BACHELOR'S PROGRAMME IN ECONOMICS

Is green growth sufficient to alleviate climate change?

Meri-Tuuli Moilanen

Bachelor's Thesis
2022

Aalto-yliopisto
Aalto-universitetet
Aalto University

Author Meri-Tuuli Moilanen

Title of thesis Is green growth sufficient to alleviate climate change?

Programme Bachelor of Science in Economics and Business Administration

Major Economics

Thesis supervisor Prof. Pauli Murto

Thesis advisor Assistant Prof. Prottoy Akbar

Date 25.04.2022 **Number of pages** 20+2 **Language** English

Abstract

Our economic system is based on growth. However, this is at odds with our planet's limited resources. As the effects of climate change become more and more severe, economists have begun to question whether GDP should be in the center of our system, and whether we can keep growing like we are used to. Green growth has emerged as a solution to these problems. It focuses on decoupling GDP growth from its inputs through technological improvements and transitioning to a green economy. The problem, however, is that we lack empirical evidence that the required levels of decoupling are achievable before it is too late. While researchers seek consensus on green growth's concept and possibilities, alternative systems, such as degrowth and a-growth are starting to gain attention. This paper is a literature review of these economic systems, especially whether green growth should be given the level of importance as it is today.

Keywords Green growth, GDP, decoupling, ecological economics, fiscal policy, environmental policy

Contents

Abbreviations

DMC	Domestic material consumption
EKC	Environmental Kuznets curve
GDP	Gross Domestic Product
GGEI	Global Green Economy Index
GHG	Greenhouse gas
GNH	Gross National Happiness
IPCC	Intergovernmental Panel on Climate Change
MF	Material footprint
OECD	Organization for Economic Co-operation and Development
SNA	System of National Accounts
UN	The United Nations
UNEP	The United Nations Environment Programme

1 Introduction

1.1 Motivation: growth on a finite planet

Human actions are overheating our planet (Victor, 2008). The catastrophic damages caused by climate change are well known. Still, it seems that action is not taken fast enough – in fact, emissions have been rising steadily since industrialization and are projected to continue this path unless immediate action is taken (IPCC, 2022). There is talk of renewable energy and plant-based diets, but a crucial underlying cause often goes entirely unnoticed by mass media: our economic system. The driving force behind the rising temperature, biodiversity loss, and melting icebergs is our society's dependence on increasing consumption and growing the economy (Hallegatte et al., 2012; Jackson, 2009; Victor, 2008).

Economic growth is often perceived as an alleviating factor to both human and natural suffering since it creates wealth and efficiency (Arrow et al., 1995), but this view has been challenged along the years. Even major economists of the past such as John Stuart Mill and John Maynard Keynes saw a time when growth would need to halt (Jackson, 2009). Since developed societies around the world have gotten used to the higher standard of living and constant flow of new opportunities created by capitalism, the question arises: what should we do to maintain our world order? Is it possible to make growth green by detaching it from resource usage and greenhouse gas emissions? If yes, what will it take, and can humanity achieve it fast enough?

Green growth has been introduced as an answer. It has become a widely endorsed political strategy to continue growth in a more sustainable way (Hickel & Kallis, 2020). Its concept is built on the assumption that we can increase efficiency of resource use to a point where material consumption does not increase with GDP. However, we lack empirical evidence of absolute decoupling being a realistic target to achieve by 2050 (Hickel & Kallis, 2020; Jackson, 2009), making green growth at least a questionable goal for climate policy.

As green growth has been widely promoted as a key tool to combat climate change, a closer look at its merits and downsides is in order. Is green growth a good goal for humanity to limit warming to 1.5°C or reach the European Union's target of net zero emissions by 2050 (European Commission)? What are the obstacles in the way of a green economy, and what other options do we have on a short schedule? An increasing interest in climate change, environmental policy, and the sustainability of our economic system made choosing green growth as my bachelor thesis topic easy.

1.2 Research questions and structure

This study is a literature review focusing mainly on green growth. Because transitioning to a green economy has been widely adopted as a strategy to combat climate change in Europe, my objective is to analyze whether green growth is a good political and economic goal to limit warming to 1.5°C. As green growth depends on technological improvements, I will also clarify the concept and assess the feasibility of decoupling, the detachment of growth from the resource and energy use required for it. These issues will be examined narrowly through an environmental lens, since the societal side of GDP or capitalism in general including income distribution, inequality, and social hierarchy would call for a separate review. More specifically, my research questions are the following:

1. Is green growth as a political strategy a sufficient way to limit global warming to 1.5°C?
2. Is absolute decoupling achievable before 2050?
3. If not, what other options exist for measuring?

The focus will be to assess if elevating green growth to the level of importance of GDP will be a viable and sufficient way for humanity to reach net zero by 2050 and slow global warming to 1.5°C. In addition to green growth, I will briefly discuss the ideas of degrowth and a-growth, as well as their meaning for economic activity.

For the structure of this study, section 2 will shed light on the history and definitions of GDP and green growth. On one hand I will discuss the benefits of having a globally recognized uniform measurement. On the other hand, GDP has many shortcomings, to which neither green growth is immune. Section 3 focuses on the problems behind green growth, more specifically its erratic definitions, insufficient policy measures, the improbability of achieving absolute resource decoupling, and the issue of rebound effects associated with efficiency improvements. Section 4 continues to explore alternatives to GDP, namely the concepts of degrowth and a-growth, the former referring to scaling down economic activity and the latter to ignoring GDP as a measurement altogether. This section also briefly reviews different sustainability indicators and indices that have been proposed throughout the years but failed to catch on. Section 5 concludes and contains a discussion on green growth and other measurement systems, as well as suggestions of further research.

2 GDP and green growth – the history and difference

2.1 GDP: the history and nature of the growth imperative

Economic growth is the norm by which we have learned to live. It is embedded as a key assumption and requirement in nearly everything in our economic system (Jackson, 2009). However, the phenomenon of measuring a nation's domestic production is quite new. The concept was originally coined in 1937 by Nobelist Simon Kuznets as a measurement to help the United States fight recession and measure their production capabilities (Thompson, 2020; Victor, 2008), but it was not until after World War II that measuring GDP became a globally consistent and widely recognized phenomenon.

GDP was taken into use properly at the same time as the World Bank and the International Monetary Fund (IMF) were founded in 1944 at the Bretton Woods Conference (Thompson, 2020). In the following decades, the new indicator reached a uniform calculation method, enabling comparison between countries and prompting it to become the center of political goals (Victor, 2008). This is GDP's feat, a success that other newer indicators of sustainable development have not managed. It is one of the reasons why GDP has become a key part of many economic models, such as the Taylor rule, which is widely used by central banks to determine interest rates based on the state of GDP (Woodford, 2001). GDP has made economies internationally comparable and given us a simple central indicator to look at.

However, the scope of meaning that GDP originally was supposed to have has begun to swell. GDP's founder Kuznets himself warned against the measurement's use as an indicator of human well-being or environmental health (Thompson, 2020). Nowadays this has become reality: GDP figures are reported several times a year around the world, and growth is often perceived as a solution for inequality and environmental issues (Arrow et al., 1995). GDP growth has become so connected with progress that some economists and politicians even see growth as a prerequisite for sustainable development. They argue that growth is necessary to create the wealth needed to pay for emission reductions and investments in clean technology (Victor, 2008).

Since GDP has become such a formidable figure despite its limitations as an indicator, it has faced increasing criticism along the years. In addition to uneven distribution of the wealth economic growth creates, GDP omits the incomes from household work, grey economy, and capital depreciation (Victor, 2008). However, GDP's main issue from an environmental perspective is its obliviousness to externalities. It measures economic output alone without considering the natural capital, emissions, land, material use or waste that was required to create the output (Jackson, 2009; van den Bergh, 2011; Victor, 2008). It can even see environmental catastrophes as positive growth, since they stir economic activity through reparation efforts (Stiglitz et al., 2008).

Because our economic system is dependent on growth, it often gets prioritized over environmental protection or climate change alleviation, leading to correlation between growth and environmental degradation (Jackson, 2009). This is what Jackson calls "the dilemma of growth" in his book: the planet needs us to consume less but our system tells us otherwise. If we were to try shift away from growth, problems arise: recession, unemployment and bankruptcy. The result is that any idea questioning or aiming to reduce growth seems highly radical, meaning environmental policies are rejected, and polluting companies get subsidies in the name of protecting growth (Jackson, 2009).

2.2 Green growth: a silver bullet for the climate crisis?

2.2.1 How is green growth different from measuring GDP?

Due to its inadequacy as an indicator of wellbeing, economists and organizations have attempted to add different aspects of wellbeing and environmental externalities to the GDP measurement. A notable contribution is the Measure of Economic Welfare (MEW) model developed by William Nordhaus and James Tobin, which incorporates leisure and household work into the measure and subtracts components that do not increase wellbeing from it (Stiglitz et al., 2008). Some public figures have called for an evaluation of alternatives to GDP, such as the prompt by the Rio Summit in 1992 for adding new dimensions into the System of National Accounts (SNA) (Schweinfest et al., 2021), or the request from French president Nicholas Sarkozy in 2008 which resulted in a report on the matter by the Stiglitz-Sen-Fitoussi Commission. China has experimented with using green GDP, an index that measures an economy's output in a year like traditional GDP, but accounts for the natural capital used to achieve that growth, though gave it up in 2005 (Schweinfest et al., 2021). As these alternative indicators have failed to catch on, and criticism towards GDP and other flow indicators like it has continued, an increasing emphasis on using changes in capital stocks as a measurement of progress has emerged (Stiglitz et al., 2008). These indicators have been gathered under a popular umbrella term, a solution seeming like a silver bullet: green growth.

Green growth is a political strategy aimed to help societies transition into green economies and combat climate change (OECD, 2019). In essence, it means optimizing resource efficiency and minimizing environmental impacts while not necessarily limiting GDP growth (Hickel & Kallis, 2020). Green growth's proponents state that this will be achieved through technological advancement and innovations enabling higher levels of decoupling growth from emissions and resource use (European Commission). Since its inception in the Rio+ 20 conference in 2012 (Hickel & Kallis, 2020), the OECD, the United Nations Environment Program UNEP, the World Bank, and many governments around the world have lunged at the chance to implement green growth into societies – if we can keep living in our old ways with little changes, why try anything new? However, their definitions for green

growth's goals all differ, leading to confusion on the unity of the concept's understanding across these prominent organizations.

First, the OECD describes green growth as "fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (OECD, 2019, p. 4). Second, UNEP calls for an "inclusive green economy" that would improve equality and make environmental resources less scarce and risky (unep.org). Finally, The World Bank calls for green growth as a solution to climate change, describing it as resource efficient, pollution-minimizing, and resilient against natural disasters (the World Bank, 2013). Moreover, their report highlights that there is no uniform green growth model across countries, but strategies will differ depending on local needs and opportunities.

These strategies often revolve around economists' favorite type of policy: pricing. Pigouvian carbon taxation, expansion of emission trading systems to road transport and aviation, and investments to renewable energy production are planned (European Commission; OECD, 2019). Even if pricing is effective, Hallegatte et al (2012) suggest complementary policies too. They demonstrate that while significant price changes may cause strong political opposition or unease, the hardships can emerge already when trying to decide on the right price considering all externalities, especially for goods and services that do not have their price determined by markets. Also, if the price elasticity of a good or service is low, it may make the policy ineffective.

Other than using prices, the OECD, for example, has stated many objectives to reach the Sustainable Development Goals (SDGs). These strategies include improving productivity and efficiency, managing and maintaining natural assets, upholding access to essential ecosystem services, creating economic opportunities and social inclusion, and monitoring sustainability through wealth accounting (OECD, 2019). Another initiative focusing on green growth is the European Green Deal, which aims for a climate neutral Europe by reducing EU countries' GHG emissions by 55% by 2030 compared to 1990 levels and committing to net-zero emissions after 2050 (European Commission). The Commission's goal is to create new jobs and growth as a byproduct of the green transition, as buildings are renovated, and renewable energy's production expanded. The aim is to decouple growth from resource use.

2.2.2 The many indicators of green growth

As the World Bank stated in 2013, green growth is not measured by one model, but multiple different indicators. In 1993, the System of Environmental-Economic Accounting (SEEA) was released along with a handbook on monetary valuation of nature by the United Nations (Schweinfest et al., 2021). These new methods made way for the development of green GDP, an indicator of economic growth considering natural degradation. It is calculated by subtracting natural capital use from GDP, namely the reductions in or damage caused to environmental resources (Stiglitz et al., 2008). After the

measurement was published, Schweinfest et al (2021) describe how some countries, such as the United States, China, and Norway tried to incorporate it into their measurement systems, but without lasting impacts. Norway became frustrated by the difficulties of valuating environmental depletion without markets, but the U.S. and China experienced internal opposition to a figure that reported their growth rates much lower than traditional GDP. This led to the failure of green GDP, and many authors have spoken against the use of a single aggregate indicator to measure both economic growth and environmental changes (Schweinfest et al., 2021; Stiglitz et al., 2008).

Fortunately, indicators focusing on different aspects of natural resources, greenhouse gases, and other pollutants exist. The OECD (2019) has indicators for green growth focusing on these topics, and their report specifies many ongoing advancements in especially measuring land cover changes, carbon emissions and raw materials involved in trade, and exposure to pollutants. They also keep data on multiple green growth indicators such as demand-based CO2 productivity on their website. There are also some more complex systems of measurement, such as the Global Green Economy Index (GGEI), which has been developed to track green growth around the world and is published by a private consultancy in the United States, Dual Citizen LLC (Dual Citizen, 2016). Now GGEI tracks 80 countries' performance on transitioning to a green economy, and it uses a total of 32 indicators and datasets for its calculations. GGEI has been published since 2010 and claims to be an essential provider or information for policymakers and other experts, but it is not mentioned in the literature reviewed for this paper.

3 Why green growth may not be the solution

3.1 Indeterminacy – from definition to goals

Green growth may seem like the perfect solution to our crisis, but in closer scrutiny many worrying issues arise. The problems start at green GDP's definition: there does not seem to be a consensus on it. As with sustainability in general, green GDP's definition can and has been redefined to fit one's own interests (Schmalensee, 2012). In many of these definitions, such as those of the OECD, UNEP, and The World Bank, the term "reduction" when it comes to environmental externalities is missing entirely (Hickel & Kallis, 2020). Moreover, especially the OECD's description seems to highlight continuing growth as the strategy's main priority, not environmental protection (OECD, 2019). This kind of vagueness in definition makes green growth a rather confusing and amorphous concept. It may be one reason why the concept or its indicators have little media presence – unlike the familiar GDP, green growth seems difficult concept to grasp.

The disagreements do not stop at the definition of green growth but also touch upon its merits. There seems to be a discord between scientific research and international economic organizations

about greening economies' potential to be a "new engine of growth". As green growth's definitions make room for continuing economic growth, many of its advocates have named the green transitions as means of forming new jobs and markets, further growing the economy (Jackson, 2009; McAfee, 2020). The OECD too has commented that with proper policy measures for the energy sector, new jobs and markets could be created (OECD, 2019). However, according to Schmalensee (2012), there is no guarantee that the benefits of the massive investments required to get there would be greater than their abatement costs. Moreover, it is surprising that green growth relies on major breakthroughs in technology leading to resource efficiency. This type of advancement has historically been feared to steal away jobs, not create them. Also, what kind of political uncertainty would it cause if those that lose their jobs to the green transition are unable to fit for the new jobs it creates in today's rapidly shifting work environment?

3.2 Insufficient policy measures and market signals

If we decide to rely on green growth as the pathway to a sustainable future, dire political action is urgently needed. Arrow et al (1995) remind us that green growth can succeed only if there is strong signaling about scarcity from policymakers to resource users. Yet it is hard for governments and firms to make ambitious policy measures if they value growth and their own advantage more than climate concerns. Emma Duncan summarized the problem for the Economist in 2009: "It is a prisoner's dilemma, a freeride problem and the tragedy of the commons all rolled into one." As she points out, our global economy, the pursuit of growth, and besting your competitors lead to a situation where reducing emissions at the cost of all that may seem like a huge disadvantage.

Perhaps this is one reason for insufficient policy measures regarding emission reductions. The OECD, for example, is focusing efforts on improving fiscal policy: researching and helping governments put together effective energy taxes, shift away from fossil fuel subsidies, and price carbon according to its negative externalities (OECD, 2019). However, OECD's reports on the progression of green growth show that change is lagging badly; energy tax levels vary greatly between countries but are all too low, fossil fuels are still subsidized and, in some countries, there is no carbon pricing at all. A good example of an insufficient policy is the "carbon pricing gap" shown in figure 1. The gap measures the difference between the target price of carbon considering its impacts and the actual price (OECD, 2019). The percentage on the y-axis indicates how many percentages lower the current price is compared to what it should be according to a low-end benchmark price for carbon, EUR 30. With this information, it is clear from figure 1 that the price level is much too low, and in some countries, there is no regulation to begin with.

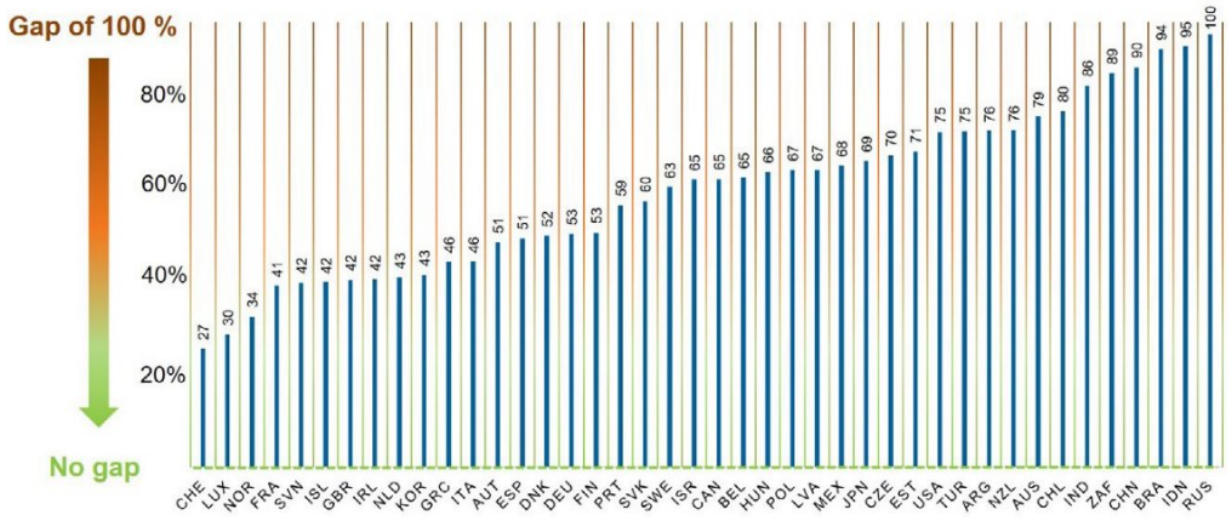

FIGURE 1: THE CARBON PRICE GAP. SOURCE: OECD, 2019.

Market failures such as this where environmental externalities are excluded from our models and calculations lead to a rising emissions. If resource prices fail to reflect the resource's social costs, consumers and firms will be misled. They will get the impressions that the resource is more abundant than it is and not be able to make informed decisions in their best interest, leading to over-extraction or overconsumption (Victor, 2008). This is well shown in the energy sector. If the scarcity signaling is too weak, companies cannot be expected to shift away from cheap and available fossil fuels (Duncan, 2009).

Unless policy measures become more ambitious and are implemented immediately, green growth does not seem to be able to curb our impact on the planet's temperature. Figure 2 shows the IPCC's projected future level of GHG emissions based on current policy measures (red line) and compares it to the required levels of reduction to limit warming to 1.5°C or 2°C. As seen from the figure, our current actions are nowhere near sufficient to stay below the given targets.

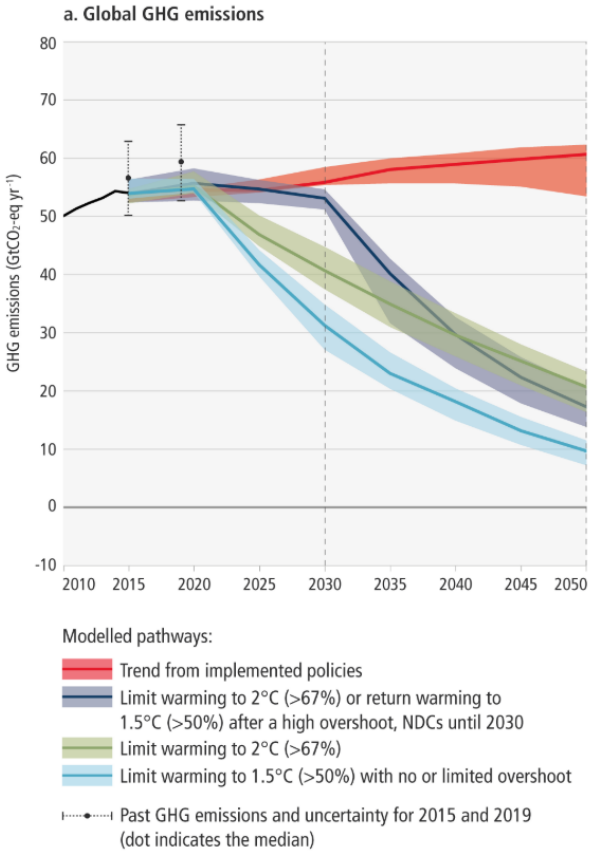

FIGURE 2: PROJECTED GHG PATHWAYS. SOURCE: IPCC, 2022.

3.3 Decoupling and the EKC

The problem with green growth is not merely lack of effective policies and political signaling. It is an issue of physical limitations and resource use. The main issue with green growth is that its entire concept is built on the assumption that economic growth can be continued, because technological progress and physically substituting for natural resources will enable humanity to reach absolute decoupling between GDP growth and resource usage (Hickel & Kallis, 2020).

Decoupling is an essential concept for eco-efficiency and therefore for green growth. It refers to a situation where growth can be detached from its inputs, such as fossil fuels causing carbon dioxide, other greenhouse gas emissions, or changes in land use (Jackson, 2009). Decoupling is usually divided into two types: relative and absolute. Relative decoupling refers to a situation where GDP grows faster than the amount on inputs necessary for it, so if GDP was divided by its inputs, the result would be more than one (Jackson, 2009). Relative decoupling is often used as a synonym for eco-efficiency. Absolute decoupling, however, is a more ambitious goal: the requirement is that when GDP grows, the material and emissions enabling that growth must stay the same or, preferably, decline (Hickel & Kallis, 2020).

For green growth to succeed in reducing emissions and mitigating the damages of climate change, absolute decoupling must be achieved on an urgent schedule. Only then can growth and the necessary emission reductions take place simultaneously (Jackson, 2009). However, there are many differing opinions on whether decoupling is a feasible tool among economists, politicians, and environmental experts. This is caused by the many ways to measure and define decoupling.

In an article by Hickel and Kallis in 2020, domestic material consumption, hereafter abbreviated DMC, is introduced as common metric for resource use in an economy. DMC is calculated by summing together the weight of all raw materials extracted within a country's borders, adding in imported material, and subtracting exported material. However, DMC does not consider the end products imported into the country, therefore omitting the raw materials used up in the country of origin and the impact of transportation. Material footprint (MF), on the other hand, adds these impacts back into the sum by considering the total consumption-based resource usage (Hickel & Kallis, 2020).

The issue with DMC is that it is used in multiple internationally recognized reports instead of MF, leading to underestimation of the reported countries' environmental impacts. For example, the OECD uses DMC to state that "Europe has reached decoupling", but when we do the calculations with MF, there seems to be no decoupling at all (Hickel & Kallis, 2020). This is illustrated in figure 3, which shows the gap between material use estimates done with DMC and MF. Additionally, according to Hickel and Kallis, the OECD's calculations leave out fossil fuels.

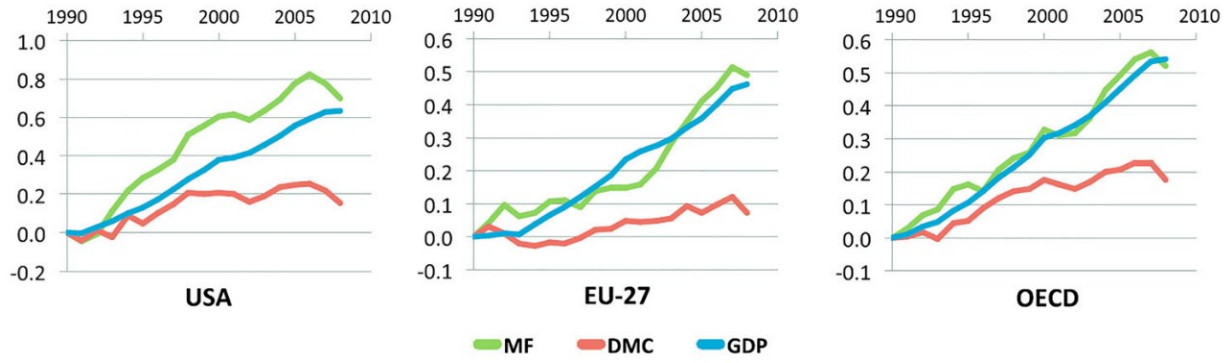

FIGURE 3: MATERIAL USE IN EU-27, OECD AND USA, 1990-2008. SOURCE: HICKEL & KALLIS, 2020.

These statements do no go unchallenged. Some economists, such as MIT professor Andrew Mcafee (Mcafee, 2020) have argued for decoupling as the winning strategy to combat climate change. In an opinion written for Wired, the author of *More from less* persuades the reader that resource efficiency and technological progress are the keys to alleviating the climate crisis by moving to dematerialization. He refers to the Environmental Kuznets curve (EKC), a highly disputed concept among researchers. The EKC illustrates the relationship between a nation's GDP and its environmental state (Victor, 2008). The idea is the following: as a nation emerges, it must grow, and therefore use up resources without much opportunity to consider externalities, causing emissions. However, when the economy grows beyond a sufficient level of income per capita, around $5000 to $8000, emissions will start to fall (Dasgupta et al., 2002). There are many explanations. Once the nation has its basic needs taken care of, it can afford to pay closer attention to environmental regulation, has advanced its technology, and can shift from goods to less resource-intensive services (Victor, 2008).

Mcafee writes that the EKC is a reality on air pollutants and water quality, a fact largely ignored by the degrowth movement. In his view, the EKC and improvements in eco-efficiency around the world are proof of degrowth, the purposeful downscaling of economic activities, being an unnecessary and unrealistic concept. This is where several other researchers' opinions differ. Jackson (2009) emphasizes that while the EKC applies to water quality and smoke, the same cannot be said about most materials, such as cement and iron ore used heavily in infrastructure, as well as carbon emissions. He adds that some level of economic downscaling is inevitable. Arrow et al (1995) agree, stating that the curve works for pollutants with short-term costs such as sulfur dioxide and particulates, but not to accumulating waster stocks or long-term pollutants like carbon dioxide. It is also highlighted that the EKC is unapplicable to resource stocks, nor does it consider potential substitution effects: using less of one pollutant may lead to increased use of another.

In addition to differing opinions on whether the EKC fits the data for even common pollutants, the methods behind it are debated too. Dasgupta et al (2002) point out the following issues. Firstly, quality data on conventional emissions and resource use is poorly available in some nations, not to mention the lack of regulation of potentially toxic pollutants. Also, often used cross-sectional analyses of

the curve have pointed towards EKC applying to pollutants like CO2, nitrogen oxides and sulfur dioxide, but when the regression was run with time series data, correlation between GDP growth and the amount of the pollutants was obtained.

Despite the controversy of these topics, Mcafee also argues for dematerialization as a natural process of technological improvements and firms' decisions to use them. He disagrees on the subject with Jason Hickel, a prominent proponent of degrowth, whose claims about a 50-billion-ton MF limit (Hickel & Kallis, 2020) are according to Mcafee not based on empirical evidence. Jackson (2009) has also commented on dematerialization. In his opinion, switching from goods to services will still require massive amounts of energy and it is questionable how much growth can be derived from a service-based economy in the end.

3.3.1 Decoupling, the growing population, and the IPAT formula

Reducing environmental impacts through dematerialization may be a trend in highly developed nations, but often not an option in emerging economies. Jackson (2009) highlight this in the following way: setting up infrastructure and growing the economy to create more opportunities and affluence to the population in developing countries is having a negative impact on relative decoupling: structural materials like iron ore, cement, and bauxite are seeing reductions in efficiency. With this, he notes that if projected population growth of 9 billion people by 2050 is to happen and all these people from emerging economies pursue the same living standards and opportunities as people in the EU today, carbon intensities would have to fall 16 times faster than the reduction rate has been since 1990. To give simple proof to this claim, he refers to the IPAT formula coined by Paul Ehrlich and John Holdren as "The Arithmetic of Growth" (Jackson, 2009, p. 53), which represents the impact of human activity on the natural world as

$$I = P * A * T,$$

where I is environmental impacts, P is the size of population, A is the affluence (income per capita) level, and T is the technology factor measuring the impact per a unite of GDP (Victor, 2008). T represents eco-efficiency, or relative decoupling, in the formula, while together P * A give GDP. If we were to rely on technological progress to make resource use more efficient, then T would have to decline faster than A and P together for there to be an actual reduction in I. However, in the past years both population and level of income have gone up (Jackson, 2009), meaning more consumers with more money to drive demand up. For absolute decoupling to happen, A and P also should decline. Both are controversial topics for policy; rising affluence is associated with higher human wellbeing and opportunities, while limiting the number of births can be viewed as a limitation to freedom and bodily autonomy. Jackson argues that both views are flawed: an increase in income does not automatically mean increase in happiness (especially if the increase is not evenly distributed within the population,

which is often the case) and the populations grow fastest in developing countries which lack information and contraception.

The IPAT formula, as most simple methods, has received criticism. It suggests that income per capita (A) and population size (P) are independent variables, which is often not the case (Victor, 2008). Therefore, Victor (2008) presents, efforts should be concentrated on reducing two or more of the variables together. He also notes that the equation is oblivious to the composition of GDP, so if a nation can produce services with less resources than it can produce goods, shifting towards services would make it seem like technology is improving, even if it is not. Given the fact that the IPCC estimates that for stabilizing emissions at the 450-ppm target, worldwide CO2 emissions would have to be reduced on average by 4,9% per year until 2050 (Jackson, 2009), it is ill-advised to only trust technological progress and ignore the impact of the growing population and average income. According to the IPAT formula, for technology to be the savior its effect on total impact would have to decline faster than affluence and population grow together.

3.3.2 The case of rebound effects

There are more reasons to not merely trust technological improvements to reduce emissions. A rebound effect refers to a situation where improvements in efficiency lead to savings of money or resources, enabling increased consumption or growth (van den Bergh, 2011). An example of rebound effects in this context is the Jevons Paradox, where efficiency improvements of resources or energy does not lead to conservation and reduction of consumption. On the contrary, the savings created by efficiency now fuel further growth, creating pressure to improve efficiency even further, forming a cycle (Hickel & Kallis, 2020). Other authors too have stated that efficiency improvements are not on their own enough to reduce environmental impacts, as their positive effects are overshadowed by the increase in the scale of economic activity enabled by them (Jackson, 2009). Another argument against eco-efficiency is the unpredictability of ecosystems. Victor (2008) brings attention to the tipping points of ecosystems, which, if realized, may cause collapse in crucial ecosystem services and be irreplaceable by technological substitution. Arrow et al (1995) also highlight the significance of ecosystem resilience to prevent the unknown consequences of such catastrophes. Because of the rebound effect, van den Bergh (2011) supports the approach of shifting externalities into consumer prices, since it would work as an incentive to change consumers' behavior.

4 Alternative systems

If green growth is a debatable solution for alleviating climate change, then what would be better? It is difficult to find an answer to this question. Tim Jackson calls for establishment of what he calls macroeconomics for sustainability, models that would not rely on growth as their engine. At the same time, he mentions that limitations on growth are the responsibility of the global North, while developing nations can still need growth to raise their standards of living (Jackson, 2009).

4.1 Degrowth and a-growth

To question growth, systems that ignore it have been proposed: degrowth and a-growth. Degrowth refers to purposely downscaling the economy. As the externalities caused by prioritizing growth over long-term damages are more and more obvious, a growing number of economists have begun to consider or even advocate for it. These advocates refer to lack of absolute decoupling as evidence of green growth's failure as the solution to climate change, leaving only reductions in consumption as the cure (Hickel & Kallis, 2020; Jackson, 2009). Degrowth circles around ideas such as work-time reductions and shared work, basic income, and shared living (Hickel & Kallis, 2020). However, degrowth may seem like a radical or communist-like idea to societies used to capitalism. In his criticism of degrowth, van den Bergh (2011) calls the concept indefinite and advises the use of more stringent environmental policy measures instead, since we cannot yet anticipate their effectiveness in the future. In his view, it would be a hasty decision to apply degrowth, as it is unclear what level of scaling down would be sufficient. However, this may be a dangerous statement, because as previously discussed, we should not trust that technological improvements will find some unforeseen solution to our problems in the future, but properly examine all viable action plans.

This is a big problem for degrowth: how to find the political support for it, when its concept clashes with the interests of those with economic or political power (Kallis et al., 2012)? One way is to talk about it in different terms. For example, Tim Jackson calls for macroeconomics for sustainability that would not rely on growth in his work (Jackson, 2009). This type of terminology, Kallis et al (2012) note, is easier for the public to digest than the term degrowth, which does not seem as appealing, as it often refers to voluntary simplicity of lifestyle and purposeful downscaling of economic activity. Additionally, their article calls it naive for degrowth proponents to expect the majority to voluntarily settle for less, when only a small fraction of the population is currently participating in a lifestyle with less. van den Bergh (2011) agrees, emphasizing that environmental policies without the term "degrowth" are more likely to gain political support, and therefore have a positive impact.

However, degrowth would not necessarily have to apply to all sectors of the economy or even target GDP growth directly. Selective degrowth emphasizes that growth in certain areas, such as renewable

energy, can be good, while degrowth should be focused on the heaviest polluters, such as fossil fuels (van den Bergh, 2011). Moreover, even its proponents do not see it as a permanent state, but more as an inevitable steppingstone towards a steady-state economy (Kallis et al., 2012).

Often brought up in the same context as degrowth is a-growth. Its idea is to ignore GDP entirely, and instead focus on actions, measurements, and policies that directly increase human and environmental wellbeing (van den Bergh & Kallis, 2012). The thought process behind this approach is that GDP cannot be trusted to effectively depict social or environmental wellness. Proponents of a-growth also argue that striving for growth is the main obstacle in the way of enacting effective environmental policies, and that removing this hurdle a green transition is easier (van den Bergh & Kallis, 2012). They note that economists often acknowledge the issues with the GDP measurement but argue that is has little impact and it serves a valuable indicator for economic policies and keep using it. This is what van den Bergh calls the "GDP paradox" (van den Bergh, 2011, p.886).

A-growth differs from degrowth in its regard of economic growth. A-growth is about opposing the indicator, not the phenomenon itself (van den Bergh, 2011). It accepts degrowth as a potential outcome of policy measures but does not strive for it. However, the two concepts share multiple proposed policy measures, such as reduced work hours, decentralizing the GDP figure from our newsfeed, and focus on indicators on human wellbeing. Another common factor in both systems is how to finance it. Here van den Bergh and Kallis (2012) suggest a tax on the wealthy.

It can be hard to imagine a time when economic growth does not dominate our daily lives, but this is a reality in Bhutan. The small Himalayan country provides a wonderful and inspirational example of prioritizing environmental sustainability and human wellbeing over economic growth. In Bhutan, instead of tracking GDP, the people follow Gross National Happiness, GNH (Gerber & Raina, 2018). A GNH index along with a GNH Policy Screening Tool was developed to map the country's progress and help its government to make decisions to stay on the right path. By focusing on GNH instead of GDP, Bhutan prioritizes its environmental and social goals, such as keeping at minimum 60 per cent of the country's land area under forest cover or limiting mining activities over the traditional economic growth opportunities its natural resources would provide it. In contrast to Bhutan, economic growth is often seen as an acceptable or even encouraged target in developing nations even by those supporting degrowth (Jackson, 2009; Victor, 2008).

If GDP was to disappear from its podium on the frontpages and environmental indicators replaced it, would public understanding and the sense of urgency for environmental policy increase? Could Western societies look up to Bhutan and shift their focus away from growth? On the other hand, would fiscal and monetary policy still be conducted in the same way? This is a topic that deserves more contemplation and publicity – especially as famous historical economists too saw a time that growth would come to a halt.

4.2 The use of sustainability indicators

The strength of GDP as an economic indicator is its globally recognized form and method of calculation (Thompson, 2020). It is simple enough to understand, as it is one number that people are familiar with and are used to looking at when determining economic health (regardless of its original purposes). On the other hand, there are numerous indicators of green growth from freshwater availability to changes in land use (OECD, 2019). Nevertheless, these figures are rarely seen in the news – when we open a mainstream news source, weekly numbers on air pollution exposure and aggregate CO_2 emissions do not pop up. The lack of publicity these indicators receive does not mean they should be excluded from the news stream – on the contrary. If a company evaluates its employees by number of profits, that is what the staff will strive for. However, if the object of measurement is customers' satisfaction, the focus is quite different. What we measure is a key factor in what we produce – hence the significance of having uniform, accurate, and well-known indicators for green growth (Victor, 2008).

5 Conclusions and discussion

Green growth is still a debatable concept. Even though it has been taken as a target in many nations and organizations, the empirical evidence to back it up is unclear. Especially absolute decoupling remains a controversial issue: can it be achieved fast enough, and with respect to which pollutants, resources, or phenomena? It seems that currently the answers are bleak. Still, sceptics and degrowth proponents do concede that green growth might be possible, but highly unlikely to happen fast enough to reach our targets of 1.5°C warming. They acknowledge that with paradigm-shifting technological improvements in the future that we cannot yet count on there could be new ways to reach absolute decoupling.

Either way, agreement on these crucial topics is lacking. How is it possible that climate change has been a known danger for so long, yet prominent researchers and public figures are still debating over what is needed to combat it? Those endorsing green growth make it seem like a silver bullet to our problems, which raises the question: why is green growth not the main strategy everywhere? The absence of consensus on the most effective, effortless, and realistic alleviation plan is surprising. It seems that further research on green growth is needed, as well as clarity on its definition and targets. A global consensus on the topic and publicity for few well-established environmental indicators measuring changes in natural capital would be a great goal for international leaders. In the meanwhile, it would be worth looking into degrowth and a-growth more closely, and as van den Bergh mentioned (2011), look for ways to attain public and political acceptance for these scary-sounding proposals.

As information about our economic systems' significance for the environment is a topic often left out of climate change discussions, education on the matter would surely be beneficial. Even if orthodox economics are important to learn, introducing more environmental perspectives and taking a critical view at economic growth also in business schools could be helpful to avoid blindly raising generations on the growth imperative. However, no matter what the economic system is, policies aiming for drastic emission reductions need to take place. Still, it is not too late to contemplate the best way forward.

References

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C. S., ... & Pimentel, D. (1995). "Economic growth, carrying capacity, and the environment." Ecological economics, 15(2), 91-95. https://doi.org/10.1016/0921-8009(95)00059-3

Dasgupta, S., Laplante, B., Wang, H., & Wheeler, D. (2002). "Confronting the environmental Kuznets curve." Journal of economic perspectives, 16(1), 147-168. https://www.aeaweb.org/articles?id=10.1257/0895330027157

Dual Citizen. (2016). "The Global Green Economy Index GGEI 2016". www.dualcitizeninc.com%0A.

Duncan, E. (2009). "Getting warmer". Special Report: Climate change and the carbon economy. The Economist. Retrieved 20 March 2022 from: https://www.economist.com/node/14994872/print

European Commission. "Delivering the European Green Deal". Retrieved 5 April 2022 from: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en.

Gerber, J. F., & Raina, R. S. (2018). "Post-growth in the global south? Some reflections from India and Bhutan". Ecological economics, 150, 353-358. https://doi.org/10.1016/j.ecolecon.2018.02.020

Hallegatte, S., Heal, G., Fay, M., & Treguer, D. (2012). "From growth to green growth-a framework" (No. w17841). National Bureau of Economic Research. https://www.nber.org/papers/w17841

Hickel, J., & Kallis, G. (2020). "Is Green Growth Possible?" New Political Economy, 25:4, 469-486, https://doi.org/10.1080/13563467.2019.1598964

IPCC. (2022) 'Climate Change 2022 Mitigation of Climate Change – Summary for Policymakers'.

Jackson, T. (2009). Prosperity without growth: Economics for a finite planet. Routledge. http://www.sd-commission.org.uk/publications.php?id=914.

Kallis, G., Kerschner, C., & Martinez-Alier, J. (2012). The economics of degrowth. Ecological economics, 84, 172-180. https://doi.org/10.1016/j.ecolecon.2012.08.017

Mcafee, A. (2020). "Why degrowth is the worst idea on the planet." Wired. Retrieved 20 March 2022 from: https://www.wired.com/story/opinion-why-degrowth-is-the-worst-idea-on-the-planet/

OECD. (2011), Towards Green Growth, OECD Green Growth Studies, OECD Publishing, Paris, https://doi.org/10.1787/9789264111318-en.

OECD. (2019), OECD Work on Green Growth 2019-20, OECD Green Growth Studies, OECD Publishing, Paris, https://issuu.com/oecd.publishing/docs/gg_brochure_2019_web

Schmalensee, R. (2012) 'From " Green Growth " to sound policies : An overview', Energy Economics, 34, pp. S2–S6. doi: 10.1016/j.eneco.2012.08.041.

Schweinfest, S., Alfieri, A., Chan, J. and Edens, B. (2021) 'The Rise, Fall and Rethinking of

Green GDP.' System of Environmental Economic Accounting, the United Nations. Retrieved 27 March 2022 from https://seea.un.org/news/rise-fall-and-rethinking-green-gdp

Stiglitz, J.E., Sen, A., Fitoussi, J.P. (2008). Report by the Commission on the Measurement of Economic Performance and Social Progress. Government of France.

The World Bank. (2013). "How Do You Measure Green Growth? World Bank & Partners Are Working on Indicators". Retrieved 5 April 2022 from: https://www.worldbank.org/en/news/feature/2013/04/04/creating-global-green-growth-indicators

Thompson, V. (2020) 'The Tragic Simplicity of GDP.' Berkeley Economic Review. Retrieved 27 March 2022 from: https://econreview.berkeley.edu/the-tragic-simplisticity-of-gdp/

UN environment programme. "About green growth". Retrieved 5 April 2022 from https://www.unep.org/explore-topics/green-economy/about-green-economy

Van den Bergh, J. C. J. M. (2011) 'Environment versus growth - A criticism of "degrowth" and a plea for "a-growth"', Ecological Economics, 70(5), pp. 881–890. doi: 10.1016/j.ecolecon.2010.09.035.

Victor, P. A. (2008). "Managing Without Growth: Slower by Design, Not Disaster." Edward Elgar Publishing. http://sarkoups.free.fr/victor2008.pdf

Woodford, M. (2001). "The Taylor rule and optimal monetary policy". American Economic Review, 91(2), 232-237. https://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.91.2.232.