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An Economy Transitioning from Brown to Green

Our current growth model and its impact on the natural environment "threatens the foundations of long-run growth and development" (OECD 2017c). With economic growth substantially depending on natural resource inputs and our planet containing only a finite amount of these, continuous growth is not a durable concept (Vavrek and Chovancova 2016). Thus, accomplishing a growth path that is "resilient, inclusive and sustainable" (OECD 2017b) is a top policy priority of our time. Green growth has been introduced as a paradigm allowing governments to re-ignite economic growth, implement climate goals and reduce inequality, positing that "these challenges are not mutually exclusive" (OECD 2017c). The OECD has identified the current years as a unique opportunity for allowing us to bring economic growth and environment agendas together (OECD 2017c).

DEFINING GREEN GROWTH

The United Nations Environment Programme defines a green economy as one where economic growth is enabled while environmental quality and social inclusiveness are increased (UNEP 2011b). Achieving green growth as a green economy means "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 2011). Besides defining green growth as a growth model which prevents environmental degradation, OECD and UNEP reports suggest that green growth has the potential to open up new channels of growth via productivity increases through greater efficiency of resource use, increased innovation, new markets being stimulated by demand for green technologies, stability due to reduced resource price volatility and fewer resource bottlenecks (OECD 2011; UNEP 2011b). However, even if the desirability of greening the economy is evident, the means of achieving such a transition remain to be fully understood.

The following section will consider an OECD framework which suggests that the ability to co-achieve economic, environmental and social progress depends on a country's capacity to achieve four main outcomes. These include: increasing the natural resource efficiency, maintaining the natural asset base, generating health benefits for society, while also generating economic opportunities (OECD 2017b). The OECD has developed a measurement framework identifying 26 indicators to capture the four main features of green growth. A partial overview of these is shown in Table 1.

Using this framework, the OECD report 'Green Growth' published in 2017 compares OECD and BRIICS countries over a time period of 1990–2015, depending on data availability. Luxembourg, Iceland, Denmark, Norway and the Netherlands have achieved the highest overall results for all four elements of green growth. However, it becomes evident that while countries achieve progress towards general green growth, they mostly succeed in one dimension of it rather than leading on all fronts. For example, in 2015 Iceland received the highest results in reducing exposure to air pollution, while little improvement in material productivity was noted. On the other hand, Denmark is a leader in environmental innovation and Luxembourg ranked first for improving material productivity, however in both countries the residents are exposed to more air pollution than in Iceland and Norway, for example. Thus the top performers vary substantially for each individual element and specific indicator. The following paragraphs will investigate the progress of OECD countries in the four central elements of green growth. A closer look will be presented at the environmental and resource productivity of the economy, since "in a resource constrained world, improving productivity is the only way to sustain growth prospects in the long-run" (OECD Stat 2016).

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Table 1

OECD Indicator Set for Green Growth

Ambitions	Green Growth Indicators
Environmental and Resource Productivity of the Economy	Carbon and energy productivity Resource productivity Environmentally adjusted multifactor productivity
Natural Asset Base	Renewable natural resource stocks Non-renewable natural resource stocks Biological diversity and ecosystems
Environmental Dimension of Quality of Life	Pollution and environmental risks Public access to environmental services
Economic Opportunities and Policy Responses	Technology and innovation Investment facilitating dissemination of technology and knowledge Production of environmental goods Prices, taxes and transfers Education

Source: OECD 2017b; author's analysis.

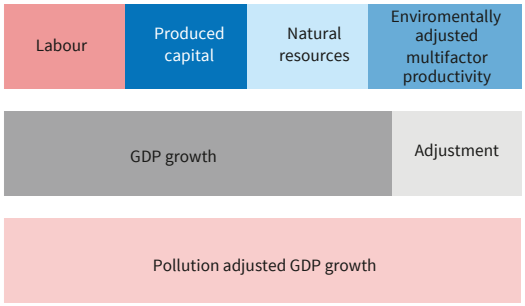
GREEN GROWTH INDICATORS

Environmental and Resource Productivity

In regards to the environmental and resource productivity of the economy, clear improvements have been made by the majority of OECD countries, but with great variation between them. One of the indicators used to assess environmental and resource productivity is environmentally adjusted multifactor productivity (EAMFP). EAMFP measures a country's ability to generate income from a given set of inputs, while accounting

Figure 1

Construction of 'Pollution Adjusted GDP Growth'



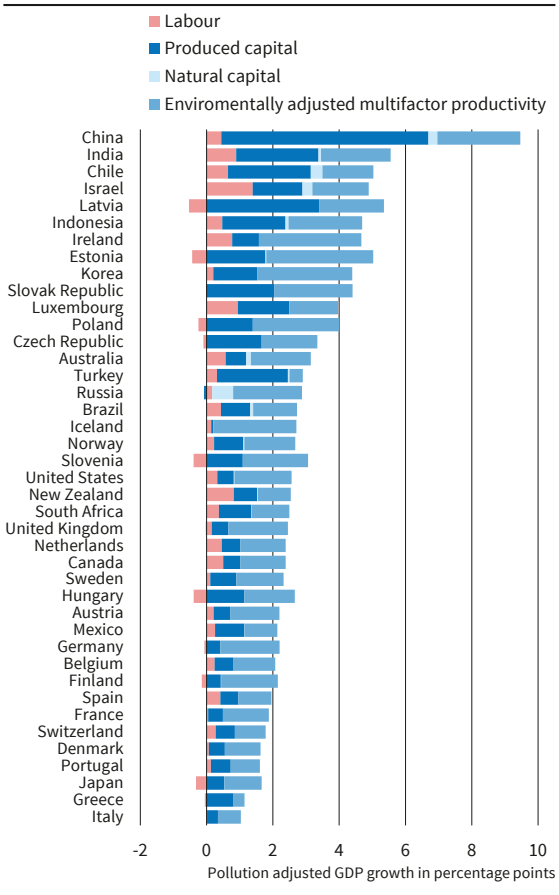
Source: OECD (2016); author's visualisation. © ifo Institute

for the consumption of natural resources and production of undesirable environmental by-products (OECD 2016). Together with the usual inputs labour, capital and natural resources, EAMFP equates to pollution adjusted GDP growth. Pollution adjusted GDP growth has been introduced as a new measure, expanding commonly used GDP growth to encompass environmental aspects of economic performance. Figure 1 illustrates how the measure is constructed. The adjustment itself can occur downwards or upwards and is based on the extent to which economic growth has occurred at the expense of environmental quality (OECD 2016).

As seen in Table 2, eight OECD countries (23%) and five BRIICS countries adjusted their GDP downwards when looking at averages from 1991–2013 (OECD 2016, author's calculations), meaning that in these countries a portion of growth occurred at the expense of environmental quality. For the majority of OECD countries (77%) and one BRIICS country, GDP growth was adjusted upwards, meaning that they managed to reduce the intensity of emissions of their economic growth. The greatest adjustment in proportion to the GDP growth level was achieved by Germany, Japan and Italy, all adjusting their GDP upwards by over 40%. Furthermore, growth accounting allows the sources of growth to be identified among labour, produced capital and natural capital. The share of pollution-adjusted GDP growth that cannot be explained by these three factors is distinguished as EAMFP. Figure 2 visualises the proportional inputs of the four factors, showing that the majority of pollution-adjusted GDP growth has been generated through EAMFP. Taking long-term averages from 1991–2013, four OECD countries exhibit a share of EAMFP of more than 80%, namely Finland with 85%, Germany with 84%, Iceland with 93% and Japan with 85% (OECD Stat 2016, author's calculations). The exact shares of EAMFP are also shown in Table 2.

Figure 2

Contribution of Inputs to Pollution Adjusted GDP Growth



Source: OECD Stat (2016); author's calculations. © ifo Institute

Looking at specific inputs, both carbon and material productivity of OECD economies have improved on average, meaning that more economic output is generated per unit of resources consumed. Regarding material productivity, OECD countries consumed an average of 416 kg of non-energy and 111 kg of energy material to generate USD 1000 of GDP in 2015 (OECD 2017b). At a consumption of 111 kg, the use of energy materials decreased by 22% since 2000. Regarding carbon dioxide, the average productivity for OECD countries increased by 53% from 2.55 USD/kg in 1990 to 3.91 USD/kg in 2014 (OECD 2017a). It is important to recall that these numbers are based on the carbon dioxide emissions produced in the country of reference. However, since most OECD countries are 'net importers' of carbon dioxide, one must consider demand-based productivity. Demand-based productivity is defined as the economic value generated per unit of carbon dioxide emitted during the production process of goods required to satisfy final demand. Thus it includes environmental flows embodied in imports and deducts those embodied in exports (OECD 2017b). While demand-based and production-based productivity started off at similar levels in 1995, demand-based productivity increased by only 29% until 2011, as opposed to the 35% increase of production-based productivity (OECD 2017a). Potential reasons for lower demand-based productivity increases include the displacement of energy-intensive production to non-OECD economies and the general growth of imports due to trade-related price benefits. Furthermore, progress from the

Table 2

Pollution Adjusted GDP Growth

Country	Adjustment in Percentage Points	Adjustment as a Share of GDP Points	EAMFP as a Share of Pollution Adjusted GDP Growth
Australia	-0.142	0.043	0.575
Austria	0.299	0.157	0.677
Belgium	0.272	0.151	0.606
Canada	0.027	0.011	0.565
Chile	-0.174	0.033	0.306
Czech Republic	0.693	0.272	0.519
Denmark	0.139	0.094	0.667
Estonia	0.086	0.019	0.703
Finland	0.237	0.134	0.854
France	0.309	0.197	0.740
Germany	0.685	0.475	0.838
Greece	0.078	0.077	0.300
Hungary	0.500	0.285	0.676
Iceland	0.028	0.010	0.926
Ireland	0.042	0.009	0.663
Israel	-0.264	0.051	0.347
Italy	0.303	0.418	0.670
Japan	0.415	0.449	0.843
Korea	-0.892	0.169	0.653
Latvia	0.232	0.051	0.407
Luxembourg	0.289	0.079	0.370
Mexico	-0.650	0.234	0.459
Netherlands	0.400	0.201	0.566
New Zealand	-0.091	0.035	0.392
Norway	0.194	0.078	0.574
Poland	0.065	0.018	0.693
Portugal	0.074	0.048	0.545
Slovak Republic	0.240	0.058	0.539
Slovenia	0.137	0.054	0.740
Spain	-0.084	0.041	0.508
Sweden	0.282	0.138	0.609
Switzerland	0.233	0.150	0.521
Turkey	-1.109	0.277	0.137
United Kingdom	0.334	0.160	0.746
United States	0.083	0.033	0.673
Brazil	-0.378	0.122	0.485
Russia	-0.741	0.073	0.741
India	-0.967	0.148	0.379
Indonesia	-0.252	0.051	0.473
China	0.214	0.083	0.265
South Africa	-0.170	0.064	0.457

Source: OECD Stat 2016; author's calculations.

demand perspective is more challenging since emissions per capita are highly correlated with living standards, while domestic production emissions reflect the structure and energy intensity of the economy (OECD 2017b).

Natural Asset Base

Maintaining the natural asset base is the second ambition of the OECD framework. In this regard, it is important to acknowledge that land resources make up a key component of our economy and ecosystems. Nonetheless, the market value of land greatly drives construction, and deforestation has thus harmed ecosystems and biodiversity globally. In comparison to 1990, construction now covers 30% more land, which is an increase equivalent to the size of the United Kingdom (OECD 2017b). The average change in construction area from 1990–2014 for BRIICS countries has been an increase of 65.2% as opposed to 31.6% for OECD countries. India has almost doubled its built-up area with an increase of 96.3% (OECD 2017a). With the exception of Argentina, Australia, Costa Rica, Israel, Luxembourg and Saudi Arabia, the majority of countries experience an increase in the built-up area per capita, such that the built-up area growth surpassed population growth (OECD 2017a).

Forest resources, freshwater resources, as well as biodiversity and ecosystems are also important features of the natural asset base. While the use of forest resources has been stable and managed sustainably, freshwater resource endowments vary greatly and local water scarcity remains a concern. Also wildlife and ecosystems remain threatened. Thus, the goal of balancing economic, social and environmental objectives remains.

Environmental Dimension of Life

Third, looking at the environmental dimension of quality of life, air pollution presents the primary environmental health risk worldwide. While there are various pollutants to consider, fine particulate matter (PM2.5) is a commonly studied one. The WHO Air Quality Guideline considers annual average PM2.5 exposure to be acceptable under a threshold of ten micrograms per cubic meter. Only 12 OECD countries (34%) are able to meet this standard, namely Australia, Canada, Estonia, Finland, Iceland, Ireland, Latvia, New Zealand, Norway, Portugal, Sweden and the United States (OECD Stat 2017). Among OECD countries as of 2015, Iceland has the lowest exposure with 2.9 micrograms per cubic meter and Korea has the highest exposure with 32 micrograms per cubic meter. In the OECD area, exposure to PM2.5 is estimated to cause around half a million premature deaths yearly, with an annual welfare cost equivalent to 3.8% of GDP (OECD 2017b). Thus, green growth proponents suggest that more ambitious policies in regards to air pollutants would generate growth benefits alongside environmental benefits.

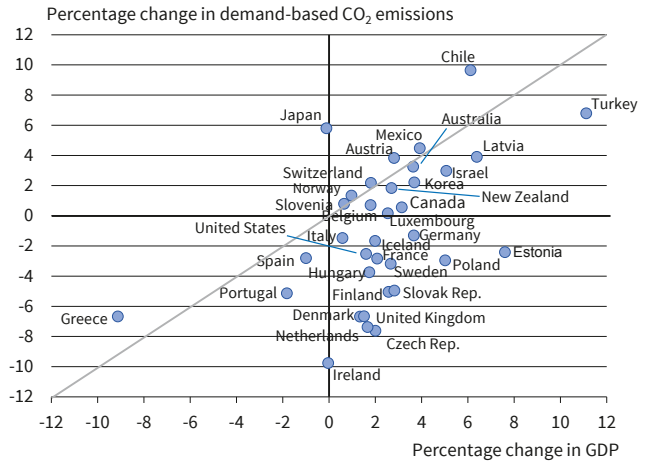
Economic Opportunities

Fourth, considering economic opportunities, it is at the centre of the green growth model to develop markets

for environmentally related products, incentivise innovation across the economy and strengthen green taxation. While R&D budgets are rising, the share devoted to environmental research has remained stagnant. The majority of green inventions (90%) have traditionally originated from OECD countries, however recently the number of contributions from China and India are rising (OECD 2017b). Furthermore, trade in environmentally related products increased in more than 20 countries between 2002 and 2015 and with it the demand for pollution prevention and abatement products. Meanwhile, these countries also experienced economic growth, suggesting that trade in environmentally related products can go alongside economic success. A UNEP report argues that orienting the market towards pollution containment drives the economy in a more efficient direction (UNEP 2011b). In addition to trade, the environmental goods and services sector (EGS)[2] influences employment, since its share of the overall economy is growing and with it the number of jobs it provides.

Figure 3

Environmental and Economic Decoupling
2010–2011



Source: OECD Stat (2016); author's calculations.

CAN ECONOMIC AND ENVIRONMENTAL GOALS CO-EXIST?

While environmental concerns and considerations are rising, the question remains how successfully economic success and environmental sustainability can co-exist. A measurement of decoupling can be used as a means of evaluating the compatibility of the two goals. Decoupling is defined as "reducing the amount of resources used to produce economic growth, and delinking economic development from environmental deterioration" (UNEP 2011a). Carbon productivity is often used as the reference for environmental deterioration, while GDP growth is typically used to indicate economic success.

When assessing decoupling, one can distinguish between relative decoupling, absolute decoupling and recessive decoupling. Relative decoupling occurs, for example, when carbon dioxide emissions increase at a lower rate than real GDP, meaning that the association between growth and the environment is positive, but its elasticity is below one (Mugdal et al. 2010). Absolute decoupling on the other hand is achieved when economic growth is entirely untied from environmental pressures (OECD 2017b), such that emissions remain steady or decrease while economic growth is achieved (Burton 2015). To achieve the goal of keeping the global-temperature rise below 2˚C (United Nations 2016), absolute decoupling is required. Recessive decoupling occurs when environmental and economic growth rates decrease, but the environmental emissions rate decreases more rapidly than GDP growth. These levels of decoupling and their corresponding elasticity values (e)

$$e = \frac{\%\Delta\ CO_2\ Emissions}{\%\Delta\ GDP}$$

are shown in Figure 3 for all OECD countries in 2011 (OECD Stat 2016, author's calculations). The set-up of the diagram is an alteration of a decoupling study by Tapio (2005) based on transport volume and economic growth. Demand-based emissions are used as the environmental indicator and GDP growth as the economic indicator.

We can see in Figure 3 that nine OECD countries experience relative decoupling, 16 achieve absolute decoupling and two experience recessive decoupling. Of the remaining eight countries which do not fall into any of the previously mentioned categories, five (Austria, Mexico, Norway, Slovenia and Switzerland) lie very close to the 45˚line, and can thus be considered as coupling since both the environment and the economy develop at similar rates. Three countries however, Japan, Chile and Greece achieve negative decoupling. Negative decoupling occurs when the change in the environmental measure is evaluated as 'worse' than that of the economy, namely: emissions increase at a faster rate than GDP (relative, Chile), both emissions and GDP decrease however GDP decreases at a faster rate (recessive, Greece), or emissions increase while GDP decreases (absolute, Japan).

It is important to acknowledge that alternative measures of decoupling, different periods of time, as

[2] Specific industries within this sector include waste management and sewerage.

well as different indicators for environmental change may influence the analysis and conclusions (Wang et al. 2013). Also, in addition to decoupling as a concept to promote the co-existence of economic and environmental success and a measure of their compatibility, other approaches include eco-efficiency, de-materialisation, materialisation and de-linking (Vavrek and Chovancova 2016).

CONCLUSION

The cross-thematic analysis of the four central factors of green growth, as presented by the OECD, suggest that progress towards green growth has been achieved. Furthermore, the decoupling analysis indicates that in the majority of cases this is achieved simultaneously with the maintenance of economic success. But is green growth enough, given the increasing demand, production and population levels? A UNEP report responds by arguing that, while it may be "less than business as usual" in the short run, it will "outperform business as usual" in the long run by both traditional GDP growth measures as well as more holistic GDP per capita measures (UNEP 2011b). Nonetheless, while we may combine all our efforts to incorporate environmental considerations into our growth model, resources as inputs continue to remain finite. Therefore, complementing resource-efficient policies and regulations as a society with concepts such as sufficiency and collective use is of great importance.

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