustainable development (Dean & McMullen, 2007). Three stocks within the model deal with circular business transitions. At first, it is made a distinction between 'Born circular businesses', starting to be circular from the beginning of their lifecycle, and 'Converted circular businesses', regarding previous linear businesses aiming to become circular. Crainer (2013) argues the need of businesses to reinvent themselves according to the promising Circular Economy perspective, by designing corporate strategies to metabolize waste in the economy.

To capture such shift, the stock of 'Converted circular businesses' is preceded by another, 'Linear businesses'. The connecting flow of 'Change in converted circular businesses' is affected by the 'Company willingness to go circular' (link 22) and by 'Interfirm circular partnerships' (link 23). This last variable is included since company partnerships are receiving growing attention for their ability to pursue shared sustainability and waste reduction goals (Veleva & Bodkin, 2018). In line with a shared value approach (Porter & Kramer, 2011), the variable helps to capture different kinds of collaborative processes helping the implementation of CE principles: born circular businesses-born circular businesses, converted circular businesses-converted circular businesses, converted circular businesses-born circular businesses.

The 'Company willingness to go circular' is affected by: 'Incentives' and 'Regulations' (links 15-16), the recovery of efficiency allowed by CE (variable 'Circular efficiency') and the stock 'Responsible consumers', representing the market demand for circular products and services. Thus the model portrays both business and contextual factors influencing the willingness of companies to transit towards a circular economy, such as the regulation activity of policymakers and international institutions (Centobelli et al., 2020).

Policymakers and governments' responsibility is due to the fact that they can act as both drivers or barriers for company CE transition, can remove existing barriers and support production and consumptions changes (Kirchherr et al., 2018), e.g. the EU Circular Economy Action Plan (European Commission, 2015), renovated with new limph at the beginning of Coronavirus crisis, presents interrelated regulatory packages "to establish a strong and coherent product policy framework that will make sustainable products, services and business models the norm" (European Commission, 2020, p. 3).

On the other side, CE is not just an environment respectful paradigm mitigating the externalities of human activities, but it encompasses (directly or indirectly) all the dimensions of sustainability. At business level, circular business models (CBMs) are a sub-category of sustainable business models (Bocken et al., 2016), which indeed target solutions for sustainable development through circular value chains and stakeholder incentive alignment. According to Geissdoerfer and colleagues (2018) the circularity of a business model, taking place whenever its constituting elements (value proposition, value creation and delivery, value capture; Richardson, 2008) go circular, allows the achievement of optimal sustainability performances. As argued by Esposito and others (2018), CE enriches sustainable paradigms by maximizing the product's lifecycle and converting unusable products in new sources of value in the same/differerent value chains (Centobelli et al, 2020).

Still, CBMs are invaluable sources of competitive advantage, promising to generate profits in a new and environmentally conscious way (Guldmann, 2016, p.7), for at least two reasons. First, by increasing product efficiency ('Circular efficiency' in the model) through the adoption of re-use, repair, refurbishment, and recycling practices for resource conservation and continuous circulation. According to a joint study of Ellen MacArthur Foundation and McKinsey, the circular transition can determine a 3% increase of Europe's resource productivity by 2030, generating cost savings of €600 billion a year and €1.8 trillion more in other economic benefits (Ellen MacArthur Foundation & McKinsey, 2015). Such figure means that industries are not taking the economic opportunities that Circular Economy can disclose. The second reason is that incorporating enviromental and social values in products, they result to be differentiated and non-commodified (D'Aveni, 2010) in the eyes of an attentive consumer. Unfortunately, contemporary entrepreneurship education is still focused on linear business models (Neumeyer et al., 2020).

Referring to the stock of 'Born circular businesses', its accumulation is due to the flow 'Change in born circular businesses', which in turn is boosted by 'Willingness to become a circular entrepreneur' (link 17), and 'Interfirm circular partnerships' (link 19). The 'Willingness to become a circular entrepreneur' is influenced, again, by 'Incentives, 'Regulations', 'Circular efficiency' and 'Responsible consumers' (links 13-16). However, in this specific case the presence of a responsible consumption's base influences the new circular initiatives in two ways: it still represents a market demand to be satisfied by new entrepreneurship energies; and it also constitutes the 'entrepreneurial humus', a basin of personalities, stimuli and values from which circular entrepreneurial intentions emerge. In fact, it is reasonable that the

wannabe-circular entrepreneurs are responsible consumers in first place. Recalling the above discourse about CE related competitive advantage, the circular entrepreneurship is a promising route either to empower economically fragile people in trying their hand at new start-ups; or to induce already existing entrepreneurs in low-income settings to develop innovative products with less price sensitive customer targets (Morris et al., 2020).

4.1.2 Conversion to responsible consumption

The CE application is not a "quick win but a long-term undertaking" (Kirchherr et al., 2017, p. 228), requiring awareness of its socioeconomic implications and key implementation barriers (De Jesus & Mendonça, 2018), among which it was highlighted the "lacking consumer interest and awareness" (Kirchherr et al., 2018). For this reason, the stock-and-flow diagram shows changes occurring in consumers, who move from the stock of 'Non responsible consumers' to the one of 'Responsible consumers'. The responsible consumer is not just a person deciding to buy circular products and services, but he/she is also involved in CE practices, such as extending the use of products as long as possible to delay waste production, collecting goods to be recycled, sensitizing other people to the importance of circular consumption.

The idea is not just to look at consumers as recipients of green marketing campaigns aimed at aligning environmental benefits with consumer self-interest and subsequent purchasing (Grimmer & Woolley, 2012), but to adopt a "design for sustainable behaviour" view (Chamberlin & Boks, 2018), focusing on individual behaviors as resulting from several motivating factors simultaneously (Bocken, 2017).

Thus, the flow of 'Change in responsible consumer base' is movimented by various influences. First, the 'Conversion from incentives' (link 4), showing the impact of extrinsic motivations on circular practices. This variable in turn results from the combined effect of: 'Discounts from the collection practices' (link 1), taking place for example when old clothes are brought to public/private second-hand circuits or to clothing shops; 'Relative prices' (link 2), considering the price ratio between circular and non-circular products; and 'Regulations' (link 3), e.g. municipal obligations to separate waste collection, envisaging fees/fines for the non-collectors. The importance of consumer empowerment in CE transition has been recently acknowledged by policymakers (European Commission, 2020, p. 5), and also in the scientific debate the attention starts not to be devoted just to cleaner manufacturing, but also on strategies

to educate consumers, to design eco-labels and to induce responsible consumption choices (Matthias et al., 2016).

Another factor stimulating responsible consumption is the 'Conversion from word of mouth', that could be a driving force for comsumption habits' switch in two ways: by spreading information about circular product quality, and by transmitting the awareness about the importance to practice CE principles. This variable depends on the contacts among non responsible and responsible consumers (links 5 and 7) and by their contact rate (link 8).

Other influences on circular consumption strictly derive from the business sector. Specifically, the 'Total circular businesses' inherently boost their own demand by proposing new circular standards of products and services ('Conversion from circular product design') and by promoting 'Awareness raising initiatives' (links 28-29). The latter, together with other initiatives coming from the public and third sectors (link 30) are aimed at educating people about circular economy concepts (Sharma, 2020). These links were included to acknowledge literature insights describing the calls for companies's good practices with consumers (in quality of downstream stakeholders) to improve their awareness and engagement, and to sensitize purchase decisions (Centobelli et al. 2020, p. 1744). Actually, limited customer knowledge of circular opportunities can slow the CE transition, given the consumers' familiarity with linear models and expectations of products and services based on it; then it is crucial to communicate with consumers and to convince them of CE benefits (Guldmann, 2016, p. 51).

As far as 'Conversion from circular product design' is concerned, it is worth noticing that the CE narrative, based on product/industry macro-loops such as product-life extension, redistribution and reuse, remanufacturing, recycling (Urbinati et al., 2017) is not just a company matter. In fact, product design practices, e.g. design for recycling, design for remanufacturing and reuse, design for disassembly (Mayyas, et al., 2012), as well as practices of product return or subscription to product service systems, where companies maintain the ownership of goods and consumer pay for their use (Tukker, 2013), are pivotal to both product engineering, commercialization to final customers (Urbinati et al., 2017) and ultimately for CE principles put in practice (Moreno et al., 2016). They act on channeling and educating responsible consumption behaviours, not just at the purchasing but also at the use phase (Bocken, 2017), and require companies-consumers close collaboration (Mendoza et al., 2017).

4.1.3 Impact on COVID related issues

Considering shifts to CE that may occur in the production and consumption spheres, it is possible to hint some wishful impacts on economic, social and environmental issues/challenges generated by the COVID crisis. Five arrows denoted by letters link circular businesses with selected challenges deriving from the pandemic. In two cases the link starts from a specific stock (respectively 'Born circular businesses' and 'Converted circular businesses'); in the other cases the positive impacts of circular business are not ascribable to certain processes of business creation/conversion and thus are modelled as descending from the 'Total circular businesses' in general terms.

The Coronavirus economic turbolence hit all industry sectors and many entrepreneurial ventures struggle to survive, while social disparities are exacerbated and financial conditions of weak social groups result worsened, limiting entrepreneurship and self-entrepreurship diversity (Neumeyer et al., 2020, p. 2).

In the stock-and-flow structure, link a) relating 'Born circular businesses' and COVID issues, expresses the concept that the start-up of circular initiatives can be a mean for the empowerment of low-income people and the reduction of 'Financial inequalitities' in society; whilst link e) to 'Business revitalization' represents the opportunity disclosed by the CE paradigm for the relaunch of pre-existing businesses hit by the systemic crisis.

In this regard, the implementation of CE principles at business level could be a source of competitive advantage for its connaturated efficiency recovery (Ellen MacArthur Foundation & McKinsey, 2015), its capacity to intercept less price sensitive customer targets (Morris et al., 2020), and its perspective opportunity to educate more and more people to the principles of responsible consumption (Matthias et al., 2016; Centobelli et al., 2020). In any case, the need for new products and services strictly related to the current safety concerns (e.g. single-use gloves and masks) and the demand of medical devices market, expected to grow by over 10% a year between 2020 and 2025 (Blériot, 2020), create new entrepreneurial spaces (Neumeyer et al., 2020).

The auxiliary variable 'Total circular businesses', resulting from the sum of the stocks of born circular and converted circular businesses, is connected with three impact variables:

→ 'Environmental awareness' (link b): the diffusion of circular business, with its educational and environmental consciousness, may contribute to respond to the Coronavirus-driven call to preserve the environment as a precondition for public health (Wuyts et al., 2020, p. 2);

→ 'Waste management' (link c): the circular entrepreneurship transition can actively contribute to address the waste management challenges imposed by Coronavirus (Neumeyer et al., 2020). In fact, beside the temporary pollution's decrease due to lockdowns, other dynamics are rising the waste production and greenhouse emissions all over the world. Sarkis and colleagues' concern (2020, p. 3) looks at environmental evolutions once production and transportation will return to pre-COVID levels. Actually, without appropriate measures, the environmental situation in the post-COVID era will be even worse than before (Climate Action Tracker, 2020). Indeed, the crisis caused a significant increase in waste production both in the medical (Wuyts et al., 2020) and non medical sectors, and a decrease in separate solid waste collection and recycling practices (Ragazzi et al., 2020). The environmental problem also concerns the dispersion of single-use masks, the increased plastic waste generation due to a new reliance on plastic-packaged food and the use of disposable utensils in the fear of virus transmission (Vanapalli et al., 2020).

→ 'Local productive resilience' (link d): in the early phase of spreading, the pandemic has caused a generalized deceleration/close of economic activities and international trading. In this context, the crisis has disclosed the fragility of many global supply chains, included the medical equipment one (Ranney et al., 2020). Even though in later stages of COVID diffusion the movements of people and goods have been restored, these dynamics led to questioning the "overreliance on just-in-time and lean delivery systems" (Sarkis et al., 2020, p. 2), showing the need for more resilient supplies at a local level (Blériot, 2020). Thus, CE transition becomes almost an imperative route to improve local resilience by building more localized supply, production and consumption systems (Sarkis et al., 2020, p. 2). Looking at the medical sector as a first illustration, it is possible to learn important lessons about the elasticity of bottom-up initiatives by private companies and individual citizens (e.g. production of sanitizing liquid and masks) to recycle locally available resources, thereby reducing the dependency from importations (Wuyts et al., 2020).

4.2 Causal loop diagram

The causal structure hypothesized for the relevant system is based on complex chains of relations among variables, generating loops of different length and complexity. Then the stock-and-flow diagram presented above was synthesized in the CLD in Figure 3, made of 11 interacting feedback loops. Since each loop

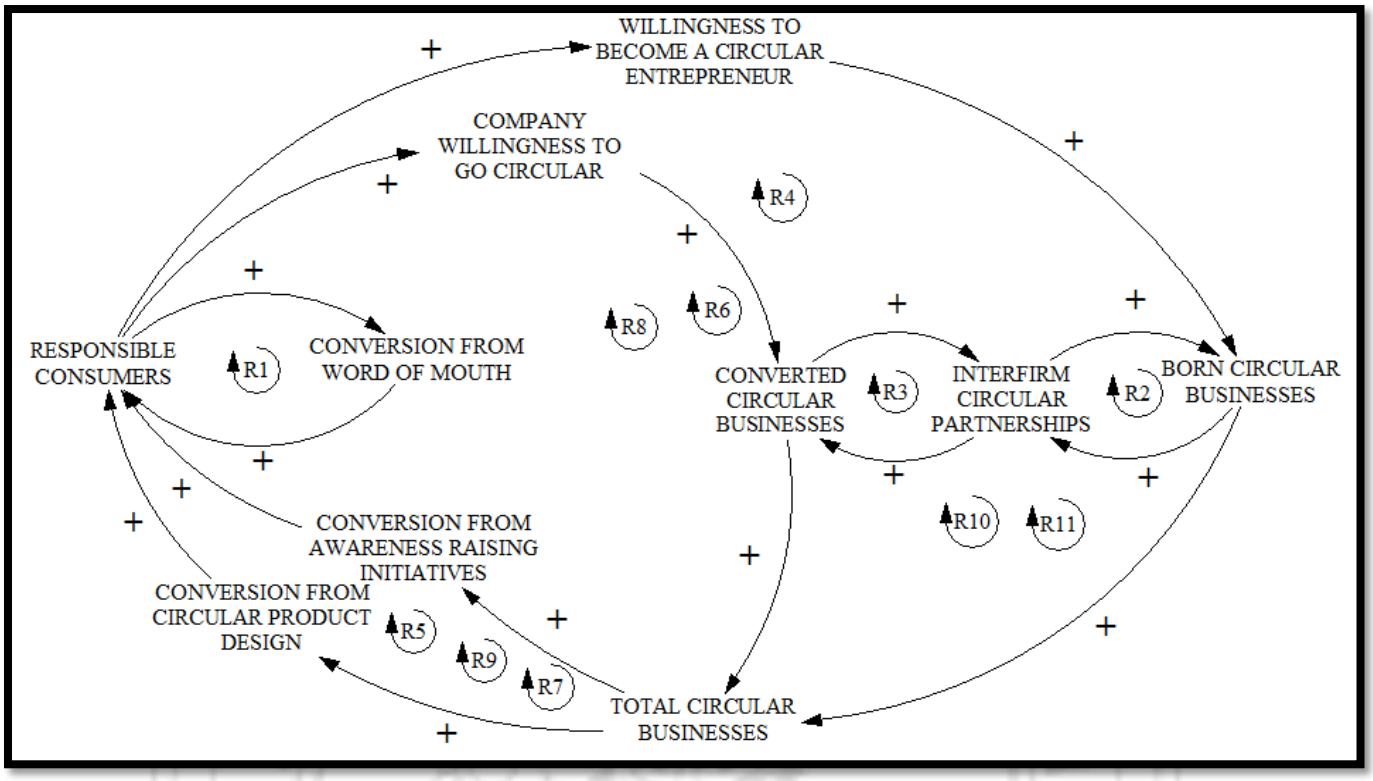
cointains just positive links, all the loops are reinforcing and distinguished from each other with a number following the R notation. The internal composition of each loop is reported in Table 1 below. As noticeable, loops R1-R3 are made of two variables, whilst the others are made of five (loops R4, R5, R8, R9) or seven variables (R6, R7, R10, R11).

Loop R1 describes responsible consumers' self-reinforcing dynamics due to word-of-mouth, Loop R2 illustrates the mutual reinforce of circular start-ups and interfirm partnerships: ceteris paribus, more 'Born circular businesses' will increase the opportunities of 'Interfirm circular partnerships', which in turn will stimulate new business creation through the spreading of examples, ideas, standard and opportunities. Similar structure in Loop 3, with the difference that the links are between 'Interfirm circular partnerships' and 'Converted circular businesses'.

The remainder loops show how responsible consumption and circular start-ups can influence each other according to different chains of causality, which take into separate consideration the effects of circular product design and awareness raising initiatives, as well as the impact of responsible consumers' enlargement, respectively on circular business creation and conversion. In Loop R4 a rise in 'Responsible consumer' has a boosting effect on the 'Willingness to become a circular entrepreneur' and thus on 'Born circular businesses' and 'Total circular businesses'. With the increase of circular businesses, also 'Conversion from circular product design' will be stimulated, thus increasing the stock of 'Responsible consumers'.

A similar circuit is contained in loop R5, with the trait that in this case the consumers' learning process takes place by mean of awareness raising initiatives. Loop R6 has a more complex chain: rising 'Responsible consumer' will induce circular business start-ups, forging more interfirm partnerships able to boost linear business conversions. This fact will result in the total amount of circular businesses, thereby enhancing consumers 'Conversion from awareness raising initiatives'.

Figure 3. Model's Causal loop diagram



Source: Author's elaboration.

Loop R7 repeats the R6's structure but considers the separate effect of 'Conversion from circular product design'. Loops R8 and R9 describe the responsible consumption and circular conversion's reciprocal stimulus, trained respectively by 'Conversion from awareness raising initiatives' and 'Conversion from circular product design'. Loops R10 and R11 portray other reinforcing dynamics: more 'Responsible consumers' will push the 'Company willingness to go circular' and then the 'Converted circular businesses', which will rise 'Interfirm circular partnerships' and, by this way, 'Born circular businesses' and 'Total circular businesses'. The latter feed back into responsible consumption, respectively through the influence of awareness raising initiatives (R10) and the circular product design (R11).

Loop groups R2-R3, R6-R7 and R10-R11 contain as a driving force the variable 'Interfirm circular partnerships', whose connotation is actually different in each couple: in the minor loops R2-R3 there are portrayed the separate effects of partnerships among homogeneous businesses: born circular in loop R2 and converted circular businesses in loop R3. In all the other cases the partnerships mix born and converted circular businesses. Specifically, loops R6-R7 show how born circular businesses participating into

circular partnerships contribute to the conversion of linear businesses stimulating their circular innovation, whilst loops R10-R11 illustrate the value added by 'Converted circular businesses' to the 'Interfirm circular partnerships' and their inspiring effect on 'Born circular businesses'.

Table 1. Model's loops internal composition

LOOP	VARIABLES
R1.	Responsible consumer → Conversion from word of mouth
R2.	Born circular businesses → Interfirm circular partnerships
R3.	Converted circular businesses → Interfirm circular partnerships
R4.	Responsible consumer → Willingness to become a circular entrepreneur → Born circular businesses → Total circular businesses → Conversion from awareness raising initiatives
R5.	Responsible consumer → Willingness to become a circular entrepreneur → Born circular businesses → Total circular businesses → Conversion from circular product design
R6.	Responsible consumer → Willingness to become a circular entrepreneur → Born circular businesses → Interfirm circular partnerships → Converted circular businesses → Total circular businesses → Conversion from awareness raising initiatives
R7.	Responsible consumer → Willingness to become a circular entrepreneur → Born circular businesses → Interfirm circular partnerships → Converted circular businesses → Total circular businesses → Conversion from circular product design
R8.	Responsible consumer → Company willingness to go circular → Converted circular businesses → Total circular businesses → Conversion from awareness raising initiatives
R9.	Responsible consumer → Company willingness to go circular → Converted circular businesses → Total circular businesses → Conversion from circular product design
R10.	Responsible consumer → Company willingness to go circular → Converted circular businesses → Interfirm circular partnerships → Born circular businesses → Total circular businesses → Conversion from awareness raising initiatives
R11.	Responsible consumer → Company willingness to go circular → Converted circular businesses → Interfirm circular partnerships → Born circular businesses → Total circular businesses → Conversion from circular product design

Source: Author's elaboration

5. Conclusion

Tackling the current pandemic as a "black swan" (e.g. Halliburton, 2020; Deloitte, 2020), i.e. an unprendictable event carrying a massive impact (Taleb, 2007), the post-COVID scenarios for policy making and socioeconomic development can be summarised by two antipodes. The first is to treat this occurrence as a "history accident", to be overpassed through stimulus packages restoring the pre-COVID, business-as-usual mode (Bleriot, 2020). In alternative, the pandemic may be considered as an opportunity to learn from the pitfalls and shortages being experienced, creating the conditions for systemic robustness and local supply resilience.

This work confirms how Circular Economy, already considered a catalyst for reaching sustainability goals (Geissdoerfer et al., 2018; Esposito et al., 2018) can be a promising paradigm to deal with Coronavirus related challenges, fostering virtuous development paths.

In detail, the study contributes to the recent strategic management debate about CE, by proposing a system dynamics insight model to describe the basic mechanisms of circular business creation and diffusion, and their potential impact on COVID issues. Building on literature inputs, the model brings the novely to combine businesses and consumers' perspectives together, postulating that the transition towards CE is a mirror process of "conversion" involving with specific features both actors. The resulting system-wide analysis completes and transcends the outputs of previous works on CE business applications, whose focus has been the separate analysis of these categories and the development of circular business models (Linder & Williander, 2017; Bocken et al., 2016). The research also recognizes the relevance of consumer's role, as well as the learning dynamics taking place in both consumers and companies (Matthias et al., 2016; Mendoza et al., 2017).

The model building was iterative and the first research output was a stock-and-flow diagram stating a complex hypothesis about the causal structure of CE diffusion and its potential in alleviating the current systemic crisis. Based on this, a comprehensive causal loop diagram synthesized self-reinforcing feedback mechanisms.

Making a distinction among "born circular" and "converted circular" businesses, the study has the merit to provide a holistic view about CE, integrating and inferring from multidisciplinary literature and emphasizing the interrelated key roles of circular entrepreneuship and consumption. According to the model, CE initiatives can be means to reduce financial inequalities and to revitalize existing firms through a recovery of efficiency (Bocken et al., 2016; Guldman, 2016), new opportunities to differentiate products (Morris et al., 2020), and the perspective to "educate" their own demand to the principles of responsible consumption (Matthias et al., 2016; Centobelli et al., 2020). In addition, the stock of circular businesses has a boosting effect on environmental awareness, improves waste management, and stimulates productive resilience at a local level.

Although created by baring in mind the COVID emergence, the model dynamics lay at a general level, and can be considered as valid insights to contribute to a more sustainable and circular economic system, less exposed to systemic risks. Specifically, a number of self-reinforcing dynamics are described and disclose the potential triggering of virtuous loops, such as the enlargement of the responsible consumers' stock due to word-of-mouth, circular product design and awareness raising initiatives, as well as the mutual stimuli of circular start-ups/conversions and interfirm partnerships.

In the end, the model illustrates the importance of stakeholders to accelerate companies' transition to circularity, highlighting both the importance of partnerships with other companies and consumers, together with the role of regulations and incentives. For the planning and implemention of effective interventions supporting CE applications, policymakers need in first place to be aware of circular business dynamics (Kirchherr et al., 2018) and their networking impact on public value (Milios, 2018). Thus, a holistic view appears necessary at both national and local level, in order to create an infrastructural tissue favoring CE, with public/public-private agencies capable to intercept (and properly manage) funds and skills devoted to circular business development, interfirms partneships and sensitization campaigns.

However the study presents a series of limitations. First, the underlying literature was retrieved through Google Scholar engine, chosen for its multidisciplinarity and attitude to also include relevant non-scientific literature dealing with a novel and contemporaneous research topic. However, some publishers are not indexed in the database and citation data are over-estimated (Mikki, 200; Shultz, 2007). Future research could furtherly validate and enlarge this work by performing new literature rounds on other databases, such as WoS or Scopus.

Furthermore, the proposed model is not tailored to a specific sector or business case, and does not concern neither functional aspects (organizational, technical and operational features related to the development of circular products/processes), nor sociocultural and technological factors (e.g. the effect of digital technologies on CE transition).

The representation of circular business creation and conversion processes just refers to net rates of change in businesses' stocks (bi-flows). This is a simplification not capturing circular business closures or "returns to linear", as well as the factors affecting them. Moreover, the circular business conversion does not consider the process graduality of circular business model testing. Even the concept of circular efficiency, treated as an exogenous variable in the model, may disclose more complex dynamics of company experimental strategies, learning by doing processes and skill formation.

Thus, later studies could tailor the model to address sector-specific dynamics or identified business case studies, also considering the mentioned aspects not covered by the present research. So far, the impact variables refererred to COVID issues are exogenous, i.e. they do not feed back to other parts of the model and just receive impulses from it.

Next model advancements could enclose more variables and bidirectional relationships in this sphere, in pace with a better understanding of the socioeconomic and environmental implications of the pandemic.

Finally, the qualitative approach of this research calls for more investigations to test the model (or future versions of it) in the real world.

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