A Macroeconomic Perspective on Green Growth

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Abstract Prevailing political economy is failing to maintain environmental, social, political and economic coherence. A fundamental shift towards a new economic model is needed 'where the acknowledged priority is to sustain human and natural communities' (GTI in Beyond the growth paradigm: creating a unified progressive politics, 2011: 1). Therefore, it is widely accepted that the current linear so-called "take-make-dispose" economy is not sustainable and that solutions need to be found in order to decrease both the input of limited resources as well as the output of human waste in any form. This paper examines how far the ideas of green growth are capable of handling this problem as they promise material welfare while reducing the impacts on the environment. Even though the underlying approaches like a circular economy, zero-emissions economy or Factor X seem to be desirable, there is reasonable scepticism in how far advances in resource efficiency can ensure a sustainable future while industrialised societies are constantly raising living standards. We show that there is an intrinsic contradiction within the desire for green growth to be an integral step into a sustainable future.

Keywords Circular economy · Material throughput · Green economy
Green growth · Sustainable development

1 Introduction

The following paper points out that the current patterns of generating economic welfare do not necessarily contribute to a total reduction of the material throughput even after the resource efficiency was significantly raised. In order to stop this trend,

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different terminology and concepts emerged to describe an economic system that goes hand in hand with nature (green economy, low carbon economy, circular economy, bioeconomy etc.).

It is very often being propagated that world development is driven by growth. Subject to sustainable development, it is said that this growth should be "greener". We will give a short overview of these green visions that all claim to ensure both economic prosperity and a reduction of the material throughput. Economists agree that economic growth must be decoupled from the material throughput but the current trend does not demonstrate a promising future. Consequently, the voices which argue that a renunciation of the growth paradigm will become inevitable in order to take pressure off the environmental capacities are getting louder. This provides a source of controversy not only in the scientific world. A shift from quantitative growth to qualitative change is needed.

This discussion only slowly finds its way to the political arena so far. Governments and businesses consider eco-efficient technologies as a potential solution for resource scarcity as well as a driving force for innovations, and of course growth. Nevertheless, there are movements like "degrowth" that are gaining more and more attention in the general public. Also, science is starting to offer rationales why savings of the material throughput on one end often lead to emissions on the other. The so called rebound effect (e.g., to buy a more efficient car but drive more).

This paper gives an insight into this intense discussion and addresses the question whether green growth is a conceivable reality or a perspective for sustainable development. In doing so, we propose a simple model that describes a crucial contradiction within the concept of green growth on a macroeconomic level.

2 Conventional Industrial Metabolism

The functionality of an economy or economic activity in general can be best described in the most abstract but plausible way: natural resources get extracted from the biosphere, are then either used directly or transformed into certain consumption goods and thereafter sold to an end-consumer. At the end of this process is the release of waste, emissions and unnecessary resource losses. So the biosphere provides the source of the material on one hand and the sink for waste on the other in order to allow economies to run (Paech 2005). In this sense the process of production and consumption is linear and stresses both, the capability of the biosphere to offer natural resources as well as its capability to serve as a sink for waste in any form. In this regard, mankind interrupts the natural flow of matter and energy.

The global resource extraction of the year 1980 is likely to double by 2020, which reflects the growing demand for natural resources (OECD 2008). Even though drastic technological improvements in energy and resource efficiency were implemented over the last 3 decades, they have been compensated by a massive

economic growth. Global carbon emissions from energy use have increased by 40% since 1990 (Jackson 2009a). There is no doubt that the total amount of economic activity dictates both the resource input as well as the emissions output. The Russian Federation is the only large economy (beside Germany) which reduced its carbon emissions extensively since 1990, as a consequence of the breakdown of its heavy industries. This illustrates how strongly the Gross Domestic Product (GDP) correlates with the emissions emitted into the atmosphere and with the material throughput in general. According to Hoffmann (2011), not only the technologically leading countries would have to endure a similar economic breakdown increase threefold in order to limit the rise of global temperature to a maximum of 3 °C.

In this regard, the degree of sustainability of material welfare corresponds to the amount of physical materials circulating throughout the global economy: the material throughput. This notion describes the relationship between the physical size of the global economy and the ecosystems it is influencing. The aforementioned functionality of any economic activity describes the chain of actions impacting the physical world, depending on energy and at the same time degrading ecosystems. Consequently, the Gross World Product (GWP) is the measure of an economic activity and at the same time a measure of the material throughput: the amount of matter and energy used in each production-consumption process (Daly and Farley 2004). Increasing population and consumption result in a higher material throughput. Hence, "understanding throughput is central to understanding sustainability" (Santa-Barbara et al. 2005: 2) because the global economy simply would not work without natural resources and ecosystem services. Further environmental degradation can be limited if the absolute limits to the material throughput are set up (Santa-Barbara et al. 2005).

Moreover, this paper proceeds with a vision of a green economy. It presents options to avoid natural resource scarcity and nature degeneration in order to achieve a balance where nature and economics meet sustainability targets.

3 Vision of the Green Economy

The rising demand for resources and steadily increasing emissions of human waste stress the limits of the biosphere. 'Earth's regenerative capacity can no longer keep up with demand—people are turning resources into waste faster than nature can turn waste back into resources' (WWF 2006: 2). New implications are necessary in order to transform the economic system towards a stable and sustainable combination which in the best case scenario covers the needs human beings have. Senge et al. (2001) predict a "Next Industrial Revolution" that aims at creating the ideal sustainable bio-based economy. The main conditions for the vision of such economy are a provision of sufficient and healthy global food supplies as well as a production of high quality products from renewable raw materials (BMBF 2011).

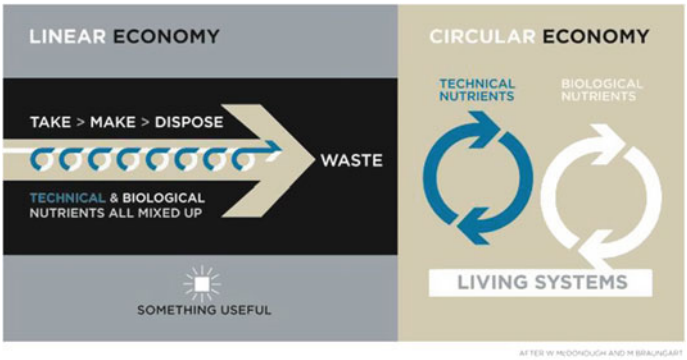

Fig. 1 End of the line or full circle? (EMF 2012)

Such a visionary economy would be characterized by having no stressing impact on ecosystem services: neither on the use of natural resources nor on the sink functions that ecosystems provide, regardless if the underlying approach is called circular economy (e.g., Preston 2012; UNEP 2006), zero-emissions economy (e.g., Ayres 2004; Baumgartner and Zielowski 2007) or Factor X (e.g., Beyers 2005; von Weizsäcker et al. 1995). All these concepts demand a so-called decoupling of economic activity from its material throughput, so that the economic system goes conjointly with the natural system.

Since nature works in perfectly closed cycles without producing any waste that is not further reused (Senge et al. 2001), the current linear pattern of production and consumption should accordingly be 'replaced by systems that reuse resources and conserve energy' (Preston 2012: 2). Following the example of nature, such a circular economy would use old products to make new ones and reintroduce biological ingredients back into the biosphere (see Fig. 1).

The demand for energy to further process unsuitable nutrients for the biosphere such as metals or plastics is generated by renewable energy sources. Wind, sun and biomass are abundant, the technologies either already exist or will be further developed (Paech 2010). A fix amount of resources would constantly provide material welfare to mankind. The previously mentioned conception idealizes the illusion of a superlative world.

4 Towards the Green Economy

For shaping the progress towards a perfectly green economy, several key elements of current production and consumption patterns need to be transformed. It will be inevitable to reorganise the structure of industrial systems both on a local and on a global scale. Material flows must be coordinated in order 'to use the "waste" streams from one factory as a resource for other companies and consumers'

(Preston 2012: 5). Using industrial waste heat to provide heating for households would be a well-known example on the local scale in this regard. Following this idea, several so-called eco-industrial parks (e.g., in Kalundborg, Denmark) were constructed in which the facilities provide each other with residual materials and energy and thus, generate diverse synergies (Preston 2012). On a large scale, industrial material flows need to be massively intensified in a way that they once may function in a closed cycle.

The construction of products must be revolutionised so they can either be recycled and reused or biodegraded. Therefore, it is crucial to explore technologies which aim at the material separation of goods so that waste becomes a new source of raw materials (Baumgartner and Zielowski 2007). A so called recycling concept of the "cradle-to-cradle" production does not minimise the total material flows but rather transforms them into a more cyclical functioning (Högner et al. 2012). It is argued that this would form 'a supportive relationship with ecological systems and future economic growth' (Braungart et al. 2006: 1338).

As both the eco-efficient construction of products as well as the reorganization of industrial systems aim at the production-side, it is important to mention that the consumption-side holds a large potential to "green up" economic systems. There are several concepts aiming at higher resource efficiency by changing consumption patterns. Many of them propose a shift away from conventional ownership towards a consumption system that is characterized by 'sharing, bartering, lending, trading, renting and gifting' (Preston 2012: 10). This social innovation requires less physical materials to satisfy the people's needs. More importantly, it results in more sustainable consumer behaviour (EEA 2016). In how far material welfare can contribute to humanity's perceived wellbeing is another debate that is not part of this work but should always be kept in mind.

Meanwhile, the necessity of "greening up" the patterns of production and consumption are especially accepted in large parts of the industrialised world. It is even assumed that innovative green technologies might be key to push economic prosperity. A new dogma is born—the "green growth imperative".

The idea is that this immense transformation can be carried out by forces which are already shaping our current economic system because 'change through market-driven innovation is the type of change our society understands best' (Senge et al. 2001: 26). Green growth implies an intrinsic faith that the relief of the biosphere itself can serve as a driver of further increasing material wealth (Paech 2010) which can create a win-win scenario. In the following part we analyse if the reduction of the material throughput fits into the concept of economic growth.

5 A Critical Discussion on Green Growth

Green growth can be a perspective for creating new growth notions with a reduced negative environmental impact while still promoting related technological and structural change. But can an increase of economic activity be a strategy to decrease

environmental degradation? Aren't the "economic goods" creating "environmental bads"? How to resource the world?

Many questions arise regarding this dubiousness. Moreover, it is a question of income equality and population growth: increased Green House Gas (GHG) emissions and consumption is not related to increased population as long as the majority of the people remain poor. But what about one of the main Millennium Development Goals: "Eradicate extreme poverty and hunger"? There are many questions to answer when debating about economic prosperity in terms of sustainable development.

However, this paper focuses strictly on the macroeconomic dynamics which go along with the concept of green growth and its ability to guide mankind into a sustainable future.

6 The Impact of "Green Growth" on the Material Throughput

In order to deal with the strain on both the sink as well as the resource capacity nature provides to human beings it is important to clarify in which way this should be measured. The relevant number in this context can only be the absolute resource use and the absolute emissions since nature itself works in strictly in absolute terms as well. In order to understand green growth ideas it is important to make a clear distinction between the absolute values of resource in- and emissions output as well as the relative resource in- or emissions output per unit of GDP (Behrens et al. 2007). Jackson (2009b) uses the term "ecological intensity" in this context. This contains indicators with regard to waste disposal such as the carbon intensity along with the resource use serving as the fossil fuel intensity.

During the last decades, several improvements were achieved referring to ecological expanses. For example, the global carbon intensity was reduced from about 1 kg CO_2 per $US in 1980 to less than 770 g of CO_2 per $US in 2006 (Jackson 2009b). Nevertheless, the absolute CO_2 emissions continued to grow. Hence, the improvements in material efficiency (in this case the carbon efficiency) were simply offset by economic growth.

Meanwhile the question arises how to set the concept of green growth into this frame. Primarily, it requires to consider the effects of the process of "greening" an economy on the resource in-and/or the emissions output. The aforesaid deviation from an economy with a high material throughput to an economy with a downsized one certainly diminishes the resource use in absolute terms. It is therefore greatly commendable and indispensable.

Accordingly, green growth has the potential to influence the relative dematerialization positively whereas growth seems to have an increased impact on the absolute resource use. Indeed, this is a given as long as the economic performance is positively coupled with the material throughput even if it is assumed to be close

to zero. In other words, additional economic welfare that is generated with the aid of natural resources must by definition raise the absolute use of resources, regardless to the underlying relative dematerialization. Thus, economic growth without an increased impact on the absolute resource use can only be achieved in case of a complete decoupling of the economic performance and resource use, for example, in the case of the perfect circular economy.

What does that tell us? Obviously there is a clear contradiction within the idea of green growth itself. As previously mentioned, the "green" part of the term implies the reduction of the ecological intensity while in contrast growth implies a strict increase of the material throughput. Therefore, an environmental policy can only be successful if the effect of lowering the environmental intensity succeeds the effect deriving from growing economic activities, meaning that 'the decrease in material, energy and pollution intensity is higher than the economic growth rate' (Giljum et al. 2005: 33).

7 Condition to Achieve an Absolute Reduction in Material Throughput

In order to understand the correlation between ecological intensity and economic growth, we propose a simple model presented in Box 1. It shows in a comprehensible way that a total reduction of material throughput can only be achieved if condition (1) is fulfilled. Furthermore, the absolute material throughput reduces above average in case both the ecological intensity and the change in GDP become negative (being below 1). This is because the correlation is not linear, so that in theory a shrinking economy that reduces its ecological intensity is more efficient in taking pressure off the biosphere than an economy with a stable GDP which reduces its ecological intensity even more. The underlying policy implication deriving from this could be stated as both "go green" and "de-growth" at once.

Box 1: A Simple Model

To visualize the interrelation between the material throughput and the economic activity (expressed as the GDP), we simply set up the following equation, where E_t is the absolute material throughput (measured, e.g., by CO_2 emissions or resource use in tons or any equivalent that is of interest for measuring the material throughput) given for a certain period. It is expanded by the absolute GDP as well given in period t. Of course this is also valid for any previous and following periods, so that

$$E_t = \frac{\mathrm{E}_t}{\mathrm{GDP}_t} \times GDP_t \quad \text{and} \quad E_{t+1} = \frac{\mathrm{E}_{t+1}}{\mathrm{GDP}_{t+1}} \times GDP_{t+1}$$

are given. An absolute increase of the material throughput is avoided in case

$$E_{t+1} \leq E_t$$

is fulfilled and respectively

$$\frac{E_{t+1}}{GDP_{t+1}} \times GDP_{t+1} \leq \frac{E_t}{GDP_t} \times GDP_t.$$

Since $\frac{E_t}{GDP_t}$ and $\frac{E_{t+1}}{GDP_{t+1}}$ simply express a certain ecological intensity, $(e_t \text{ and } e_{t+1})$ we simplify the equation to

$$\frac{e_{t+1}}{e_t} \leq \frac{GDP_t}{GDP_{t+1}}$$

and consequently to

$$\Delta \boldsymbol{e} \leq \frac{1}{\Delta \boldsymbol{GDP}} \tag{1}$$

It is interpretable as the condition that must be fulfilled so that an absolute increase in the mateiial throughput is avoided in the observed period of time.

An additional finding which is expressed in condition (1) is the possibility to reduce the absolute material throughput while the GDP increases. In this case, as previously mentioned, the reduction of the ecological intensity must exceed the effect caused by growth.

In conclusion, we developed a very simple but significant condition that policy makers should take into account if sustainable development, as a goal for the environmental and economic policy, is persistently considered. Not expanding the economic activity is a potentially strong instrument for achieving a sustainable pathway of development.

8 The Growth Dilemma

At this point it is necessary to raise the question in how far it is possible for an economy to "de-grow". Without going into detail, some core principles should be mentioned.

Modern economies are based on constant advances in technology related to efficiency gains. This leads to a downgrading of labour since less work is needed to produce the same amount of goods and services (Jackson 2009b). Thus, in order to

prevent unemployment and a resulting drop in demand for means, such economies compensate this by the expansion of their economic activity: they grow. The problem is not realizing what the main goal of the growth is. Shouldn't this goal be to eliminate poverty?

Another reason for growth being inevitable lies within the monetary system and in the nature of debts. Making debts implies that you are forced to pay them back, including an additional amount of money deriving from a certain interest rate. This difference requires an additional generation of money. A state in debt can compensate this either by printing additional money (resulting in inflation) or generating economic growth (O'Neill et al. 2010).

In case of a shrinking economy, these described core requirements cannot be fulfilled anymore and the economy might enter into a spiral of recession which entails a risk of system collapse. The crisis in Southern Europe, especially in Greece, demonstrated this dilemma in a very tragic way. The fact that Greece was forced to retrench their spending made the Greek economy shrink. And this lead to a dramatic increase of the unemployment rate, political instability and thereby disrupted the Hellenic nation. Accordingly, economic growth was and still is urgently needed. Jackson (2009b) describes this dilemma to the point where he states that 'growth may be unsustainable, but „de-growth"appears to be unstable' (Jackson 2009b: 8).

9 Conclusion

What we can learn from this paper is that the massive increase of economic activity is closely related to both the input of extracted natural resources as well as the output of harmful human waste. Mankind stresses the limits of what the biosphere is able to handle and thus threatens its own livelihood. The risks deriving from the current linear production and consumption patterns are widely recognised, especially in those parts of the world that are mainly responsible for the huge throughput of natural resources. It means that our current lifestyle is not sustainable and natural resources are under threat.

For this reason solutions are needed but only compromises were found so far. Several visions were developed that all have the common aim of an economic system which ensures material welfare and prosperity without having negative impacts on the environmental dynamic. The "growth imperative" gets continuously converted into a "green growth imperative". Green technologies offer a promising future for growth.

On a macroeconomic level we have shown that there is a clear contradiction within the concept of green growth since economic growth strictly implies a higher level of the material throughput. Abating ecological intensity can only have an advert effect on this. An absolute reduction of the material throughput can solely be achieved if the decreasing effect of the ecological intensity exceeds the increasing effect deriving from growth. Nevertheless, the strategy of reducing economic

activity while being more resource- and energy efficient would be above the average efficiency. Unfortunately, policies aiming at generating a lower GDP are not very popular because this would confront the structure of current market economies. This can be seen the best in the developing countries because it is not easy to promote a de-growth strategy where growth is the main macroeconomic incentive. This growth dilemma will become more famous the closer humanity gets to the limit of the world's biosphere system.

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