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ACTION OR REACTION TO SAVE THE PLANET?
LOCAL AND GLOBAL STRATEGIES
FOR ECOLOGICAL AND SOCIETAL TRANSITION"

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Commodities Prices and Trends in a Globalized and Circular Economy. A Local Perspective

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Abstract
In recent years, as never before, temporary and structural events such as natural disasters, logistical and distribution problems, socio-political and pandemic, the depletion of supply sources, had a negative impact on the availability and prices of many raw materials. To this scenario, rebound effects of policies and practical actions to support the transition towards circular economic systems must be considered, such as the substitution effects, e.g. linked to the use of secondary raw materials resulted from the recycling processes or, more in general the output of closed-loop options.
The article intends to highlight the technical, economic and environmental potential and criticalities of these options and propose an eco-industrial perspective of analysis, for the enhancement of local economies and territories.
Keywords: Commodities prices, Global economy, Circular economy, Industrial Ecology, Local territories

1. Introduction

"Commodity markets are under tremendous pressure, with some commodity prices reaching all-time highs in nominal terms". This sentence, pronounced by one of the Senior Analysts of the World Bank, summarises the contents of the latest Commodity Markets Outlook Report (WBG, 2022), which takes stock of the recent developments of a growing trend in the commodities markets, that has started a few years ago and shows no signs of reducing, producing negative cascading effects on businesses, supply chains, consumers and, more generally, on economic systems all over the world.
Analyzing World Bank and Nasdaq data relating to the last decade, it is evident that, for many raw materials and resources for industrial use (e.g. Steel, Copper, Zinc, Palladium, Natural Gas, Wood, Cereals, Cotton), to an ever-increasing underlying trend, periodically, sudden changes linked to temporary phenomena are added up to a rapid surge that characterizes the last two years, with increases reaching 200% of the average price prior to 2020 (Nasdaq, 2022) (Fig.1).
For several years, scholars have been trying to study the reasons of this escalation and what factors contributed to achieving, in such a short time, this result (Nicoleta, 2011), both to predict possible further developments, but also to understand if there are solutions to reduce, or at least, contain their negative effects.
Among the phenomena that, which, according to recent chronicles have contributed most to these increases, we can recognize: i) natural events (earthquakes, fires, storms), such as the "Vaia" storm that hit central Europe in 2018; ii) pandemic events, such as the SARS-COVID19 epidemic; iii) infrastructural and logistical problems, such as the blockading of the Suez Canal in March 2021; iv) socio-political events, such as the recent war in Ukraine. It is clear that the effects of these phenomena have manifested themselves rapidly and globally.

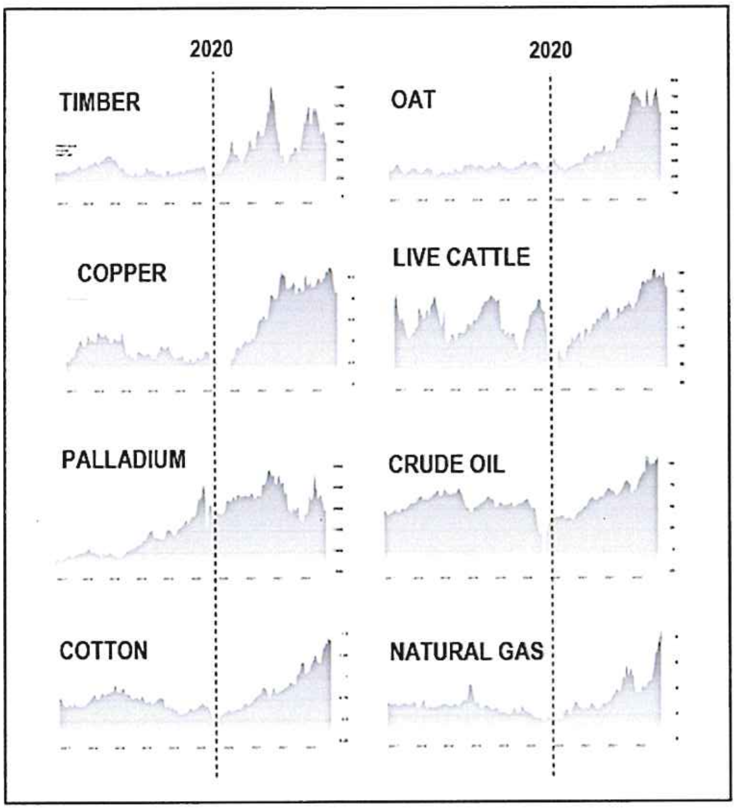

Fig.1. Recent trends of some commodities prices (Source: Commodities Market Data & News, Nasdaq, 25.05.2022).

When the paradigm of globalization caught on (Iwabuchi, 2002), for the removal of restrictions, duties and customs barriers for the mobility of people and goods, fragmentation of supply chains, through outsourcing and relocation of production activities, logistics integration, we were not yet aware of the speed with adverse events could also have been spread from one point of the globe to another and also the extent of "rebound" effects that they could have generated and which is threatening the economic sustainability of many businesses. In fact, in addition to the temporary increases (and the consequent "settling" delays), the main issue is related to the structural increases linked to the problems of availability of some production factors, especially raw materials.

This article, through a critical analysis of the recent global trends which are deeply modifying and redesigning the world's socio-economic and geo-political balances, aims to propose some reflections on the environmental implications and the related challenges of these changes, analyzed in the framework of Circular Economy, highlighting potential and criticalities of secondary raw materials as substitute of virgin raw materials and emphasizing the potential role of local economy in an eco-industrial perspective. The results are also analyzed in the view of previous studies and empirical analyses conducted by the authors in recent years on the themes of the circular economy, industrial ecology and the development of these approaches in local contexts.

2. Commodities prices, sustainability and the Circular Economy paradigm

In the light of what expressed in the introductory remarks, it becomes essential to broaden the spectrum of analysis to consider the environmental and, more generally, the sustainability reflections of the phenomena up to now described, in order to include the new paradigm of Circular Economy (CE), bearing in mind that the two concepts (sustainability and Circular Economy) are not coincident, nor even necessarily linked in a linear way.

Taking, for example, the problem of the possible depletion of the availability of some raw materials (e.g. the so-called "rare earths" or critical raw materials (CRM)), in addition to determining ecological imbalances and the aforementioned "market" effects on the prices of such materials and products in which they are used, can generate many problems: i) geopolitical, because their distribution on the globe is not uniform, (Graedel et al., 2019) (Fig.2); ii) technological, because these materials are indispensable in many of the strategic sectors of the so-called digital and green economy; iii) social, if we consider, for example, how these materials are extracted from scraps and treated in some developing countries. These dimensions cannot be addressed in isolation, but rather require a holistic and integrated approach.

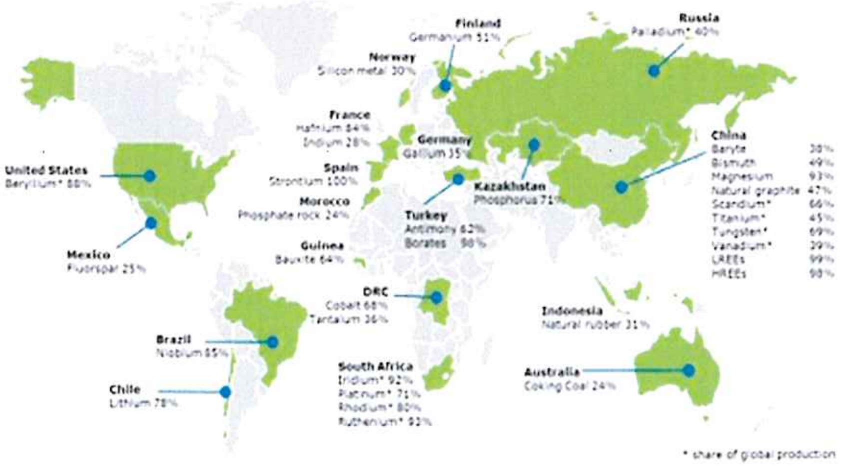

Fig.2. Biggest supplier countries of CRMs to EU (Source: EU Commission Report on the criticality assessment, 2020).

The underlying logic of the CE concept was probably born in 1989, when two scholars envisioned a more integrated model of industrial activity that would be environmentally sustainable on a global level (Frosch and Gallopoulos, 1989).
The concept of CE, which has been spreading widely in recent years, summarizes the current need to move towards more sustainable socio-technical systems. CE entails a systemic transformation of whole economic systems, at various scales, covering production, use/consumption and end-of-life phases, so that the value of material and energy flows can be maintained in the technosphere as long as possible (decoupling effect), while reducing environmental impacts in terms of resource depletion and pollution (Kirchherr et al., 2017).
CE is progressively establishing itself as a new socio-technical and economic paradigm. It is well known that paradigmatic jumps require an "adaptation" of the system, from both a structural-morphological (e.g. roles, technologies) and functional-operational point of view (e.g. rules and routines), from the various actors involved. In this case they are the different economic agents, and as such they operate according to the rules of economy (cost-effectiveness). The speed with which the principles of the CE are spreading (also due to the pressures exerted by some recent environmental emergencies, such as marine litter, global warming) raises some concerns on systems' ability to metabolize and implement these changes in an effective way.
However, still today the question arises as to whether and to what extent the "closed loop" systems of a CE can generate a mass of flows capable of representing an effective substitute for virgin raw materials. In the Circularity Gap Report, recently released (Circle Economy, 2022), it has been estimated that the world economy is only 8.6% circular; this value suggests a significant circularity gap of more than 90% (in only two years, global circularity wilted from 9.1% in 2018 to 8.6% in 2020). In addition, the research indicates that by 2050 the material use will amount to between 170 and 184 billion tons (in 2015 it was

of 84.4 billion tons). This data should make policy makers and economic actors reflect and understand that we are still quite far from a real 'circular economy'. The strategies to embed circularity into the economy and to define a sustainable course to resource efficiency are different, but they have to be used in a systematic way and not as spot solutions. It is important to note that many of the practices we define as examples of CE are not correct. Take recycling, for example, it is a relevant element of CE and has the potential to increase circularity for some materials, but circularity cannot be achieved on the basis of recycling alone (Haas et al., 2015).

3. Prices and trends of secondary raw materials

From a technical point of view, a circular paradigm should include more options for closing the loops, starting from the famous 5Rs proposed by the European Directive 2008-98 EC (2008): Reduce, Reuse, Repair, Recycle, Recover, up to the current 10 -or more- recently recognised (Reike, 2018).
When fully operational, the benefits of their systemic application, especially those Rs directly related to material flows, would be important, in particular on the alteration of the balance of the global ecosystem, both from the point of view of the withdrawal of resources and the release of waste substances, and able to generate positive effects in terms of:

- reduction of extracted raw materials;
- reduction of energy consumption during the extraction phase;
- reduction of transport impacts;
- reduction of impacts in the processing phases (waste and energy);
- reduction of materials to be disposed of at the end of their life.

However, to ensure their implementation to be effective, as well as efficient, there are some conditions that must be respected:

- the closed loop must guarantee the restoration of suitable conditions of usability of products, components, materials (effective substitutability for actors and consumers, and respect for competitiveness, e.g. the substitution/replacing of virgin paper with recycled one, accordingly to the Integrated Product Policy - IPP);

- the closed loop process must have less impact than the primary production process, assessed through a life cycle analysis (including the phases of collection, selection, pre-treatment and the inevitable disposal of some component parts and materials);
- the closed loop must be compatible, in terms of volumes, temporal distribution of flows and stocks, variability, with the processes it will feed.

Furthermore, prices of secondary raw materials are also not free from influences, both internal and external. They can include:

- the listing of secondary raw materials. Basically the price is linked to the price of the raw material;
- market demand for secondary raw materials. This is the factor that most of all determines the strong instability of prices. Currently, the largest share of commercialized material depends on big contractors, which have the power to strongly influence prices, especially in the case of plastics;
- market offer for secondary raw materials. The main producers are the treatment and recovery centres of the materials coming from urban waste collection;
- law provisions. This aspect can concern, for example, a strategy of buying minimum fractions of recycled material to feed industrial production cycles (as already happens in public administrations through the adoption of Green Public Procurement - GPP). Possible incentives for the recovery and recycling of materials given the increasing problems linked to the management of landfills can be also addressed;
- technological development. New technical and management solutions for recovery can increase the quantity and quality of processable and resalable materials, as well as affect transformation (and disposal) costs;
- intrinsic quality of material. Depending on the type of material, the production process to which it has been subjected and the use it has performed during its life, the methods of use change and consequently also its economic value;

- purity, size and shape of the scraps. The value of the scrap will be the higher the closer it gets to the purity and conformity requirements of the secondary raw materials required by the market. The presence of contaminating substances negatively affects the evaluation of the materials (e.g.: different substances from the primary material that can deposit on the surface but also to those parts composed of a different material that it was not possible to separate). With the same condition, size and shape affect the analysis to the extent that they can complicate the phases of storage, transport and actual recycling;
- supply chain costs. In this category, costs of collection, transportation and selection can be mentioned.

Also these considerations should make us reflect both on how far the economic system is still from being considered effectively "circular", but above all, on how much this circularity can be transferred in terms of sustainability (Walker et al., 2021 and 2022).

4. Global and local scale: the "biological" and the eco-industrial approaches

The question remains of what level of analysis is the most suitable for implementing circular options. This issue is still widely debated also in the literature, someone is calling for initiatives at a global level (Yong et al., 2019), others, for a return to territories (Tapia et al., 2021), emphasizing the key role of the local dimension.
Some basic considerations, related to the costs and impacts of transportation in a life cycle perspective are undeniable; however, there are also other aspects to consider, perhaps more "soft", but equally important. For example, on a global scale, there is a persistent problem related to operational complexity and inevitable geographical disparities, difficulties in supply chains traceability and control and impacts related to transportation activities, which make fully circular principles and models less applicable. In this sense, local-scale systems have greater potential of revaluation. The overall picture is so complex that it would be practically impossible to hypothesize that all the possible aspects could be enclosed in a large-scale single model, and in a balanced functional relationship.
Recent studies propose hypotheses and approaches for the analysis of economic systems characterized by a simple and extraordinarily effective inspiration: the biological systems. These studies, grouped under the "Industrial Ecology" (IE) concept (Graedel, 1996), was definitively established at a global level in the late 1980s and proposed a new concept in which an industrial system is viewed not in isolation from its surrounding systems but in concert with them. IE seeks to optimize the total materials cycle from virgin material to finished product and to ultimate disposal moving from the natural ecosystems metaphor, which starts from a certainty: in the natural world, no waste is produced; waste is essentially a social or human construct. *"In a biological ecosystem, some of the organisms use sunlight, water, and minerals to grow, while others consume the first, alive or dead, along with minerals and gases, and produce wastes of their own. These wastes are in turn food for other organisms, some of which may convert the wastes into the minerals used by the primary producers, and some of which consume each other in a complex network of processes in which everything produced is used by some organism for its own metabolism"* (Jelinsky et al., 1992).
In this kind of system, the concept of "waste" (intended as an object or substance which an actor intends to discard) is practically lost in favour of a cyclical vision of flows, whose technical and economic value is maintained within the system, (almost) decoupling them, for quite a long period of time from their reference biological system. For these reasons, the IE can be recognized to all intents and purposes as the scientific basis of the CE and the methodological approaches and tools of the IE can effectively be used to guide change towards the CE.
The most effective approaches in this sense, in the IE research field, are the so-called "Place based" (Simboli et al., 2012). Place-based approaches to IE can promote more sustainable paths of local development or redevelopment through innovative methods, tools and applied solutions able to improve the socio-economic and the environmental performances of local economies, through a collaborative and synergic management of material flows, resources and energy. Most of them are based on the concept of Industrial Symbiosis (IS) (Graedel, 1996; Lowe, 1997; Chertow, 1999; Côté and Cohen-Rosenthal, 1998; Desrochers, 2002).
In 2004, a study proposed a spatial analysis of this phenomenon and demonstrated how, at a regional level, a fair compromise can be found between technological and organizational skills, economic feasibility and the degree of involvement of the actors in this type of initiative (Sterr and Ott, 2004) (Fig.3).

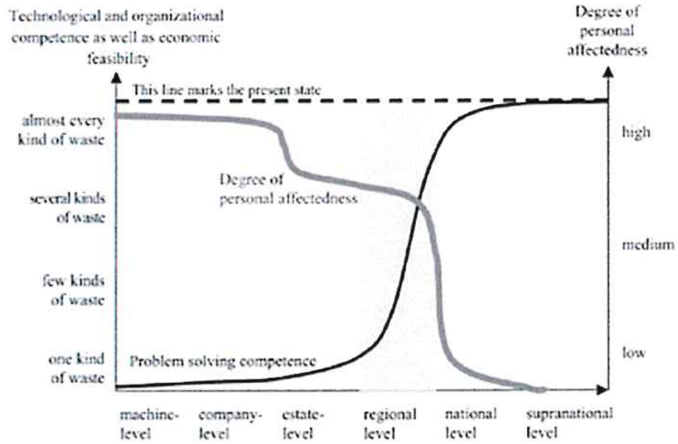

Fig.3. Applicability of the regional dimension for IE development (Source: Sterr and Ott, 2004).

Empirical evidence emerging from recent studies conducted by the authors (Taddeo et al. 2012; Simboli et al., 2014; Simboli et al., 2015; Taddeo 2016) also indicate that local territories and, in particular, those chacachterized by the co-presence of different dimensions, the s.c. "hybrid" contexts, express a great potential in closing the loop of materials.

In figure 4, the main result of a study conducted by the authors, is presented. This study started with a retrospective investigation for a technical and socio-economic qualification of such contexts, continued with the development of a specific approach based mainly on contributions from Urban Metabolism and IS, and an analysis for the specific synergies that are potentially associated. The results obtaind have been summarized in an integrated analytical framework, which illustrates the main flows and synergies among the different dimensions of these contexts (Simboli et al., 2019).

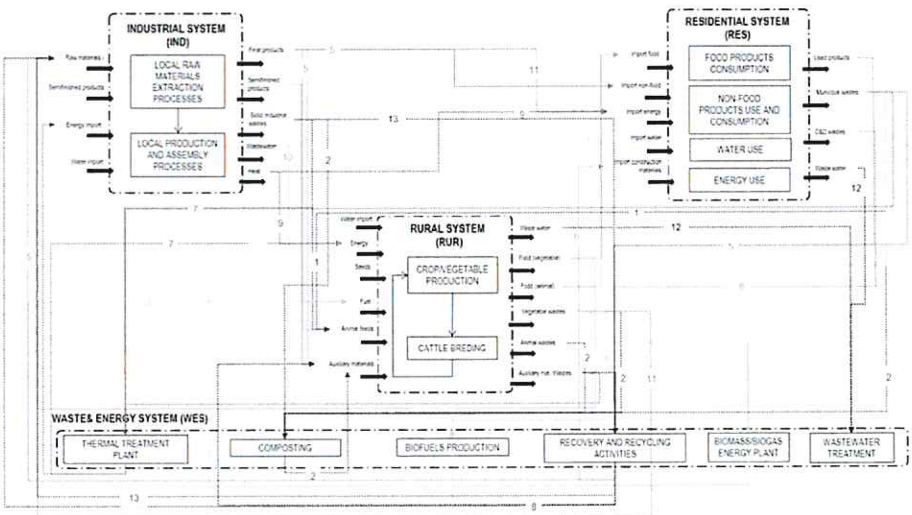

Fig.4. Potential synergies in material and energy emerging from a local hybrid system (Source: Simboli et al., 2019).

This study demostrated that an integrated vision of the different dimensions can be useful for efficiently identifying and managing material and energy flows beyond the typical use and consumption in local systems as well as for developing improvement actions, favoured by greater heterogeneity and proximity, along with more effective policies for a sustainable approach to local development in a circular perspective, thus demonstrating capable of reducing the physical and economic dependence of local actors on global supply chains and markets.

5. Conclusions

While resource use globally is growing at high rates and has even accelerated in the last decade (Schaffartzik et al., 2014), it is becoming evident that the scale of humanity's metabolism is unsustainable and must be reduced. Promising opportunities are at "meso" level of scale, in which networks of complementary entities perform complex functions. It is especially related to issues such as transportation, waste and reprocessed materials management and external costs, that could adversely affect the economic and environmental scenario in the case of macro level analysis (Roberts, 2004; Zhang et al., 2008), and poorly valued and exploitable in a "micro" level of analysis. In the paradigm of CE, and moving from the insights of IE framework, it has been suggested that the "meso" scale is the one in which maximum efficiencies are achieved in the development of closed-loop initiatives, both for the organizational-managerial complexity connected to them, and for the availability of flows and technological skills for their realization. The future developments of this research will have to go in beyond the prospective vision of such scenarios to include the options for closing cycles in models that can effectively support the decisions of sustainable economic growth, at a local and, therefore, global level.

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