

# Greening Prosperity Stripes 2: Consumption-Based Refinement

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# Greening Prosperity Stripes 2: Consumption-Based Refinement

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## Abstract

This paper is a sequel to my ‘greening prosperity stripes’ article, Mihailov (2026). It refines the calculation of these illustrative color stripes to take into account consumption-based, or trade-embodied, carbon dioxide (CO<sub>2</sub>) emissions, not production-based CO<sub>2</sub> emissions as in the earlier study, thus revealing the influence of, in particular, offshoring polluting industries. Yet, the refined indicator comes at the cost of losing nearly half of the countries in the world and most country groupings in the World Bank classification, due to unavailability of such data. Nevertheless, it offers a more precise – and, perhaps, fairer – image, relative to the original production-based greening prosperity stripes, of how green(ing) is the prosperity for most countries in the world. The novelty of this sequel paper consists in illustrating clearly the difference between the two indicators of greening prosperity, in pairs of comparative graphs. Because images and colors have power to impress human minds deeper than words, the greening prosperity stripes, in addition to raising awareness and mobilizing immediate climate policy action worldwide, can essentially be used to track the progress of each country in comparison with other countries toward the goal of net zero. Ideally, an annually updated public-domain website could serve this crucial monitoring function at a global scale in a straightforward way with immediate online illustration and verification.

*Keywords:* consumption-based (or trade-embodied) greening prosperity stripes and maps; production-based greening prosperity stripes and maps; comparative colormap data visualization; communicating science to raise public awareness; tracking progress to net zero

*JEL codes:* C82, F64, O44, Q51

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# 1 Introduction

Global warming has been unprecedented over the past few years in terms of the recorded history of average annual or monthly temperatures across the world. There is also by now consensus that a considerable part of it is human caused, mostly by increasing emissions of greenhouse gases (GHG) since the time of the Industrial Revolution, and especially during the latest few decades. An awareness in research and the wider society has been gradually established, more and more since the 1970s (see, e.g., Keeling et al. (1976)) that it is high time for humanity to take responsibility and reverse as much as possible the negative trends and effects of climate change.

Against such a background, the relationship between economic development or growth, or – less so – life expectancy, and carbon dioxide (CO<sub>2</sub>) emissions, or – less so – GHG emissions, has generated a large literature. But Mihailov (2026)<sup>1</sup> was the first study that proposed to link real gross domestic product (GDP) per capita, as a typical measure of economic prosperity approximating social welfare, and CO<sub>2</sub> emissions per capita, as a typical measure of GHG emissions approximating environmental pollution, in a ratio by country expressed in visually comparable stripes of colors. This new indicator of macroeconomic and environmental trade-offs was denoted as ‘greening prosperity’ and expressed either as color stripes over time per country or region or as country colors for a given year on the map of the world. The specific color nuances are assigned depending on the value of the indicator and, thus, allow straightforward comparison of where a country is and how it has been moving across time at the scale of a common ‘measuring stick’, i.e., the palette of 16 color nuances shown in the right-hand side of the stripe graphs (that will be analyzed later). The aim of the original study was to define an intuitive visual representation for a widely accepted indicator of ‘greening prosperity’ and thereby track down, via the color stripe and map comparisons, progress toward the goal of net zero for any country or group of countries.

This sequel paper refines the calculation of the color stripes by taking into account consumption-based, or trade-embodied, CO<sub>2</sub> emissions, not production-based CO<sub>2</sub> emissions as in the earlier article. In particular, the visual comparison of the two versions of stripes picks up the effects of offshoring polluting industries, as well as a cleaner domestic production structure and/or faster transitioning to renewable sources of energy. The refined indicator has a cost though, namely that almost half of the countries in the world and most country groupings in the World Bank classification are lost in the calculation due to missing data. The refined greening prosperity stripes also have a benefit, namely that they paint (literally, paint!) a more precise image, relative to the original production-based greening prosperity stripes, of how green(ing) is the prosperity for most

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<sup>1</sup>Indeed, the earlier discussion paper version, Mihailov (2023).

– even if not all – countries in the world. The novelty of this sequel paper consists in illustrating clearly the difference between the two indicators of greening prosperity, in pairs of comparative graphs. Because images and colors have power to impress human minds deeper than words, the greening prosperity stripes help raising awareness and mobilizing immediate climate policy action worldwide. Moreover, and as suggested, the stripes and maps in their refinement here using consumption-based or trade-embodied CO<sub>2</sub> emissions per capita can essentially be employed intuitively and compellingly to measure progress by country or region toward the goal of net zero. Ideally, an annually updated public-domain website that allows easy visual comparisons across countries could serve this crucial monitoring function at a global scale in a straightforward way with immediate online illustration and verification.

In this section, we briefly mention a selection of background literature that relates most closely to our two studies, the original and the sequel. For more details and additional citations, we would refer to Mihailov (2026).

As discussed in the latter article, the scientific literature on the so-called ‘greenhouse effect’ is about two centuries old. Dobes et al. (2014) trace down its origins to Fourier (1827/2013) and Tyndall (1861). In economics, Arrhenius (1896) was the first to raise the issue about the effect of anthropogenic carbon emissions on the global climate. Dobes et al. (2014) survey the subsequent literature in economics decomposing it into three strands: (i) on trends in climate change, the oldest chronologically – e.g., Keeling et al. (1976) measured the concentration of atmospheric CO<sub>2</sub> at Mauna Loa Observatory, Hawaii, to document the effects of the combustion of coal, petroleum, and natural gas on the distribution of CO<sub>2</sub> in the atmosphere, and found that the annual average CO<sub>2</sub> concentration rose by 3.4% between 1959 and 1971; (ii) on mitigation of climate change, where the field of environmental economics gained more prominence after the first oil price shock in the early 1970s, e.g., d’Arge et al. (1982), Edmonds and Reilly (1983a), Edmonds and Reilly (1983b); and (iii) on adaptation to climate change, where the policy concerns regarding urgent global action became increasingly more acute since the late 1980s and the early 1990s, e.g., with the development of the dynamic integrated climate economy (DICE) models and the regional integrated climate economy (RICE) models of Nordhaus (1993) and Nordhaus and Yang (1996), as well as, more recently, Stern (2008) and many studies that followed.

The earliest formalized awareness of the concern about limited and exhaustible natural resources appears to have been proposed by Hotelling (1931). A second wave in this literature spurred in the 1970s and a third wave followed in the 1990s, notably with Grossman and Krueger (1991, 1993, 1995), defining the environmental Kuznets curve (EKC), first in their 1991 NBER working paper, by analogy with the work of Kuznets (1955) relating economic growth to income inequality (see also Acemoglu and Robinson

(2002) on the political economy of the original Kuznets curve). According to the EKC hypothesis, as also claimed in the survey by Dinda (2004), p. 431 (abstract), there exists “an inverted-U-shaped relationship between different pollutants and per capita income, i.e., environmental pressure increases up to a certain level as income goes up; after that, it decreases.” Dinda (2004) provides an overview of the EKC literature, its history, insights, policy as well as its conceptual and methodological critiques, and summarizes this literature (up to 2004) in the sense that “evidence for the existence of EKC is inconclusive.” (p. 450).

Only very few papers in the very recent literature have attempted to take account of the differences in the production-based vs consumption-based measurement of CO<sub>2</sub> emissions, e.g., Ritchie (2019). Her analysis does not extend, however, to formulating indicators or stripes capturing the trade-offs and tensions between economic well-being and CO<sub>2</sub> emissions. Some other papers (co-)authored by the same researcher along similar lines are also worth mentioning, e.g., Ritchie (2021) and Ritchie et al. (2023). Again, there is no much overlap with our work and the objectives and visualizations in our approach remain novel and insightful, as we shall illustrate and discuss further down.

Similarly to the resource and environmental economics literature just outlined, the measurement and theory of macroeconomic indicators and price and quantity indexes is now more than a century old too: see, e.g., Mitchell (1913), Fisher (1921), Kuznets (1934), Leontief (1936), Burns and Mitchell (1946), Koopmans (1947), Kaldor (1961). But, to keep focus, we would not engage here in providing an overview of the rich and well-known history of these contributions. We would rather pass next directly to describing the methodological design and construction of our novel visual indicator that captures economic prosperity relative to CO<sub>2</sub> emissions for any country or region with available data as gradually ‘greening’ (or ‘browning’) over time.

The paper is hereafter structured as follows. Section 2 provides the theoretical basis that defines our new color indicator of macroeconomic and environmental trade-offs, distinguishing between two possible methodological approaches in constructing it: the production-based approach, as in the original study of Mihailov (2026), vs the consumption-based, or trade-embodied approach, which is the refinement proposed in the present sequel paper. Section 3 provides our visualizations and their analysis, emphasizing the usefulness of the color stripes in depicting clearly progress and tensions along the road to net zero for any country or region and in arriving at some conclusions to guide policies. The final section concludes, and a supplementary online appendix provides further details and illustrations.

## 2 Methodology and Data

This section draws heavily on a similar section in Mihailov (2026). However, it differs in that the refinement of the greening prosperity ratio (GPR) and its numerator and denominator is explicitly added and discussed. We have preserved the logic of exposition and the main theoretical arguments, but have enriched them with providing a parallel of the differences in the original production-based approach of defining the GPR vs its consumption-based or trade-embodied refinement here in this sequel paper. This is an improvement that most would agree arises because of a fairer attribution of who emits CO2 in production for consumption elsewhere.

### 2.1 Theory

This subsection is almost identical with the corresponding one in Mihailov (2026), but for the sake of completeness, we repeat it with minor edits, as necessary to incorporate the refinement of the approach undertaken in this sequel paper.

Mathematically, we aim at an indicator that is some function of variables changing over time  $y_t(\dots)$ . The arguments of the function may potentially be several, and the functional forms may potentially be several too. The simplest and most obvious approach we pursue hereafter is to impose a general function of two arguments  $y_t(x_t, z_t)$ , where  $x_t$  is some measure of economic prosperity and  $z_t$  is some measure of the degree of environmental pollution, with the respective partial derivatives as

$$\frac{\partial y_t(x_t, z_t)}{\partial x_t} > 0 \text{ and } \frac{\partial y_t(x_t, z_t)}{\partial z_t} < 0 \quad (1)$$

The specific functional form that satisfies the above conditions can be, in its simplest expression, just a ratio

$$y_t(x_t, z_t) = \frac{x_t}{z_t} \quad (2)$$

where  $x_t$ , some measure of prosperity in real value per capita, will tend to grow over time, while  $z_t$ , some measure of environmental pollution in real value per capita, will tend to decrease over time, ultimately reaching a minimum of a unit, the latter defined as virtually zero pollution. So, as  $z_t \rightarrow 1$ ,  $y_t \rightarrow x_t$ , with the limit defining completely green – i.e., unpolluted, clean or ‘undiscounted’ (by detrimental emissions) – prosperity in real value per capita.

To translate the above prosperity indicator discounted by the degree of harmful emissions into a colormap stripes image, one needs to define a function capturing the global minimum and the global maximum in a dataset, represented as a matrix  $\mathbf{M}$ , ideally a balanced panel of countries (and country groups) as rows,  $\mathbf{M}_j$ , of the matrix,

$j = 1, 2, \dots, J - 1, J$ , and years as columns of the matrix,  $\mathbf{M}_t$ ,  $t = 1, 2, \dots, T - 1, T$ . Then each element of the matrix,  $m_{jt}$ , is a country-year observation, each row of the matrix,  $\mathbf{M}_j$ , is a country  $j$  evolving over time, and each column of the matrix,  $\mathbf{M}_t$ , is a cross section in year  $t$ . Now there are two straightforward ways to define the stripes, depending on their desired number  $n = 1, 2, \dots, N - 1, N$  in a colormap image.

One can determine the range,  $R$ , between the *global* maximum,  $Max(m_{jt})$ , and the *global* minimum,  $Min(m_{jt})$ , in the dataset matrix  $\mathbf{M}$  as

$$R \equiv Max(m_{jt}) - Min(m_{jt}), \text{ for all } j = 1, \dots, J \text{ and all } t = 1, \dots, T \quad (3)$$

as we do in our subsequent visualization of the proposed colormap stripes by countries over time to ensure direct comparability<sup>2</sup>, and then allocate to it the respective number of desired colors (and nuances) as *stripe*  $S$  (we chose  $N = 16$ ):

$$S \equiv \frac{R}{N} \quad (4)$$

Alternatively, one can wish instead to focus on a *particular country* stripes  $s$  as they are evolving over time, and the respective definitions then involve the particular country vector only in defining the *country* (or *local*) maximum,  $\max(m_j)$ , and minimum,  $\min(m_j)$ , range  $r_j$ , and stripe  $s_j$ :

$$r_j \equiv \max(m_j) - \min(m_j), \text{ for a given } j \text{ and } t = 1, \dots, T \quad (5)$$

and

$$s_j \equiv \frac{r_j}{N} \quad (6)$$

The above is a *time-series* stripe representation or visualization, i.e., for a country  $j$  over time – but such colors, while more in number for a typical country than under the global scale just introduced, are not comparable across countries, so we do not use it in this paper as well as in Mihailov (2026).<sup>3</sup> Another perspective can present the *cross-section* stripe visualization in a plot of sequences of stripes or on the world map, i.e., for all countries in a given year  $t$ , with respectively defined variables  $\max(m_t)$ ,  $\min(m_t)$ ,  $r_t$ , and  $s_t$  – but such colors are not comparable across years, as is the case under the preferred global scale:

$$r_t \equiv \max(m_t) - \min(m_t), \text{ for a given } t \text{ and } j = 1, \dots, J \quad (7)$$

and

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<sup>2</sup>Illustrated further down in the present paper as well as in Mihailov (2026).

<sup>3</sup>We, however, do illustrate this visualization too in Mihailov (2023).

$$s_t \equiv \frac{r_t}{N} \quad (8)$$

The colormap stripe definitions suggested here above can each be winsorized in several ways, and we exploit one such winsorization, at 5% and 95%, in two versions: (i) a ‘static’ winsorization, as in Mihailov (2026) for the last year with relatively complete data for most countries in our panel, 2020, illustrated in all figures to follow in the main text; and (ii) a ‘dynamic’ winsorization, illustrated in the appendix and not appearing in Mihailov (2026), where the 5 and 95 percentiles are preserved but instead of using the respective 2020 distribution for the involved variables (that is, the GPR, its numerator and its denominator), we use the respective global panel data distribution for the same variables. Winsorization is undertaken essentially to allow sharper comparison by enhancing visibility in the sense of ‘forcing’ the display of more colors (compared to the same approach without winsorization) within the chosen palette, as will also be discussed and illustrated in the figures coming later on.<sup>4</sup>

## 2.2 Measurement

We now define our indicator of ‘greening prosperity’ more precisely, that is, with view to the available – and comparable across countries – data. In this respect, and differently from the original article, Mihailov (2026), we hereafter distinguish two possible methods of computing the greening prosperity ratio as well as, and depending on, the measurement of its numerator and denominator: a consumption-based refinement over the initial production-based calculation. One possible, still general, definition consistent with equation (2) could be

$$G_{Yt} \equiv \frac{Y_t}{E_t} \quad \text{or} \quad G_{Lt} \equiv \frac{L_t}{E_t} \quad (9)$$

where  $G_{Yt}$  is some measure of ‘greening prosperity’, defined with reference to or use of  $Y_t$ , which is some measure of well-being or welfare per capita (could even be, more generally, some measure of quality of life or general health or longevity, such as life expectancy at birth, possibly denoted with a different letter, e.g.,  $L_t$ ), relative to  $E_t$ , which is some measure of harmful emissions in the environment per capita (could even be, more

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<sup>4</sup>The dynamic winsorization moves the 5 and 95 percentiles capturing the top and bottom colors in the right-hand side palette scale when adding new years and new data to the panel data set, and in this way always splits the 16 color nuances across a range of varying magnitude, consistent with the theory of measurement we propose. In effect, it preserves the allocation of all 16 color nuances within this same spectrum no matter how big the gap between the 5 and 95 percentiles is, in each vintage of extended data samples. The static winsorization, taking the 5 and 95 percentiles of the 2020 distribution of each of the measured variables as a benchmark or anchor, by contrast, avoids this ‘drift’, and results in color stripes that deviate further and further when new data are arriving with reference to the anchor, or benchmark, 2020 distribution for each measured variable.

generally, some measure of environmental pollution or degradation, denoted by a different letter, e.g.,  $P_t$  or  $D_t$ ). For both the numerator and the denominator in the above ratio there seem to be several obvious candidates. For the numerator, one could use real GDP per capita (pc) or real gross national income (GNI) pc or real consumption pc (all measured so as to be comparable internationally) or life expectancy at birth (comparable internationally). For the denominator, one could use a general measure of harmful emissions, such as caused by GHG, which are several,<sup>5</sup> or the largest share of these GHG, which belongs convincingly (as the numbers just mentioned in the footnote indicate) to CO2 emissions. However, CO2 emissions (as well as GHG emissions, more generally) could be measured either based on the location/country where the production of certain goods and services occurs and so CO2 is emitted, or based on the location/country where the consumption of the same goods and services ultimately takes place. Exactly along such a dimension is our refinement of the original greening prosperity stripes proposed here, in this sequel paper, accounting for the consumption-based measure of CO2 emissions, which appears to reflect a fairer attribution, via the location of final consumption, of the ‘guilt’ of originating CO2 emissions, even if via production of goods and services elsewhere in the world. Accordingly, accommodating this difference we introduce now, the still general definition in equation (9) may specialize as:

$$GPBProd_{Yt} \equiv \frac{RGDPpc_t}{GHGEProdpc_t} \quad \text{or} \quad GPBCons_{Yt} \equiv \frac{RCons_{pc_t}}{GHGECons_{pc_t}} \quad (10)$$

where  $GPBProd_{Yt}$  is greening prosperity defined *broadly* in terms of real GDP pc,  $RGDPpc_t$ , ‘discounted’ (or ‘deflated’) by (or ‘corrected’ for or ‘cleaned’ from) production-based GHG emissions pc,  $GHGEProdpc_t$ ; and  $GPBCons_{Yt}$  is greening prosperity defined *broadly* in terms of real consumption pc,  $RCons_{pc_t}$ , ‘discounted’ by consumption-based (or trade-embodied) GHG emissions pc,  $GHGECons_{pc_t}$ ;

or:

$$GPNProd_{Yt} \equiv \frac{RGDPpc_t}{CO2EProdpc_t} \quad \text{or} \quad GPNCons_{Yt} \equiv \frac{RCons_{pc_t}}{GHGECons_{pc_t}} \quad (11)$$

where  $GPNProd_{Yt}$  is greening prosperity defined *narrowly* in terms, again, of real GDP pc,  $RGDPpc_t$ , but now divided by production-based CO2 emissions per capita,

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<sup>5</sup>The Kyoto Protocol to curb GHG emissions, signed by 39 developed economies in 1997, covered carbon dioxide, accounting for 82% of total anthropogenic GHG emissions from developed countries in 1995, according to UNEP (1999/revised 2002), methane (with 12%), nitrous oxide (with 4%), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride, as cited in, e.g., Bengochea-Morancho et al. (2001), p. 165, and updated online at UNEP (1999/revised 2002): <https://www.unep.org/resources/report/climate-change-information-kit>.

$CO2EProdpc_t$ ; and  $GPNCons_{Yt}$  is greening prosperity defined *narrowly* in terms, now, of real consumption pc,  $RCons_{Yt}$ , divided by consumption-based (or trade-embodied) CO2 emissions per capita,  $CO2EConspc_t$ .<sup>6</sup>

To keep simplicity and in continuity of our choice made in the original article, Mihailov (2026), we employ in this sequel study hereafter the – ‘measurement’ or ‘empirical’ – definition in equation (11). Differently from Mihailov (2026), we now add the refinement of the consumption-based or trade-embodied attribution of CO2 emissions per capita, which results in the refined version of our three types of color stripes per country in the present sequel. Further down we also show together in parallel for comparative purposes the images resulting from either methodological variation. As is well-known in the literature, data for CO2 emissions are more widely available for all countries in the world than the corresponding, and more encompassing in terms of harmful gases, GHG emissions. We, nevertheless, keep in mind any alternative definitions in the equations above for future exploration.

As noted in Mihailov (2026),<sup>7</sup> one advantage of our choice to define greening prosperity as in equation (11) is that it is thereby measured in a way allowing for an intuitive interpretation, namely, real GDP pc or real consumption pc (in constant PPP international USD), respectively under the production- or consumption-based approach, ‘discounted’ by the degree of CO2 emissions (in metric tons), production-measured or consumption-measured, respectively.<sup>8</sup> To define the goal of ‘net zero’, the metric tons in the typical measure of CO2 emissions per capita could be expressed as kilograms – or even grams – and the minimum defined at unity, as already suggested: the net zero greening prosperity ratio, then, has a denominator of 1 and, thus, does not discount anymore the value of ‘pure’ or ‘green’ economic prosperity per capita.

## 2.3 Data

Table A1 in the appendix presents the World Bank list of all 217 countries in the world, plus 49 country groupings or regions (with their number of ordering, name and country or group code), which we could potentially use hereafter in a comprehensive comparative visualization. The World Bank provides highly comparable time series of real GDP pc and real consumption pc in international constant US dollars for the majority of

<sup>6</sup>An alternative definition of welfare or life quality and the related greening prosperity indicator may use the same two versions of the denominator, as in equations (10) and (11) and with the production-side vs the consumption-side alternative measurement of detrimental emissions, but with a different measure in the numerator, e.g., life expectancy at birth, as was mentioned: see Mihailov (2023) for more details and some illustrations of such an indicator.

<sup>7</sup>And the earlier versions of the same article as a detailed discussion paper, Mihailov (2023) and a dense policy column, Mihailov (2024).

<sup>8</sup>In the environmental literature, such a definition is usually interpreted as the carbon intensity of output of a country.

countries in the world and applying the methodology of purchasing-power parity (PPP) exchange-rate conversion at annual frequency since 1990. To ensure better precision and comparability, we employ exactly this PPP-USD World Bank time series. In particular, and as in Mihailov (2026), for the production-based GPR calculation we used the World Bank indicator ‘GDP per capita, PPP (constant 2017 international \$)’, with code NY.GDP.PCAP.PP.KD;<sup>9</sup> for the consumption-based GPR calculation we used the World Bank indicator ‘Households and NPISHs<sup>10</sup> Final consumption expenditure per capita, PPP (constant 2021 international \$), with code NE.CON.PRVT.PP.KD’.<sup>11</sup>

For the production-based CO<sub>2</sub> emissions, as in Mihailov (2026), we used again, for continuity and comparability, the World Bank indicator ‘CO<sub>2</sub> emissions (metric tons per capita)’ with code EN.ATM.CO2E.PC.<sup>12</sup> Our data on consumption-based CO<sub>2</sub> emissions per capita are downloaded from the website of Our World in Data, in particular in relation to their Global Carbon Project.<sup>13</sup> Consumption-based emissions are calculated as ‘domestic’ or ‘territorial’ emissions that have been adjusted for trade. The adjustment takes production-based emissions as a starting point, then subtracts from them emissions embedded (or embodied) in exports, and adds emissions embedded (or embodied) in imports.

In effect, consumption-based emissions attribute the emissions generated in the production of goods and services according to the location or country of their final consumption, rather than where they were produced. If a country’s consumption-based emissions are higher than its production emissions it is a net importer of carbon dioxide. If its consumption-based emissions are lower, then it is a net exporter. Consumption-based emissions are not available for all countries because not all countries have sufficient, high-quality trade data. But those without complete data are a small fraction (3%) of the global total.<sup>14</sup>

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<sup>9</sup><https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD>. While the World Bank has very recently switched from 2017 PPP-USD to 2021 PPP-USD in this same measurement, we kept the 2017 PPP-USD measurement of the production-based GPR calculation, that is, for its numerator of real GDP pc, to ensure that the production-based approach remains the same as in Mihailov (2026).

<sup>10</sup>In the System of National Accounts, non-profit institutions serving households (NPISH) are defined as institutions that provide goods and services either free or below market prices, mainly derive their income from grants and donations and are not controlled by the government. These typically include charitable and religious organizations, trade unions, political parties, universities and further education establishments: see, e.g., <https://www.ons.gov.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountsthebluebook/2023/householdsandnonprofitinstitutionservinghouseholdsnpish>.

<sup>11</sup><https://data.worldbank.org/indicator/NE.CON.PCAP.PP.KD>.

<sup>12</sup>This indicator has been discontinued and updated as from 16 December 2024 and does not appear anymore online, see: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906522-data-updates-and-errata>.

<sup>13</sup><https://ourworldindata.org/grapher/consumption-co2-per-capita#sources-and-processing>.

<sup>14</sup>The data we use from the Global Carbon Project measures carbon dioxide emissions from fossil fuels and industry and does not include emissions from land use change, deforestation, soils, or vegetation.

### 3 Visualization and Analysis

#### 3.1 Country Stripe Images across Time: Production-Based vs Consumption-Based Comparison

To illustrate the differences in the production-based vs consumption-based (or trade-embodied) methodological approaches, we proceed in this section with a direct comparison of the colormap stripe images generated by each of them for the recent time period of 1990-2020. The stripes start in 1990 due to lack of earlier highly comparable data across countries, even at the World Bank from where we source most annual data. It stops at 2020, for two reasons: (i) to allow comparability with the corresponding colormap production-based visualizations in my *Ecological Economics* article, Mihailov (2026); and (ii) to avoid missing data for many countries in 2021, 2022 or 2023, the latest years with data availability for some countries. The comparisons of the stripes by method, production- vs consumption-based, are structured to begin with the novel indicator of focus in the present paper, namely, the greening prosperity ratio, depicted as stripes of evolving colors over the years of the sample from dark brown (bottom end of the palette used to locate each country on the common scale in the right-hand side) to dark green (top end of the same scaling color palette). We then also show and discuss, in turn, the denominator of the greening prosperity ratio, namely CO2 emissions per capita according to both the production- and consumption-based approaches, on a reversed colormap going now from dark green (minimal carbon emissions pc) to dark brown (maximal emissions pc), and the numerator, a measure of economic prosperity according to both the production- and consumption-based methods on a dark blue (low/‘cold/poor-economy’ values) to dark red (high/‘heated/rich-economy’ values) for the same years. The decomposition of the greening prosperity ratio into its denominator and numerator is insightful in understanding its dynamics depicted by the color stripe images and in assessing which its dominant driver is.<sup>15</sup>

The figures that follow in the present subsection illustrate the colormap stripes for four ‘major’ economies and four ‘other’ economies from 1990 through 2020 in two parallel rows of four panels each, obtained by both methodological approaches we proposed in section 2.1 for their definition and visualization, namely the production-based computation (top row of four subplots) vs the alternative or complementary consumption-based computation (bottom row of four respective subplots). The two rows of image panels in each of the figures shows a palette of the same 16 color nuance patterns, defined by

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CO2 emissions per capita are calculated by dividing emissions by population at the indicated data source. Emissions from international aviation and shipping are not included in the data for any individual country or region. They are only counted in the global total.

<sup>15</sup>The replication archive, with the data and MATLAB and STATA codes, is publicly available on my GitHub webpage: <https://github.com/AlexnaderMihailov>.

the winsorized minimum at 5% and maximum at 95% in the cross section for 2020 for each respective compared variable, i.e., the 2020 distribution for each of the GPR and its numerator and denominator is taken as a benchmark (or anchor) in the comparisons along the y-axis. The variation across time is depicted along the x-axis for all these six variables and, potentially, for for all individual countries in the World Bank database (listed in Table A1 in the appendix). We denote the described winsorization approach as ‘static’, as it uses only the respective 2020 distributions to ‘anchor’ the respective color palettes by variable (numerator, denominator and ratio). Winsorization based on the respective distributions for 2020 is chosen for all figures in the main text because 2020 was the same last year in the sample for the production-based approach in the earlier article, Mihailov (2026), and also because data for later years are available for some countries but are largely incomplete. In the supplementary appendix, an alternative ‘dynamic’ winsorization is also illustrated, as a complementary variant of the visualization or as a robustness check: in it, winsorization for each of our six variables depicted as country color stripe or world map images (production-based vs consumption based ratio, denominator and numerator) is based instead on the bottom 5% and the top 95% of the respective global panel data distributions (for these six variables), as they evolve over time and with addition of new data/years.

As mentioned in Mihailov (2026), the purpose of providing the winsorized rather than raw version of the various color stripes by country or world maps expressing in color each of the six indicators we propose, visualize and study is to enhance the visibility of, and hence facilitate, the comparisons across countries or country groups/regions. The effect of the winsorization, by packing together the outliers below and above the chosen thresholds, is to define the bottom color and the top color in each ‘measuring stick’ or palette on the y-axis scale, shown with value ticks in the right-hand side of each subplot image, and thereby to ‘force’ more colors within the palette to appear for each country stripes or for each continent on the world maps relative to the reduced number of colors without winsorization.

Figure 1 compares the production-based (top row of four subplots) vs the consumption-based approach (bottom row of four respective subplots) of constructing the greening prosperity stripes over the period 1990-2020 for four economies that are among the largest in the world, the United States (US), China, India and Germany. We would point to several insights from this comparison.

Figure 1: Greening prosperity stripes, 1990-2020 – 1: original (top row) in ‘discounted’ PPP-USD of 2017 vs 2: refined (bottom row) in ‘discounted’ PPP-USD of 2021; World Bank annual data, static winsorization at 5% and 95% using the respective 2020 distributions as benchmarks

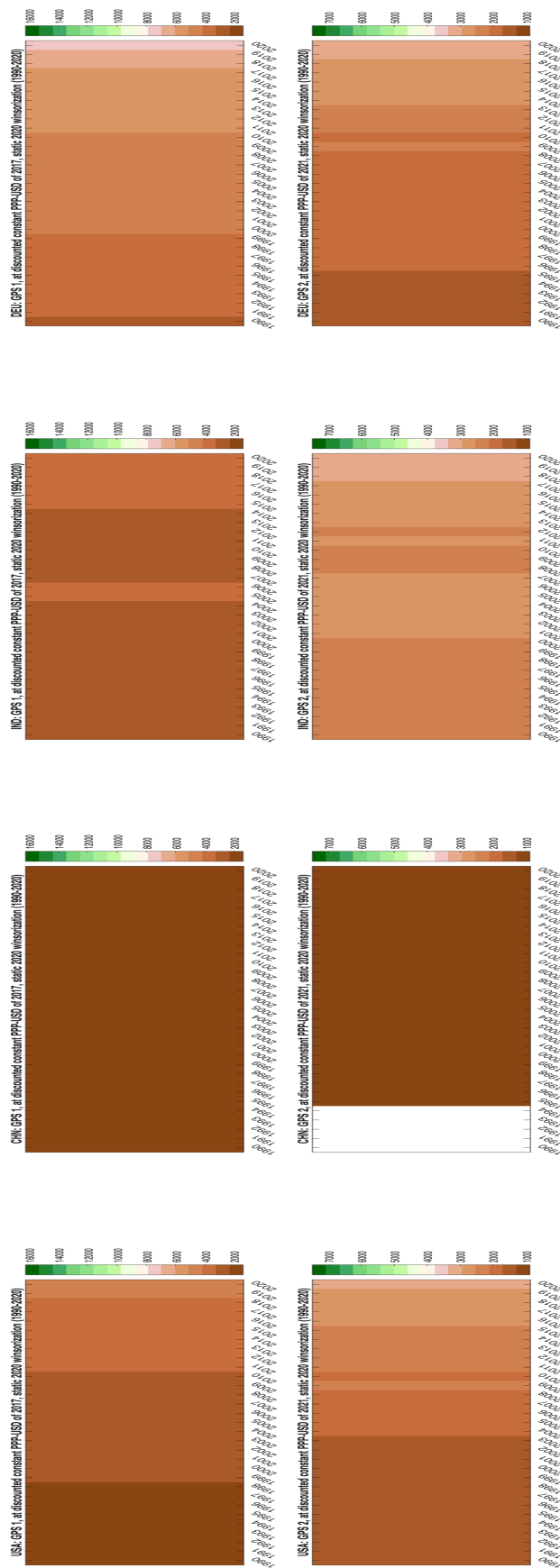


Figure 2: Production-based CO2 emissions pc (top row) vs consumption-based CO2 emissions pc (bottom row) in metric tons; 1990-2020, World Bank annual data, static winsorization at 5% and 95% using the respective 2020 distributions as benchmarks

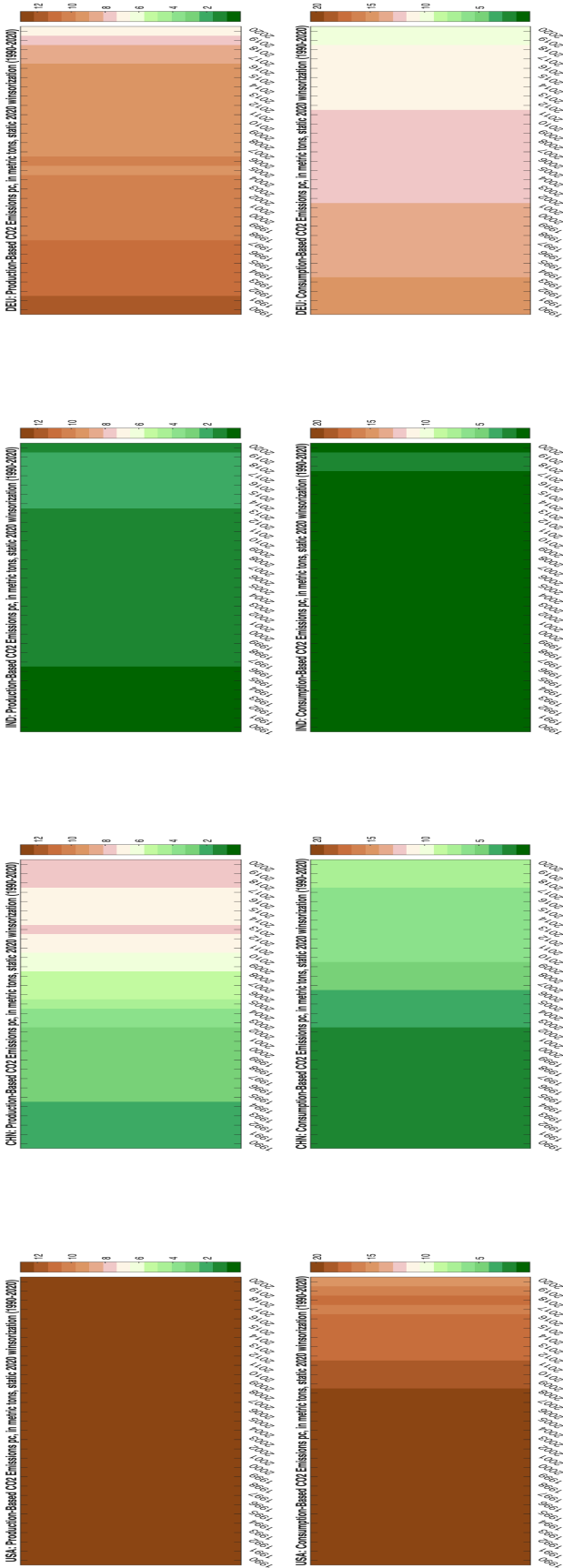
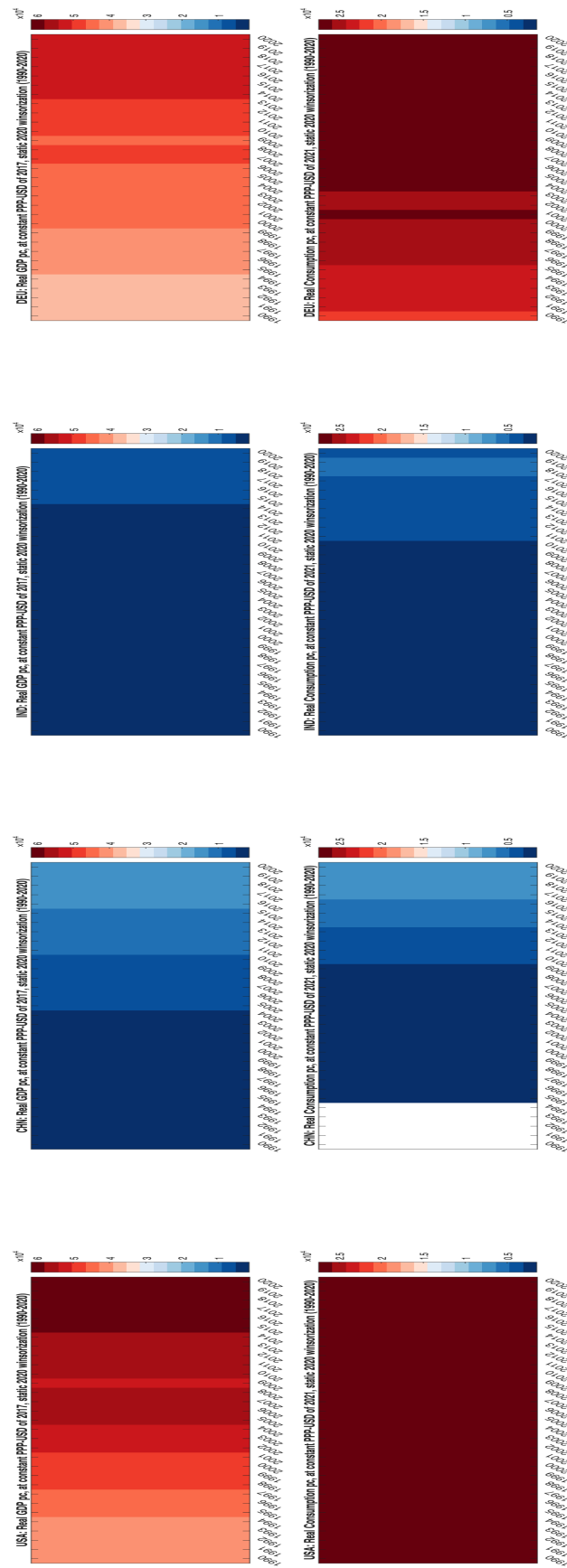


Figure 3: Real GDP pc at PPP in international USD of 2017 (top row) vs real consumption pc at PPP in international USD of 2021 (bottom row); 1990-2020, World Bank annual data, static winsorization at 5% and 95% of the respective 2020 distributions as benchmarks



First, the refinement in the present paper, seen in the bottom row of subplots, to use consumption-based measures of economic prosperity (real consumption per capita in the numerator) and CO2 emissions per capita attributed to the final consumer, and not production-based ones as in Mihailov (2026), seen in the top row of subplots, illustrates the problem of missing data (see the blank/white years for China) when the former approach is pursued rather than the latter. For continuity and comparability with my published article, I selected in this sequel paper the same countries as examples to discuss when visualizing the various stripes. In the case of Figure 1, however, I had to recur to a first adaptation: data for the European Union (EU) as a whole were missing for the entire period of 1990-2020, so I opted to depict instead the greening prosperity stripes for Germany, its biggest EU economy, in the present study.

Second, the consumption-based measures in the second row of subplots make the US and India to look better, that is, enjoying a higher degree of greening (not yet, indeed, green nuances but lighter brown) prosperity compared to the production-based measures. To put it differently, when accounting for trade and final consumption in contributing to global CO2 emissions and not for production only that emits CO2 on their territory, the US and India come out as lighter brown, and improving over the years. For China, the same deepest dark brown color and the same conclusion of a lowest degree of greening prosperity, as captured by the bottom color nuance in the palette on the right-hand side, is invariant to the choice of methodology. For Germany, one observes a reversal of the finding just noted with regard to the US and India: Germany appears in darker brown nuances, even if improving over time, in the consumption-based vs production-based calculation of its greening prosperity stripes.

Third, all these 4 largest economies in the world are too far yet from even approaching the colors of greening prosperity in the top half of the ‘measuring stick’, i.e., the color palette in the right-hand side. That is, the trade-off, or balance, between high standard of living per capita (as numerator of the ratio) and CO2 emissions per capita (as denominator) is twisted in all of these countries in favor of more production and consumption even at the cost of not sufficiently reducing CO2 emissions. The decomposition of the greening prosperity ratio by denominator and numerator in the following two figures will confirm our conclusions here and make them sharper.

Figure 2 provides the same visualization in terms of stripes and comparative perspective across the 4 major economies, but now zooming on the denominator of the GPR. The top row shows production-based CO2 emissions per capita while the bottom row parallels the images with consumption-based CO2 emissions per capita.

One can easily detect a sharp contrast or divide in this figure: the US and Germany emit CO2 per capita at much higher levels than China and India, and therefore are assigned brown color nuances. For the US, the production-based measure stays on the

darkest brown color throughout the whole period, a persistent high level of CO2 emissions per capita at the winsorized world maximum for the 2020 distribution. Changing to the consumption-based analogous measure mitigates the above extreme results somewhat, as the brown shades become gradually lighter after 2009, but never reach the green top half of the spectrum of colors in the palette.

For Germany, the consumption-based CO2 emissions get lower over time faster, thereby reaching the light green nuances near the middle of the measuring stick in the right-hand side. This essentially reflects slow transitioning to renewable energy sources on the production side of the economy. On the other hand, China and particularly India, come out as quite green in terms of CO2 emissions per capita, especially taking into account their consumption-based (or trade-embodied) measure.

Figure 3 preserves the contrast we just discussed but now in terms of economic prosperity measures. The US has been increasing its levels of real GDP pc and has, therefore, been moving from lighter red to darker red stripes over the 1990-2020 period in the top row of subplots, while it has preserved the maximal darkest red color status throughout in the real consumption per capita ranking in the bottom row of subplots. Germany shares similar trends and stripe patterns, but less extreme than those for the US. China and India remain in the darker blue stripe nuances on both rows, but have started a catch-up process in both real GDP pc (i.e., on the production side) and real consumption pc (i.e., on the consumption side), and the consumption gap to the most advanced economies is somewhat melting faster than the production gap.

A final insight comes from comparing the numerator and denominator of the greening prosperity ratio for all these four major economies. It explains in colors the driving force behind the divide we uncovered, between the US and Germany, on one side, and China and India, on the other in terms of denominator and numerator of the GPR. The dominant brownish colors in the greening prosperity stripes for the US and Germany (that is, relatively low GPR, as the scale shows) are driven by the relatively high (dominantly brownish on the respective relative scale) levels of CO2 emissions per capita in both the production- and consumption-based approaches (the denominator), which outweighs the upward forces or contributions coming from their relatively high (reddish, on the respective color palette scale) economic prosperity (the numerator), again, measured either way, production-based vs consumption-based. By contrast, for China and India we would conclude the opposite regarding their dominant brownish GPR: the main driver behind is now the still very low level (dark blue nuances) of both production- and consumption-based economic prosperity measures (the numerator), that cannot get high enough (reaching the red nuances in the top half of the color palette) over the years so as to increase their GPR (i.e., make it lighter brown to light green), no matter that the levels of CO2 emissions according to both production- vs consumption-based measures

(the denominator) are low enough (i.e., green to dark green in the bottom half of the respective color palette). Our interpretations here illustrate the value of this visualization approach in the analysis at a general/macro level of what drives the greening prosperity ratio to a larger extent, its numerator or its denominator, and how this can inform policies in order to advance along the path toward net zero in the future, which may imply different trade-offs or re-balancing of growth and emissions for different countries.

To expand a bit on our visualizations and analysis of the production- vs consumption-based approach to defining the greening prosperity stripes and their ingredient variables (numerator and denominator), which are in principle computed and plotted given available data for all 217 countries in the world and 49 country World Bank groups,<sup>16</sup> we present the same images and interpretations as for the four major economies above but now for four ‘other’ economies, partly linking to the country cases I focused on in Mihailov (2026) and partly representing diversity across the globe in terms of continents and stages of economic development. These are the United Kingdom (UK) and Switzerland, both advanced economies out of the European Union that have been good examples of greening from their respective stripe images generated by the production-based calculations in my published article, as well as Brazil, a key emerging market economy (EME) in the BRICS bloc of countries (together with China and India earlier here, and Russia to be mentioned further down) and Mozambique, an illustrative case from the less developed EMEs.

Figure 4 compares the greening prosperity stripes for these four countries along both approaches of their computation, the production-based (top row) vs the consumption-based (bottom row). What strikes directly by the colors for Switzerland, and much less so for the UK, is that the favorable picture painted by the production-based approach to defining the greening prosperity stripes is reversed completely. Part of this for both countries could be due to the offshoring of heavy-emitting industries: while offshoring helps improve the greening image of a given country along the production-based approach, such as in the cases of the UK and Switzerland (and I did comment in a bit more detail on both in Mihailov (2026)), this same country may not look green and emerge as rather brown, when the emissions of CO<sub>2</sub> by other countries which export their goods and services for consumption are properly counted in the consumption-based refinement of the greening prosperity indicator (proposed in the present paper), as the color stripes for Switzerland now illustrate vividly. Of course, the differences in the consumption- vs production-based approach of calculating the GPR does not arise from offshoring only. Another part of the explanation is the production structure of a given economy, where polluting industries are absent or minimal, as is the case for Switzerland. By

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<sup>16</sup>See Table A1 and the link to my Github webpage with the data and code referred to in an earlier footnote.

contrast, the conclusion regarding Brazil is the opposite: its GPR looks dominantly (light) brown according to the production-based approach of counting CO<sub>2</sub> emissions but dominantly (light) green according to the consumption-based or trade-embodied approach promoted in this sequel refinement study. Part of the explanation here again is the production structure, which relies on industries that emit more CO<sub>2</sub>, and another part is the slow transitioning of the production side of the economy to renewable energy sources as well as to lack of or insufficient offshoring. As for Mozambique, the trends in its greening prosperity stripes from 1990 through 2020 are not optimistic, and this is confirmed (with certain variation) by both approaches. What drives these conclusions: is it the denominator of the greening prosperity ratio, as was in the case of the US and Germany, or is it rather the numerator, as it appeared for China and India earlier?

Looking first at the denominator of the GPR as its key determinant, CO<sub>2</sub> emissions per capita along both approaches, in Figure 5 one can confirm the conclusions regarding the role of offshoring in the UK and the existing production structure and the transitioning to renewables in Switzerland from the preceding Figure 4. Again, the case of Switzerland is the most striking and sharp in terms of contrast across the two approaches. When production-based CO<sub>2</sub> emissions per capita serve as denominator in the GPR definition, Switzerland is greening, that is, emitting less and less CO<sub>2</sub> all over the sample and reaches close to the darkest green of the bottom of the comparative measuring stick performed by the right-hand side color palette scale. However, turning to consumption-based (i.e., trade-embodied) CO<sub>2</sub> emissions per capita, Switzerland is persistently (lighter) brown throughout, reaching a peak in 2012 and 2014, 2015 and 2026 (the darkest brown stripe on its graph) and somewhat improving (returning to lighter brown nuances) thereafter. Like the UK, Brazil looks somewhat greener under the consumption-based approach to attributing CO<sub>2</sub> emissions per capita, while Mozambique is equally characterized by a single darkest green wide stripe throughout the whole 1990-2020 period, irrespective of the approach to calculation.

Now looking at the numerator of the GPR for these four other countries, illustrating here in an expanded country comparison the usefulness of our visualization approach embodied in the greening prosperity stripes, especially in their consumption-based refinement in the present sequel paper over the production-based alternative of my original study, Figure 6 similarly splits the compared countries sharply into two groups: Switzerland and the UK, among the richest countries, especially so in terms of real consumption per capita (bottom row) rather than real GDP per capita (top row), come out darkest red in all or most years (except the UK being lighter red according to its production-based stripes). By contrast, Mozambique, which illustrates the case of one among the poorest countries in the world, remains at the bottom darkest blue in terms of real output per capita as well as real consumption per capita, no matter the chosen alternative indicator

in the numerator of its GPR. Brazil appears closer to Mozambique in color nuances, of the light blue range, and it catches up faster with more advanced economies in terms of real consumption per capita (lighter blue shades in the bottom row) and not that much real output (darker blue shades in the top row). All in all, thus, the brown stripes (relatively lower values) of the Swiss consumption-based GPR are driven by its brown stripes (relatively high values) of trade-embodied CO<sub>2</sub> emissions (in the denominator of the GPR) rather than its darkest red (highest values) of real consumption (in the numerator). Similar, but less sharp conclusions are valid for the UK, whereas the GPR for Brazil and Mozambique seem to be driven by their relatively low real output and real consumption (blue to darkest blue), given that the values of CO<sub>2</sub> emissions remain low (dominantly darkest green).

We now would like to complement the visualizations and analysis thus far from a different, single-country perspective that summarizes all six types of stripes: generated via the production-based approach (in the left-hand side column of three subplots) as well as the consumption-based approach (in the right-hand side column of three subplots). We also reverse the order of arranging these summary stripes per country, by putting the final product of interest, our greening prosperity stripes, at the bottom row, while their respective numerator is on the top row and their respective denominator in the middle row. This kind of an alternative visualization is illustrated in the next four figures for four country cases that represent important economies in different world regions or with various economic development history. Japan and Canada are among the Group of 7 (G7) countries with the most influential economies in the world, as are the US, Germany and the UK in our earlier visualizations and analysis. Australia is another large and important economy in the South-East part of the globe. And Poland is among the most dynamic and largest economies in Eastern Europe that have successfully transitioned from a previously communist organization of society back to market incentives.

Figure 7 illustrates the case of Japan in terms of its production- vs consumption-based greening prosperity stripes and their main drivers in the numerator and denominator. What is worth noting in the analysis of this summary stripes for Japan is its similarity to the UK earlier in that the consumption-based greening prosperity stripes look browner than the production-based ones. However, any effect of significant offshoring is not confirmed when comparing the respective denominators, with the production-based CO<sub>2</sub> emissions being systematically higher (browner) than the consumption-based CO<sub>2</sub> emissions. On the other hand, the consumption-based CO<sub>2</sub> emission stripes and economic prosperity stripes present Japan in a definitely more favorable light than the production-based ones. The outcome of the brown GPRs along both measurement approaches appears here mostly driven by the relatively high CO<sub>2</sub> emissions per capita but the somewhat insufficient levels of prosperity per capita seemingly contribute as well.

Figure 4: Greening prosperity stripes: original (top row) in ‘discounted’ PPP-USD of 2017 vs refined (bottom row) in ‘discounted’ PPP-USD of 2021; 1990-2020, World Bank annual data, static winsorization at 5% and 95% of the respective 2020 distributions as benchmarks

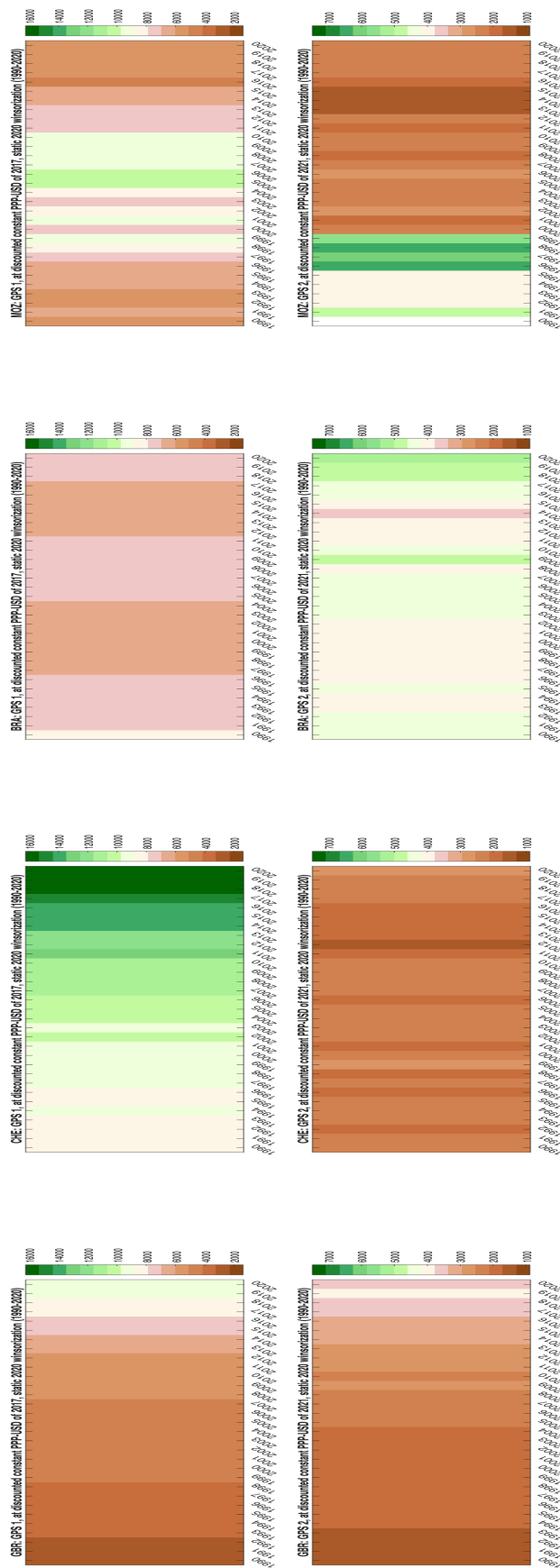


Figure 5: Production-based CO2 emissions pc (top row) vs consumption-based CO2 emissions pc (bottom row) in metric tons; 1990-2020, World Bank annual data, static winsorization at 5% and 95% of the respective 2020 distributions as benchmark

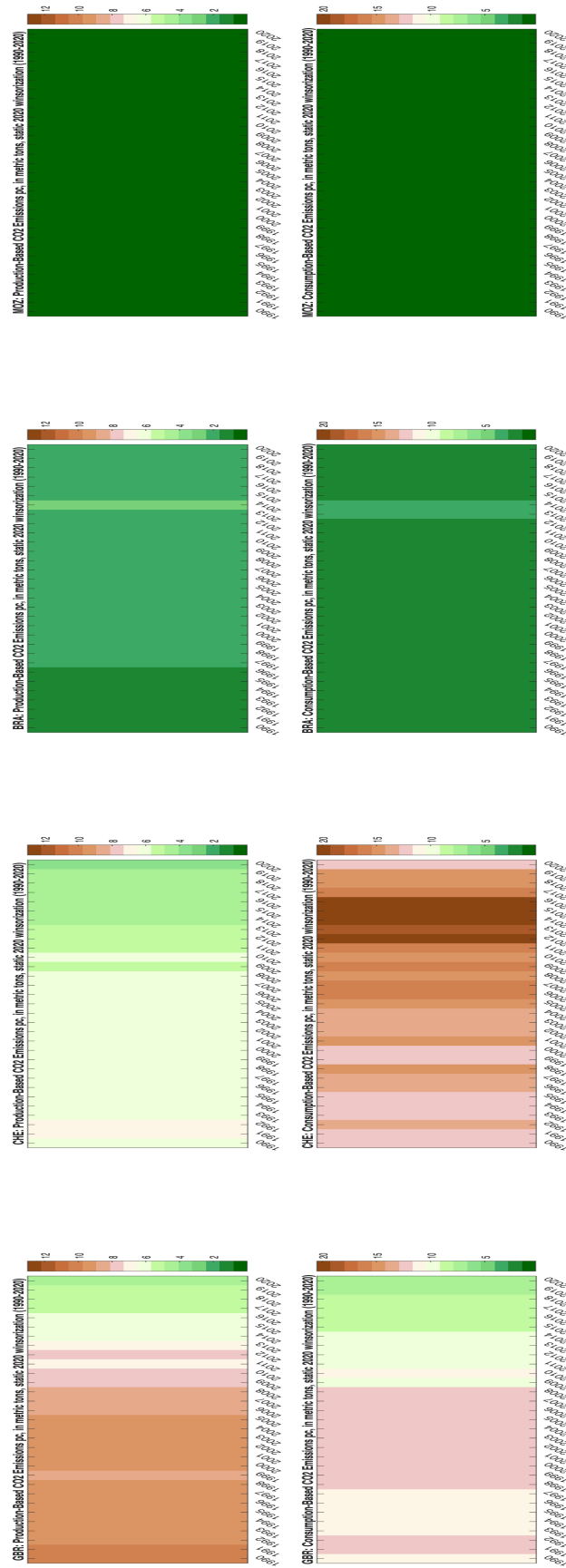
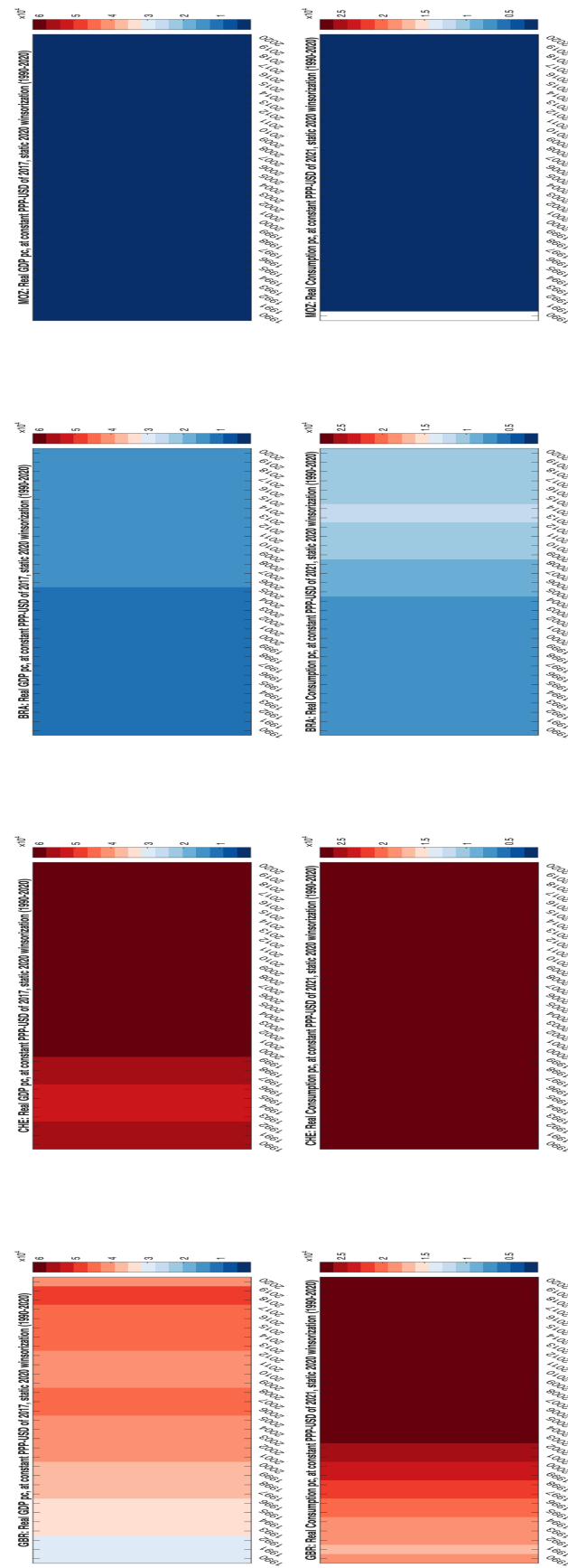


Figure 6: Real GDP pc at PPP in international USD of 2017 (top row) vs real consumption pc at PPP in international USD of 2021 (bottom row); 1990-2020, World Bank annual data, static winsonization at 5% and 95% of the respective 2020 distributions as benchmarks



Looking next at the summary stripes graph for Australia, one can generally uncover similar as well as different conclusions in Figure 8. First, differently from the case of Switzerland and similarly to those of the UK and Japan, the consumption-based greening prosperity stripes for Australia show some faster but insufficient improvement, remaining in the dark brown nuances of the palette, compared to the production-based ones. In terms of output-generated CO<sub>2</sub> emissions Australia is persistently ranking among the highest emitters per capita in the world and – similarly to the US – cannot leave the darkest brown wide stripe stretching over the whole 1990-2020 period. On a consumption-based or trade-embodied measurement, CO<sub>2</sub> emissions per capita are somewhat lower, but still hesitating with ups and downs through lighter or darker brown stripes over the sample period. In terms of real consumption per capita, Australia has reached the very top in the world of the darkest red, while in terms of real output per capita this is not yet the case. All in all, the poor performing greening prosperity stripes tend to be driven here by the bad record of CO<sub>2</sub> emissions per capita (in their denominator), along both methods of calculation.

Figure 9 reveals in colors the same main trends and conclusions for Canada as for Australia. Indeed the similarity between the summary stripes graphs of these two countries is so striking that the analysis just made for Australia is not worth repeating for Canada here.

Finally, Figure 10 looks at the summary stripes of Poland, a country in Eastern Europe of a relatively big size for the region, whose economy has recently been booming but which has emerged from a communist past (between 1945 and 1989), just before the stripe sample period we focus on (indeed the data are missing in the case of Poland for real consumption per capita before 1995, consequently for the consumption-based GPR, and this is captured in the respective subplots). What is worth noting is, first, that the three consumption-based color stripe indicators paint a more favorable image for Poland than the respective production-based ones. Second, when comparing production vs consumption-based CO<sub>2</sub> emissions per capita, the country sharply changes colors throughout the full sample period (now there are available data) from (light) brown nuances to (light) green nuances, that is, in the opposite way compared to Switzerland discussed earlier. This is indicative of a polluting production structure and/or insufficient offshoring and/or slow transitioning to renewable energy sources, as in the cases of Germany, the UK and Japan. Third, in terms of real consumption per capita the catching-up process following post-communist transition has been faster, reaching the light red stripe nuances, than in terms of real output production. The dominantly brown prosperity stripes (in the bottom of the measurement color scale) according to both calculation methods, however, appear driven by a mixture of insufficiently high (close to the median in the color palette) economic prosperity per capita (the numerator of the GPR)

and relatively high (again, close to the median, as the colors in the palette mark) CO2 emissions per capita.

### 3.2 Country Colors on the World Map for 2020: Production- vs Consumption-Based Comparison

This subsection presents an alternative and complementary visualization and comparison to that of the preceding subsection: instead of looking at each country across time in terms of a sequence of color stripes, we now turn to a representation of each country's color on the world map in a single recent year, 2020, as assigned by the production- vs consumption-based approaches of defining the greening prosperity ratio and its numerator and denominator. The color palette range that spans the map is exactly the same as defined in the preceding section for each of the three variables of interest and according to each of the two approaches considered.

Commencing the analysis of insights gained from the colors on the world map with the indicator at the center of attention in this paper, the greening prosperity ratio, Figure 11 provides a comparison of the results obtained by the production-based approach (top panel) vs the consumption-based (or trade-embodied) approach (bottom panel). Several conclusions are in order.

First, switching from the production-based to the consumption-based calculation of the GPR leads to a loss of countries/data, and this loss is not to be underestimated. It accounts to nearly half of all countries in the world, appearing blank/white on the world map in the bottom/consumption-based panel. The missing data, mostly due to the denominator of the greening prosperity (as we shall see next, comparing figures 12 and 13) cover almost all of the continent of Africa. Some countries in South America and Asia also appear blank/white on the map, due to missing consumption-based data.

Second, the consumption-based variant of the GPR reveals – once again as in some of the stripe images by country over 1990-2020 – the effect of offshoring polluting industries from advanced economies into developing economies eager to catch up industrially. The green-nuanced North-West part of Europe according to the production-based calculation disappears into the (lighter) shades of brown when the consumption-based approach is applied instead. On the other hand, some less-advanced economies in Europe such as Romania, Albania and Portugal move into (lighter) shades of green when the trade-embodied computation of greening prosperity is similarly used.

Figure 7: Japan: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

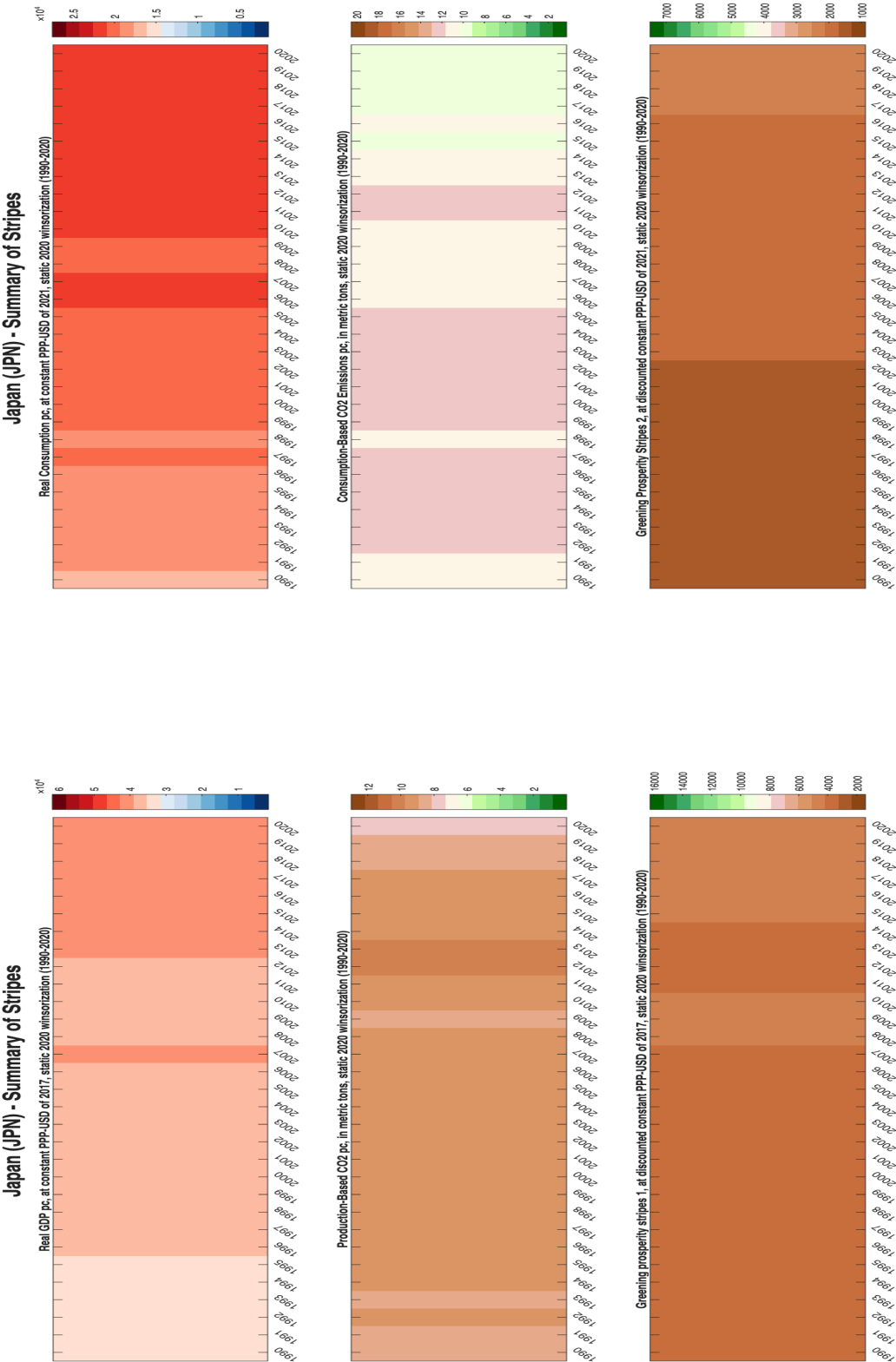


Figure 8: Australia: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

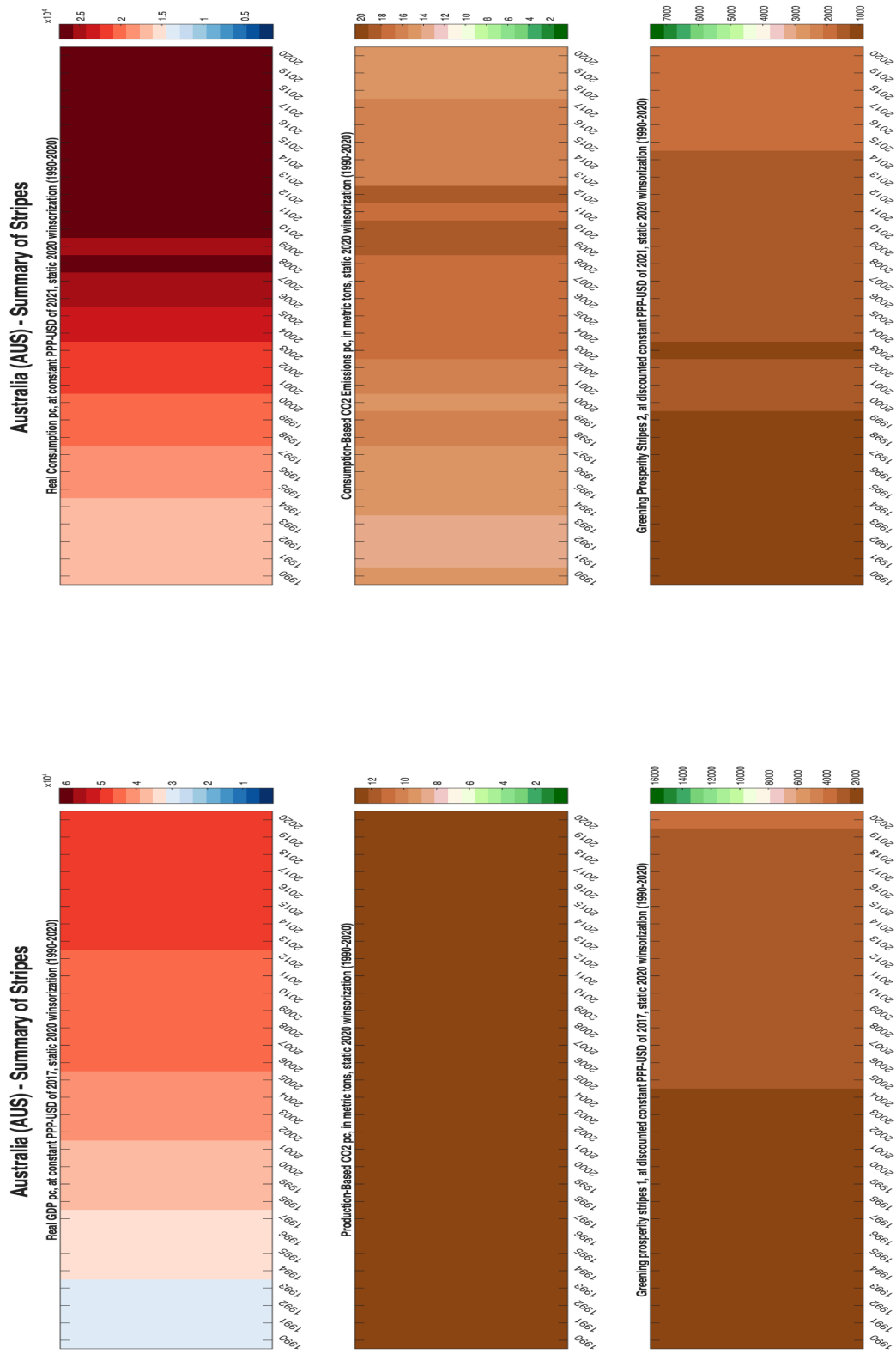


Figure 9: Canada: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

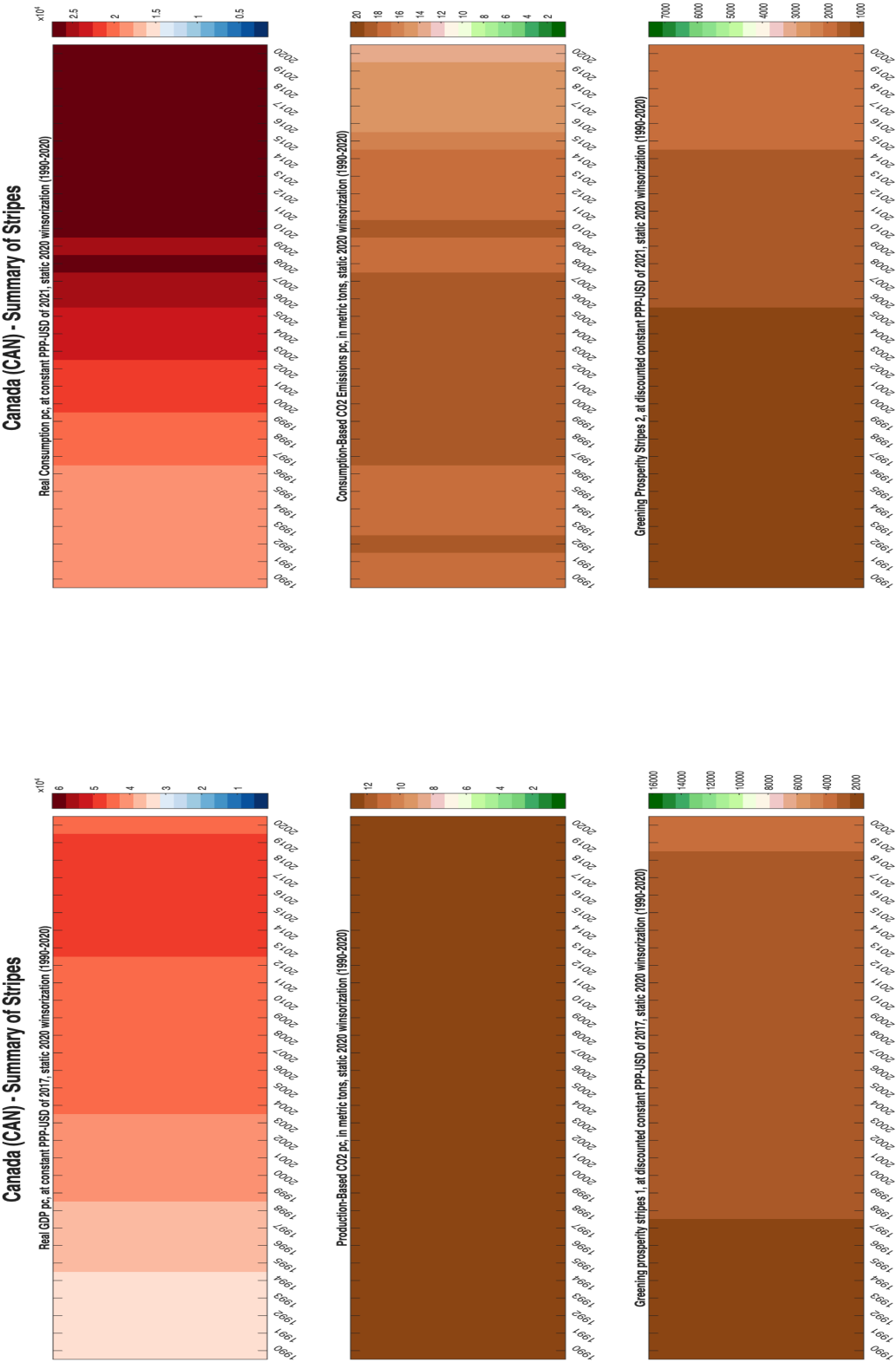
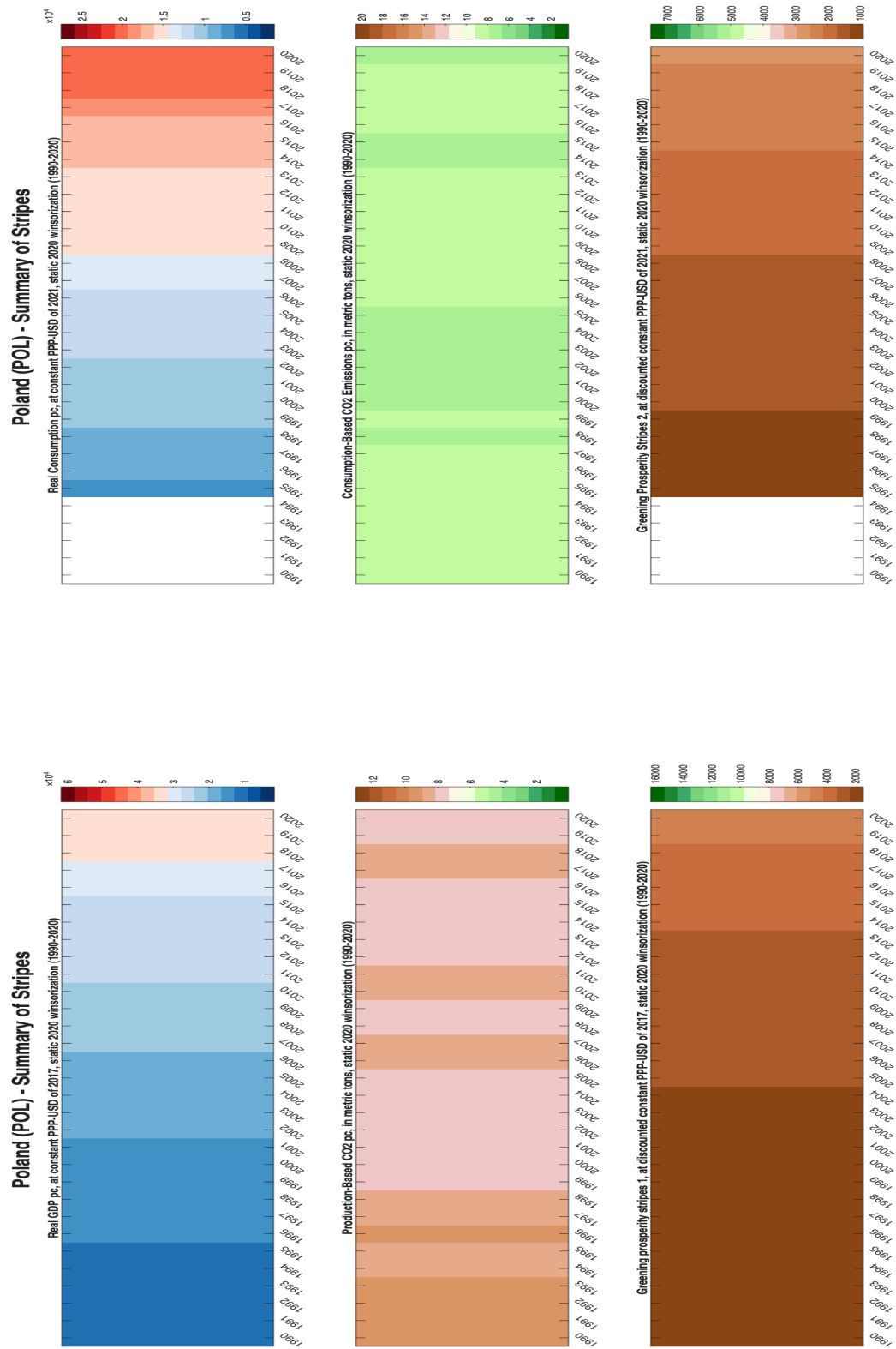


Figure 10: Poland: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)



Third, the latter trend of greening when the production-based approach is replaced by the consumption-based one, that is, the opposite of the offshoring effect, is even stronger for the North-East half of South America and the small southern countries North-West of Panama in North America. The same trend is typical for the South-West half of the South American continent as well, but the opposite of the offshoring effect is less convincing and remains in the light brown nuances of the color palette instead of going into the light green ones.

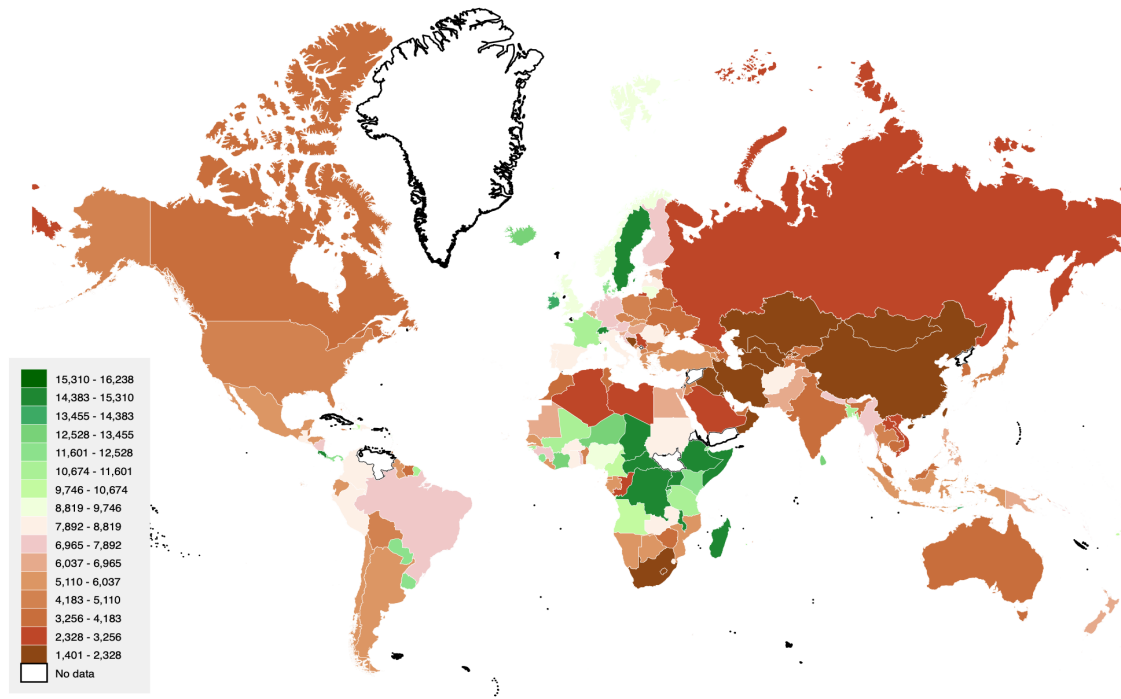
Notice the difference in the measurement scale of the greening prosperity ratio under the two approaches, production- vs consumption-based. This is, of course, due to the different variables used as its numerator and denominator under these two compared approaches, as clarified in the theoretical subsection 2.1. Nevertheless, the two world maps in Figure 11 allow a fair comparison of the differently designed approaches of calculation of the GPR and its color visualization. Depending on the aim of analysis, each can be preferred over the other. Yet, if what ultimately matters more are the consumption-based measures, then preference should be given to the consumption-based coloring, not the production-based one. Finally, nothing prevents both approaches to track and illustrate in a convincing, visually comparative way the trajectory of each country in the world toward the goal of net zero emissions (captured with approximation in the color palette proposed on the figures by its top darkest green nuance). But, again, if the consumption-based (or trade-embodied) approach is deemed fairer, as it does not hide the ‘green-washing’ accounting of offshoring polluting sectors, for example, priority should be accorded to that particular, refined approach. This conclusion is indeed the key message that transpires throughout the present paper.

As we argued already, decomposing the greening prosperity ratio into its numerator and denominator is helpful in figuring out which of them drives it in a prevailing or dominant way for a given country (or country group/region). Figure 12 presents the same comparison between the production- vs consumption-based calculations underpinning the whole of this paper but now with a zoom on the denominator of the GPR, namely carbon dioxide emissions per capita. The consumption-based approach in the bottom world map counts in, perhaps in a fairer way, the consumption of imported goods and services by the same given country, whose production has increased CO<sub>2</sub> emissions in a foreign country, as well as counting out the CO<sub>2</sub> emissions caused in the production of exported goods and services, whose consumption has occurred abroad. Several thoughts, again, are in order.

First, as already mentioned, most of the continent of Africa is lost in this analysis here due to absence of data: see the blank/white territories in the bottom world map. A few countries in central Asia do not measure consumption-based CO<sub>2</sub> emissions per capita either.

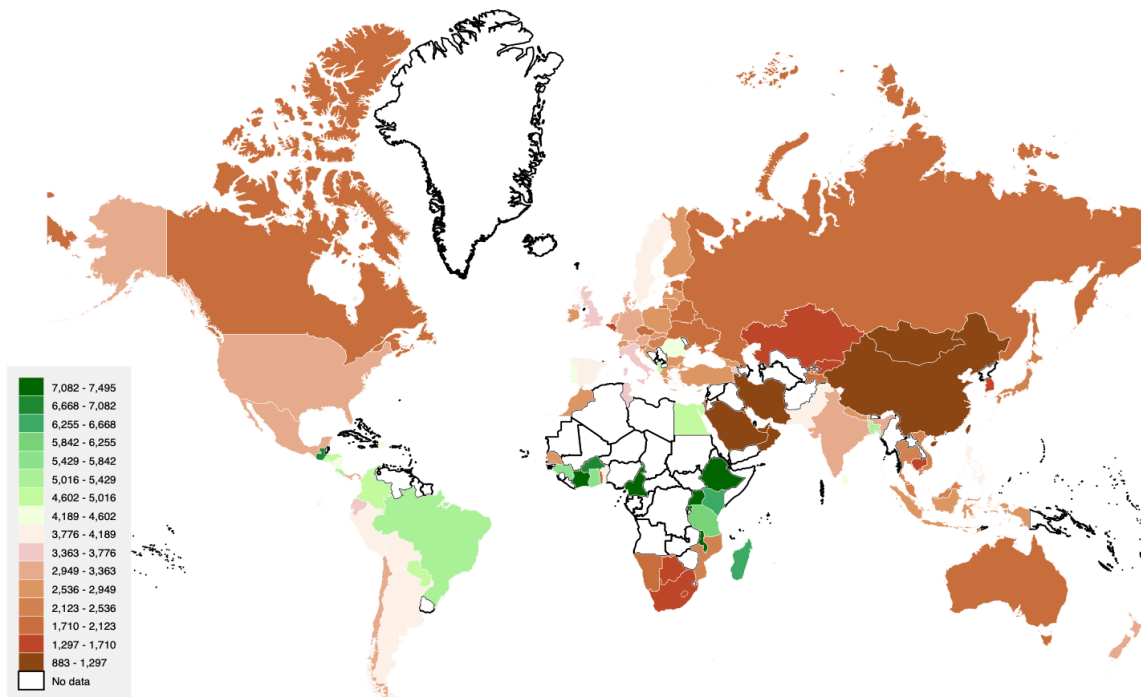
Figure 11: Country color comparison on the world map in 2020 – greening prosperity colors: production- vs consumption-based

GPR in Color Ranges across the Globe in 2020, discounted PPP-USD of 2017 (winsorized scale at 5% top and 5% bottom)



Source: World Bank data files.

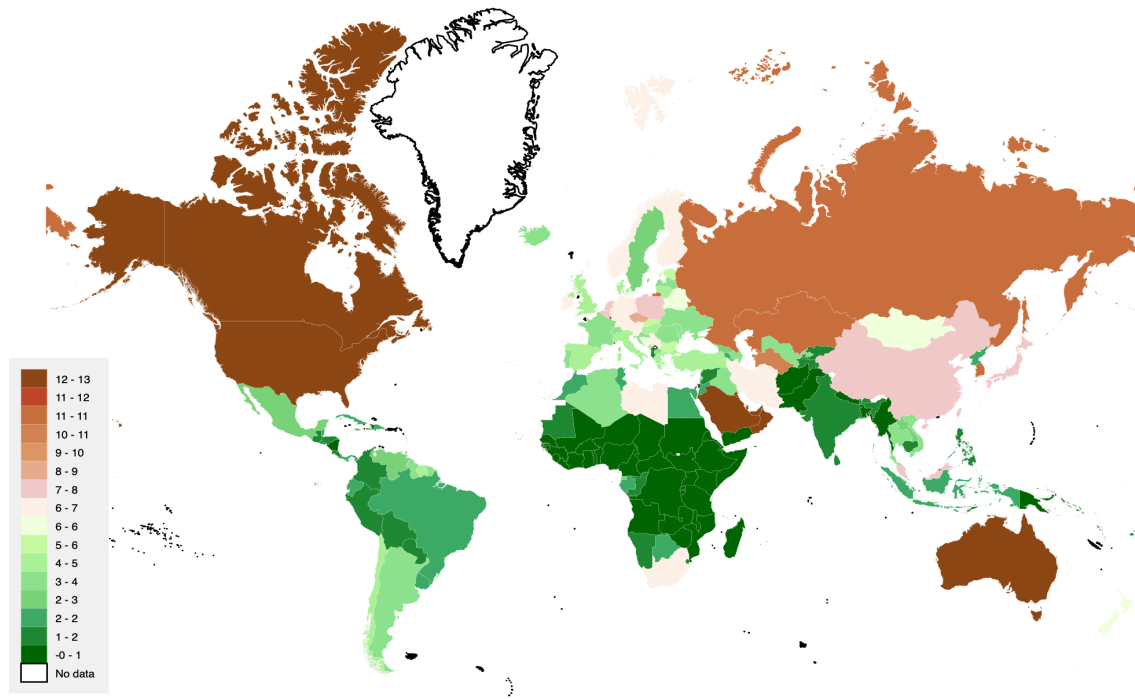
Consumption-Based Greening Prosperity Ratios in Color Ranges across the Globe in 2020, discounted PPP-USD of 2021 (winsorized scale at 5% top and 5% bottom)



Source: World Bank data files.

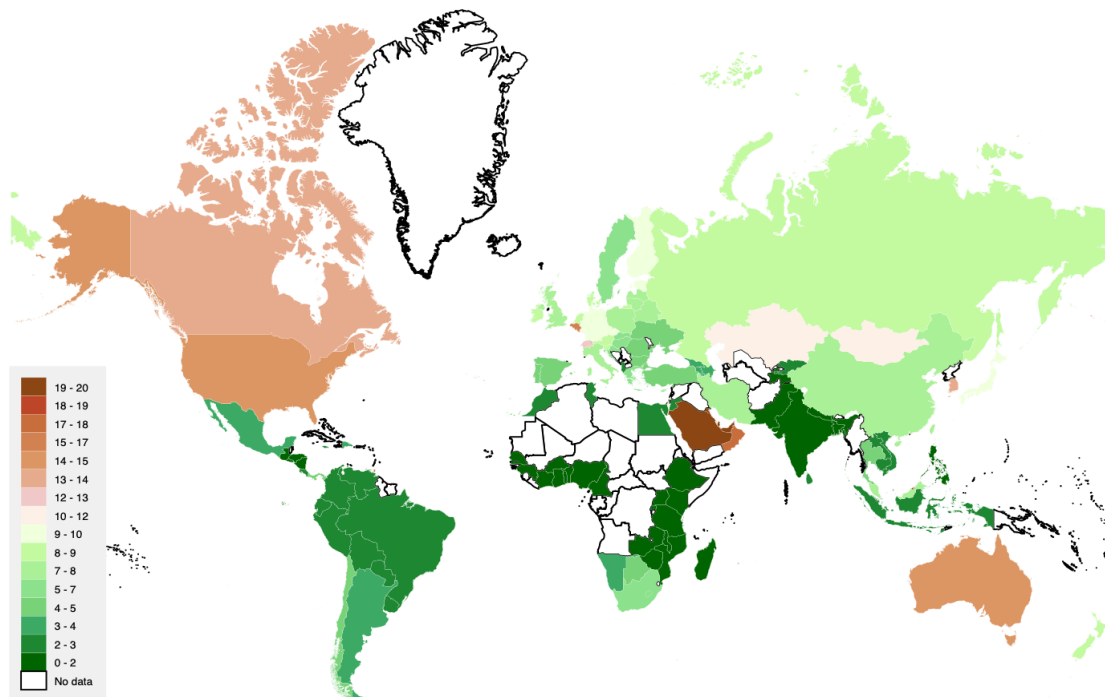
Figure 12: Country color comparison on the world map in 2020 – CO2 emissions pc: production- vs consumption-based

CO2 Emissions per Capita in Color Ranges across the Globe in 2020, metric tons (winsorized scale at 5% top and 5% bottom)



Source: World Bank data files.

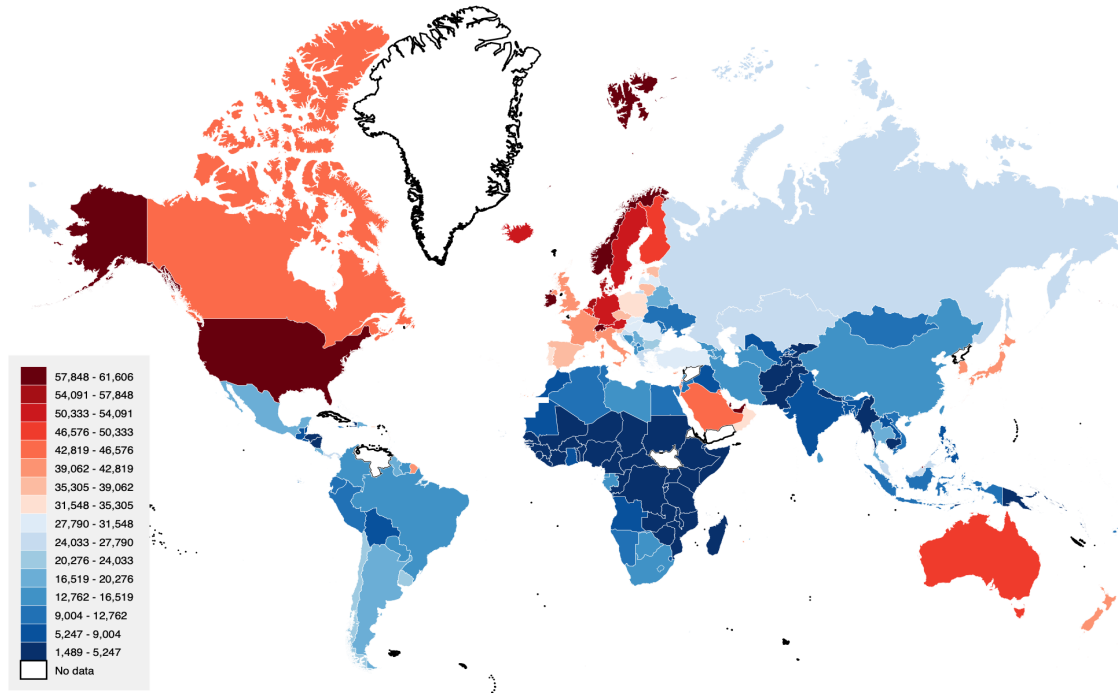
Consumption-Based CO2 Emissions per Capita in Color Ranges across the Globe in 2020, metric tons (winsorized scale at 5% top and 5% bottom)



Source: World Bank data files.

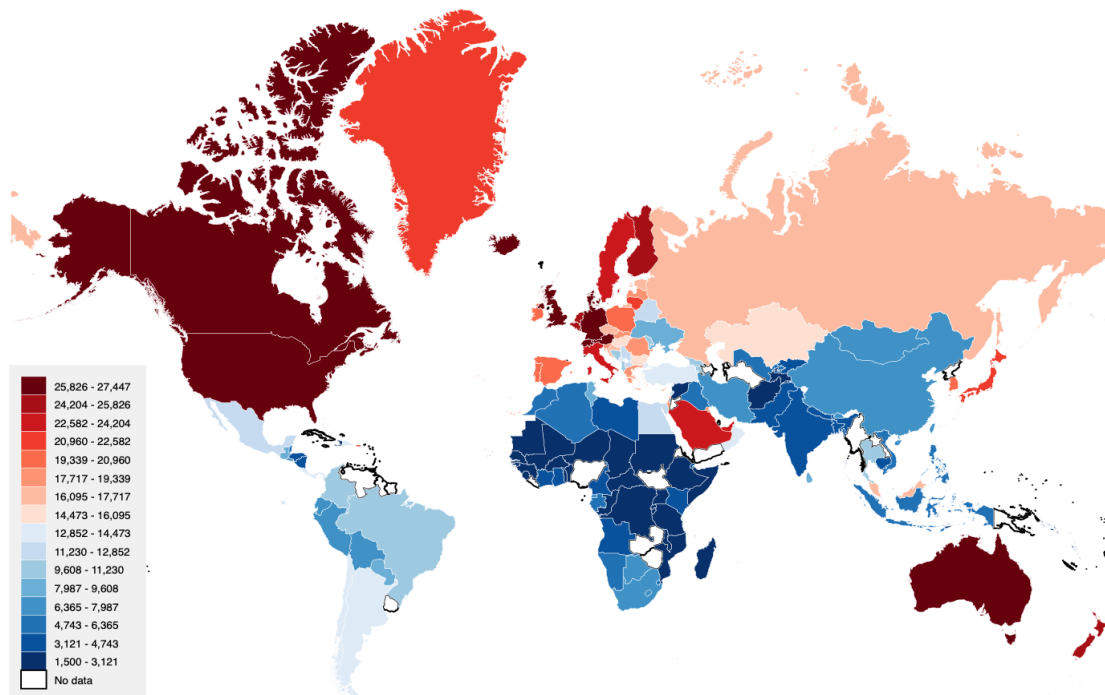
Figure 13: Country color comparisons on the map of the world in 2020 – GDP pc in USD of 2017 at PPP (top panel) vs real consumption pc in USD of 2020(?) : CHECK) at PPP (bottom panel)

GDP per Capita in Color Ranges across the Globe in 2020, PPP-USD of 2017 (winsorized scale at 5% top and 5% bottom)



Source: World Bank data files.

Real Consumption per Capita in Color Ranges across the Globe in 2020, PPP-USD of 2021 (winsorized scale at 5% top and 5% bottom)



Source: World Bank data files.

Second, the world as a whole looks greener when CO<sub>2</sub> emissions are attributed to the country where the final consumption of an exported good or service happens, that is, in the bottom map by the trade-embodied approach. By the same logic, the top production-based CO<sub>2</sub> emissions world map misrepresents the ‘fair’ picture in the sense that consumers in foreign countries are responsible for the CO<sub>2</sub> emissions and, hence, pollution caused in the producer country.

Third, from the several largest emitters of CO<sub>2</sub> according to the production-based approach (top map), only Saudi Arabia does not change its darkest brown color under the consumption-based approach (bottom map). The US, Canada, Australia, the other smaller countries at the bottom of the Arab peninsula as well as Russia and China do mitigate their darkest or darker brown (top map) into respective lighter shades of brown when consumption and trade are taken into account (bottom map).

Finally, now looking at the numerator of the GPR and comparing the production-based (top map) with the consumption-based (bottom map) approach of calculation, Figure 13 presents a more optimistic image of the world; namely, when we measure economic prosperity with taking into account real consumption levels per capita achieved via trade, the world looks somewhat more advanced and kind of more homogeneous compared to real output levels (more red nuances in the bottom map relative to the top map).

In addition to viewing the global picture and providing some trends and clues to its interpretation, the decomposition of the GPR into its numerator and denominator on the world map also helps at a country level, to figure out which of these drive it mostly or dominantly. If one takes as visual example here Russia, it is clear that its darker brown GPR under the production approach is caused more by its high level of CO<sub>2</sub> emissions per capita (darker brown near the very top of the palette) rather than its economic underdevelopment (light blue at the margin within the bottom half of the palette); while the consumption approach somehow mitigates this logic: Russia is at almost equal distance from the median dividing the color nuances (light red / marginally in the top half of the scale) in real consumption per capita compared to consumption-based CO<sub>2</sub> emissions (light green / marginally in the bottom half of the scale). But this analysis by country is better depicted in the time-varying color decomposition in the stripes of the preceding subsection, so for such a purpose the earlier visualization should be preferred.

## 4 Concluding Remarks

This paper was a sequel to my ‘greening prosperity stripes’ article, Mihailov (2026). Its purpose was to refine the calculation of these illustrative color stripes by taking into

account consumption-based, or trade-embodied, carbon dioxide (CO<sub>2</sub>) emissions, rather than production-based CO<sub>2</sub> emissions as in the earlier study. The comparative visualization approach we proposed in the present paper helped reveal, through the difference between the two methods of calculation of the greening prosperity ratio, the influence of higher or lower degree of offshoring any polluting industries and/or of faster or slower transitioning to renewable energy sources in the production structure of the economies considered in our illustrations. A complete archive of all such similar stripe images for all countries of the world and some country groupings where data are available can be accessed at my Github webpage, together with the code and data, as was mentioned earlier.

The refined indicator, however, comes at the cost of losing nearly half of the countries in the world and most country groupings in the World Bank classification, due to unavailability of such consumption-based CO<sub>2</sub> emissions data. Nevertheless, it offers a more precise – and, we would admit, fairer – image, relative to the original production-based greening prosperity stripes, of how green(ing) is the prosperity for most countries in the world.

The main contribution of this sequel paper was to illustrate clearly the difference between the two indicators of greening prosperity, in pairs of comparative graphs. Because images and colors ‘speak stronger’ than words, the greening prosperity stripes can raise awareness and mobilize immediate climate policy action across the world. Beyond that, and as a consequence of it, the greening prosperity stripes can be used to track progress toward net zero over the next decades. To enable such a crucial monitoring function at a global scale in a straightforward way and with immediate online illustration and verification, we would propose to showcase the greening prosperity stripes, as well as their numerator and denominator, on an annually updated public-domain website that allows easy visual comparisons across countries. The obvious advantages of the stripes visualizations to perform such a socially-valuable and policy-informing function consist mainly in their simplicity of design, intuitive power and effectiveness of visual impact, as discussed earlier.

Nevertheless, there are, of course, some limitations of our greening prosperity indicator. Possible avenues for further exploration, refinements and improvement remain, at least along the following desirable extensions: (i) prosperity may be measured along several dimensions and a composite index could be constructed out of such multiple ingredients to serve as numerator; (ii) the same applies to the denominator, namely, environmental pollution that captures the degree of ‘greening’ or ‘browning’ of the global and national economies beyond, simply, CO<sub>2</sub> emissions but including other GHG emissions; (iii) the analysis could be extended to tracking greening prosperity requirements and scenarios for the future; (iv) the proposed comparable colormap stripes across coun-

tries sometimes do not capture adequately progress made within the bottom or top stripes of the worldwide scale, due to the winsorization enabling the appearance of a larger number of stripes (as was discussed); (v) finally, the measures of economic prosperity we used could be complemented by incorporating some index of ‘decent living standards’, as suggested in the related literature.

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**A    Appendix**  
**to “Greening Prosperity Stripes 2:**  
**Consumption-Based Refinement”**  
**(for online publication)**

**Alexander Mihailov**

**August 2026**

This appendix contains supplementary material and begins with Table A1, describing the World Bank database, which we used, listing all countries and country groupings according to its various classifications and their unique three-letter codes. Figures A1 through A10, then, provide analogous comparative colormap stripe visualizations as in the main text but now employing an alternative, ‘dynamic’ winsorization at 5% (the bottom color in each palette) and 95% (the top color in each palette), which takes the global panel data minimum and maximum for the respective distributions of the variables rather than the local minimum and maximum for the benchmark year, 2020, in the ‘static’ winsorization at 5% and 95% in the main text. The dynamic winsorization illustrated further below can also be viewed as a sort of robustness check.

Table A1: World Bank Database (Online) – All Countries and Groups in the World

| Abs | Country / Group             | CodeRel | Abs | Country / Group                        | CodeRel | Abs | Country / Group             | CodeRel |
|-----|-----------------------------|---------|-----|----------------------------------------|---------|-----|-----------------------------|---------|
| 1   | Aruba                       | ABW 1   | 91  | Grenada                                | GRD 78  | 181 | New Zealand                 | NZL 149 |
| 2   | Africa Eastern and Southern | AFE 1   | 92  | Greenland                              | GRL 79  | 182 | OECD members                | OECD 33 |
| 3   | Afghanistan                 | AFG 2   | 93  | Guatemala                              | GTM 80  | 183 | Oman                        | OMN 150 |
| 4   | Africa Western and Central  | AFW 2   | 94  | Guam                                   | GUM 81  | 184 | Other small states          | OSS 34  |
| 5   | Angola                      | AGO 3   | 95  | Guyana                                 | GUY 82  | 185 | Pakistan                    | PAK 151 |
| 6   | Albania                     | ALB 4   | 96  | High income                            | HIC 14  | 186 | Panama                      | PAN 152 |
| 7   | Andorra                     | AND 5   | 97  | Hong Kong SAR, China                   | HKG 83  | 187 | Peru                        | PER 153 |
| 8   | Arab World                  | ARB 3   | 98  | Honduras                               | HND 84  | 188 | Philippines                 | PHL 154 |
| 9   | United Arab Emirates        | ARE 6   | 99  | Heavily indebted poor countries (HIPC) | HPC 15  | 189 | Palau                       | PLW 155 |
| 10  | Argentina                   | ARG 7   | 100 | Croatia                                | HRV 85  | 190 | Papua New Guinea            | PNG 156 |
| 11  | Armenia                     | ARM 8   | 101 | Haiti                                  | HTI 86  | 191 | Poland                      | POL 157 |
| 12  | American Samoa              | ASM 9   | 102 | Hungary                                | HUN 87  | 192 | Pre-demographic dividend    | PRE 35  |
| 13  | Antigua and Barbuda         | ATG 10  | 103 | IBRD only                              | IBD 16  | 193 | Puerto Rico                 | PRI 158 |
| 14  | Australia                   | AUS 11  | 104 | IDA & IBRD total                       | IBT 17  | 194 | Korea, Dem. People's Rep.   | PRK 159 |
| 15  | Austria                     | AUT 12  | 105 | IDA total                              | IDA 18  | 195 | Portugal                    | PRT 160 |
| 16  | Azerbaijan                  | AZE 13  | 106 | IDA blend                              | IDB 19  | 196 | Paraguay                    | PRY 161 |
| 17  | Burundi                     | BDI 14  | 107 | Indonesia                              | IDN 88  | 197 | West Bank and Gaza          | PSE 162 |
| 18  | Belgium                     | BEL 15  | 108 | IDA only                               | IDX 20  | 198 | Pacific island small states | PSS 36  |
| 19  | Benin                       | BEN 16  | 109 | Isle of Man                            | IMN 89  | 199 | Post-demographic dividend   | PST 37  |
| 20  | Burkina Faso                | BFA 17  | 110 | India                                  | IND 90  | 200 | French Polynesia            | PYF 163 |
| 21  | Bangladesh                  | BGD 18  | 111 | Not classified                         | INX 21  | 201 | Qatar                       | QAT 164 |
| 22  | Bulgaria                    | BGR 19  | 112 | Ireland                                | IRL 91  | 202 | Romania                     | ROU 165 |
| 23  | Bahrain                     | BHR 20  | 113 | Iran, Islamic Rep.                     | IRN 92  | 203 | Russian Federation          | RUS 166 |
| 24  | Bahamas, The                | BHS 21  | 114 | Iraq                                   | IRQ 93  | 204 | Rwanda                      | RWA 167 |
| 25  | Bosnia and Herzegovina      | BIH 22  | 115 | Iceland                                | ISL 94  | 205 | South Asia                  | SAS 38  |

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| Abs | Country / Group                | Code Rel | Abs | Country / Group                                   | Code Rel  | Abs | Country / Group                                | Code Rel |
|-----|--------------------------------|----------|-----|---------------------------------------------------|-----------|-----|------------------------------------------------|----------|
| 26  | Belarus                        | BLR 23   | 116 | Israel                                            | ISR 95    | 206 | Saudi Arabia                                   | SAU 168  |
| 27  | Belize                         | BLZ 24   | 117 | Italy                                             | ITA 96    | 207 | Sudan                                          | SDN 169  |
| 28  | Bermuda                        | BMU 25   | 118 | Jamaica                                           | JAM 97    | 208 | Senegal                                        | SEN 170  |
| 29  | Bolivia                        | BOL 26   | 119 | Jordan                                            | JOR 98    | 209 | Singapore                                      | SGP 171  |
| 30  | Brazil                         | BRA 27   | 120 | Japan                                             | JPN 99    | 210 | Solomon Islands                                | SLB 172  |
| 31  | Barbados                       | BRB 28   | 121 | Kazakhstan                                        | KAZ 100   | 211 | Sierra Leone                                   | SLE 173  |
| 32  | Brunei Darussalam              | BRN 29   | 122 | Kenya                                             | KEN 101   | 212 | El Salvador                                    | SLV 174  |
| 33  | Bhutan                         | BTN 30   | 123 | Kyrgyz Republic                                   | KGZ 102   | 213 | San Marino                                     | SMR 175  |
| 34  | Botswana                       | BWA 31   | 124 | Cambodia                                          | KHM 103   | 214 | Somalia                                        | SOM 176  |
| 35  | Central African Republic       | CAF 32   | 125 | Kiribati                                          | KIR 104   | 215 | Serbia                                         | SRB 177  |
| 36  | Canada                         | CAN 33   | 126 | St. Kitts and Nevis                               | KNA 105   | 216 | Sub-Saharan Africa (excluding SSA high income) | SSA 39   |
| 37  | Central Europe and the Baltics | CEB 4    | 127 | Korea, Rep.                                       | KOR 106   | 217 | South Sudan                                    | SSD 178  |
| 38  | Switzerland                    | CHE 34   | 128 | Kuwait                                            | KWT 107   | 218 | Sub-Saharan Africa                             | SSF 40   |
| 39  | Channel Islands                | CHI 35   | 129 | Latin America & Caribbean (excluding high income) | ex-LAC 22 | 219 | Small states                                   | SST 41   |
| 40  | Chile                          | CHL 36   | 130 | Lao PDR                                           | LAO 108   | 220 | Sao Tome and Principe                          | STP 179  |
| 41  | China                          | CHN 37   | 131 | Lebanon                                           | LBN 109   | 221 | Suriname                                       | SUR 180  |
| 42  | Cote d'Ivoire                  | CIV 38   | 132 | Liberia                                           | LBR 110   | 222 | Slovak Republic                                | SVK 181  |
| 43  | Cameroon                       | CMR 39   | 133 | Libya                                             | LBY 111   | 223 | Slovenia                                       | SVN 182  |
| 44  | Congo, Dem. Rep.               | COD 40   | 134 | St. Lucia                                         | LCA 112   | 224 | Sweden                                         | SWE 183  |
| 45  | Congo, Rep.                    | COG 41   | 135 | Latin America & Caribbean                         | LCN 23    | 225 | Eswatini                                       | SWZ 184  |
| 46  | Colombia                       | COL 42   | 136 | Least developed countries: UN classification      | LDC 24    | 226 | Sint Maarten (Dutch part)                      | SXM 185  |
| 47  | Comoros                        | COM 43   | 137 | Low income                                        | LIC 25    | 227 | Seychelles                                     | SYC 186  |
| 48  | Cabo Verde                     | CPV 44   | 138 | Liechtenstein                                     | LIE 113   | 228 | Syrian Arab Republic                           | SYR 187  |

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| Abs | Country / Group                               | Code Rel | Abs | Country / Group            | Code Rel | Abs | Country / Group                      | Code Rel |
|-----|-----------------------------------------------|----------|-----|----------------------------|----------|-----|--------------------------------------|----------|
| 49  | Costa Rica                                    | CRI 45   | 139 | Sri Lanka                  | LKA 114  | 229 | Turks and Caicos Islands             | TCA 188  |
| 50  | Caribbean small states                        | CSS 5    | 140 | Lower middle income        | LMC 26   | 230 | Chad                                 | TCD 189  |
| 51  | Cuba                                          | CUB 46   | 141 | Low & middle income        | LMY 27   | 231 | East Asia & Pacific (IDA & TEA 42    |          |
|     |                                               |          |     |                            |          |     | IBRD countries)                      |          |
| 52  | Curacao                                       | CUW 47   | 142 | Lesotho                    | LSO 115  | 232 | Europe & Central Asia (IDA & TEC 43  |          |
|     |                                               |          |     |                            |          |     | IBRD countries)                      |          |
| 53  | Cayman Islands                                | CYM 48   | 143 | Late-demographic dividend  | LTE 28   | 233 | Togo                                 | TGO 190  |
| 54  | Cyprus                                        | CYP 49   | 144 | Lithuania                  | LTU 116  | 234 | Thailand                             | THA 191  |
| 55  | Czechia                                       | CZE 50   | 145 | Luxembourg                 | LUX 117  | 235 | Tajikistan                           | TJK 192  |
| 56  | Germany                                       | DEU 51   | 146 | Latvia                     | LVA 118  | 236 | Turkmenistan                         | TKM 193  |
| 57  | Djibouti                                      | DJI 52   | 147 | Macao SAR, China           | MAC 119  | 237 | Latin America & the Caribbean TLA 44 |          |
|     |                                               |          |     |                            |          |     | (IDA & IBRD countries)               |          |
| 58  | Dominica                                      | DMA 53   | 148 | St. Martin (French part)   | MAF 120  | 238 | Timor-Leste                          | TLS 194  |
| 59  | Denmark                                       | DNK 54   | 149 | Morocco                    | MAR 121  | 239 | Middle East & North Africa TMN 45    |          |
|     |                                               |          |     |                            |          |     | (IDA & IBRD countries)               |          |
| 60  | Dominican Republic                            | DOM 55   | 150 | Monaco                     | MCO 122  | 240 | Tonga                                | TON 195  |
| 61  | Algeria                                       | DZA 56   | 151 | Moldova                    | MDA 123  | 241 | South Asia (IDA & IBRD)              | TSA 46   |
| 62  | East Asia & Pacific (excluding high income)   | EAP 6    | 152 | Madagascar                 | MDG 124  | 242 | Sub-Saharan Africa (IDA & TSS 47     |          |
|     |                                               |          |     |                            |          |     | IBRD countries)                      |          |
| 63  | Early-demographic dividend                    | EAR 7    | 153 | Maldives                   | MDV 125  | 243 | Trinidad and Tobago                  | TTO 196  |
| 64  | East Asia & Pacific                           | EAS 8    | 154 | Middle East & North Africa | MEA 29   | 244 | Tunisia                              | TUN 197  |
| 65  | Europe & Central Asia (excluding high income) | ECA 9    | 155 | Mexico                     | MEX 126  | 245 | Turkiye                              | TUR 198  |
|     |                                               |          |     |                            |          |     |                                      |          |
| 66  | Europe & Central Asia                         | ECS 10   | 156 | Marshall Islands           | MHL 127  | 246 | Tuvalu                               | TUV 199  |
| 67  | Ecuador                                       | ECU 57   | 157 | Middle income              | MIC 30   | 247 | Tanzania                             | TZA 200  |
| 68  | Egypt, Arab Rep.                              | EGY 58   | 158 | North Macedonia            | MKD 128  | 248 | Uganda                               | UGA 201  |

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| Abs | Country / Group                          | Code Rel | Abs | Country / Group                                    | Code Rel | Abs | Country / Group                | Code Rel |
|-----|------------------------------------------|----------|-----|----------------------------------------------------|----------|-----|--------------------------------|----------|
| 69  | Euro area                                | EMU 11   | 159 | Mali                                               | MLI 129  | 249 | Ukraine                        | UKR 202  |
| 70  | Eritrea                                  | ERI 59   | 160 | Malta                                              | MLT 130  | 250 | Upper middle income            | UMC 48   |
| 71  | Spain                                    | ESP 60   | 161 | Myanmar                                            | MMR 131  | 251 | Uruguay                        | URY 203  |
| 72  | Estonia                                  | EST 61   | 162 | Middle East & North Africa (excluding high income) | MNA 31   | 252 | United States                  | USA 204  |
| 73  | Ethiopia                                 | ETH 62   | 163 | Montenegro                                         | MNE 132  | 253 | Uzbekistan                     | UZB 205  |
| 74  | European Union                           | EUU 12   | 164 | Mongolia                                           | MNG 133  | 254 | St. Vincent and the Grenadines | VCT 206  |
| 75  | Fragile and conflict affected situations | FCS 13   | 165 | Northern Mariana Islands                           | MNP 134  | 255 | Venezuela, RB                  | VEN 207  |
| 76  | Finland                                  | FIN 63   | 166 | Mozambique                                         | MOZ 135  | 256 | British Virgin Islands         | VGB 208  |
| 77  | Fiji                                     | FJI 64   | 167 | Mauritania                                         | MRT 136  | 257 | Virgin Islands (U.S.)          | VIR 209  |
| 78  | France                                   | FRA 65   | 168 | Mauritius                                          | MUS 137  | 258 | Vietnam                        | VNM 210  |
| 79  | Faroe Islands                            | FRO 66   | 169 | Malawi                                             | MWI 138  | 259 | Vanuatu                        | VUT 211  |
| 80  | Micronesia, Fed. Sts.                    | FSM 67   | 170 | Malaysia                                           | MYS 139  | 260 | World                          | WLD 49   |
| 81  | Gabon                                    | GAB 68   | 171 | North America                                      | NAC 32   | 261 | Samoa                          | WSM 212  |
| 82  | United Kingdom                           | GBR 69   | 172 | Namibia                                            | NAM 140  | 262 | Kosovo                         | XKX 213  |
| 83  | Georgia                                  | GEO 70   | 173 | New Caledonia                                      | NCL 141  | 263 | Yemen, Rep.                    | YEM 214  |
| 84  | Ghana                                    | GHA 71   | 174 | Niger                                              | NER 142  | 264 | South Africa                   | ZAF 215  |
| 85  | Gibraltar                                | GIB 72   | 175 | Nigeria                                            | NGA 143  | 265 | Zambia                         | ZMB 216  |
| 86  | Guinea                                   | GIN 73   | 176 | Nicaragua                                          | NIC 144  | 266 | Zimbabwe                       | ZWE 217  |
| 87  | Gambia, The                              | GMB 74   | 177 | Netherlands                                        | NLD 145  |     |                                |          |
| 88  | Guinea-Bissau                            | GNB 75   | 178 | Norway                                             | NOR 146  |     |                                |          |
| 89  | Equatorial Guinea                        | GNQ 76   | 179 | Nepal                                              | NPL 147  |     |                                |          |
| 90  | Greece                                   | GRC 77   | 180 | Nauru                                              | NRU 148  |     |                                |          |

Note: 'Abs' (olute number) denotes the order of each country or group (all marked in red to facilitate visualization and count in each of these two subsets) the total count in the World Bank dataset, whereas 'Rel' (ative number) denotes its order in a separate count in either countries or groups. The respective country or group 'Code' is the same as in the online source.

Figures A1, A2 and A3 are the ‘dynamic’ winsorization version of figures 1, 2 and 3 in the main text, presenting the largest world economies of the US, China, India and Germany.

Figures A4, A5 and A6 are, similarly, the ‘dynamic’ winsorization version of figures 4, 5 and 6 in the main text, presenting four other example economies of at different stages of economic development and in different locations on the globe, namely the UK, Switzerland, Brazil and Mozambique.

Figures A7, A8, A9 and A10 are, in turn, the ‘dynamic’ winsorization version of figures 7, 8, 9 and 10 in the main text, presenting a single-country summary-stripes perspective in a graph with six panels for each of four additional important economies, those of Japan, Australia, Canada and Poland.

As one can see by inspecting and comparing the stripes in the respective pairs of graphs with static winsorization (in the main text) vs dynamic winsorization (following in this appendix), there are no essential differences in the ranking, that is, the stripe color sequences, assigned to the various country examples of this kind of visualization. In a sense, this alternative winsorization provides a kind of robustness check, as was mentioned in the main text

Figure A1: Greening prosperity stripes, 1990-2020 – 1: original (top row) in ‘discounted’ PPP-USD of 2017 vs 2: refined (bottom row) in ‘discounted’ PPP-USD of 2021; World Bank annual data, dynamic winsorization at 5% and 95% using the respective global panel data distributions

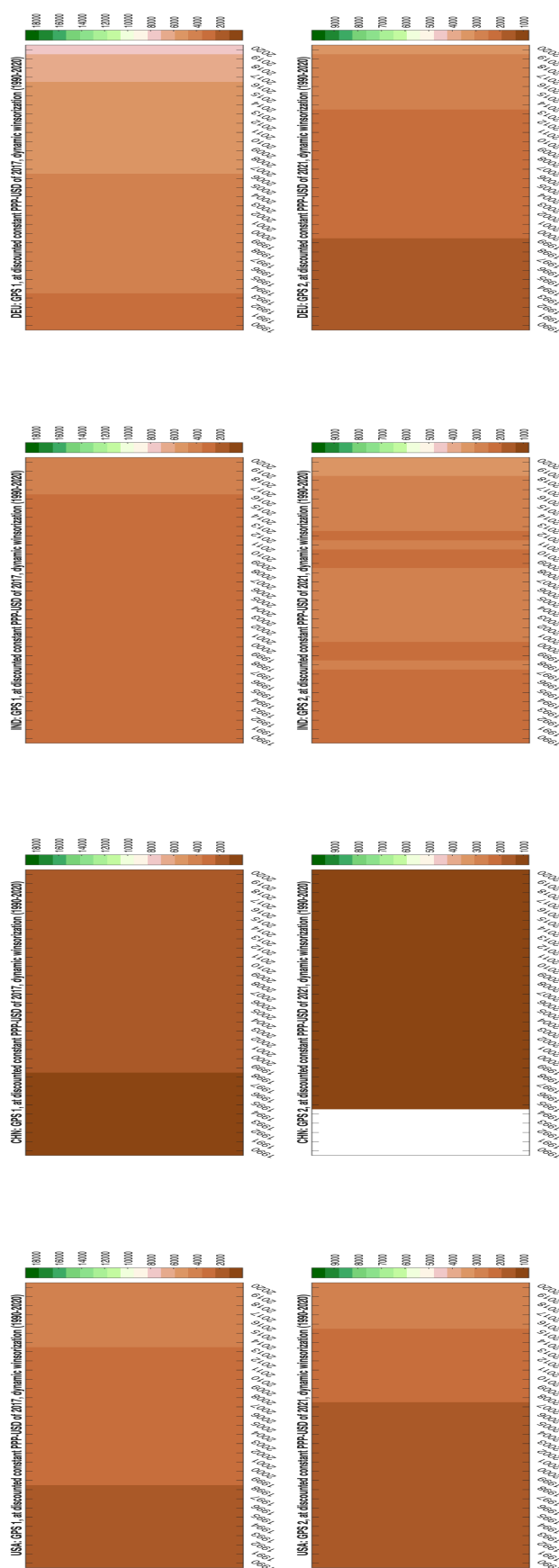


Figure A2: CO2 emissions pc (top row) vs consumption-based CO2 emissions pc (bottom row) in metric tons; 1990-2020, World Bank annual data, dynamic winsorization at 5% and 95% using the respective global panel data distributions

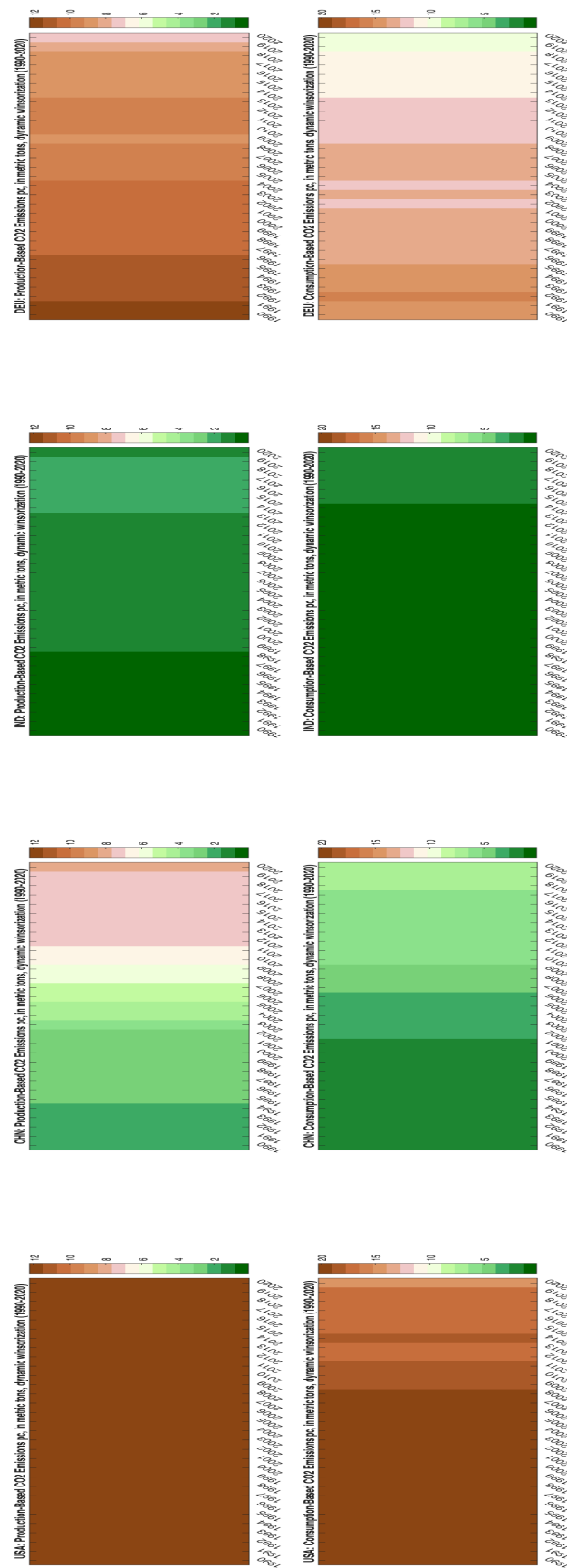


Figure A3: Real GDP pc at PPP in international USD of 2017 (top row) vs real consumption pc at PPP in international USD of 2021 (bottom row); 1990-2020, World Bank annual data, dynamic winsorization at 5% and 95% of the respective global panel data distributions

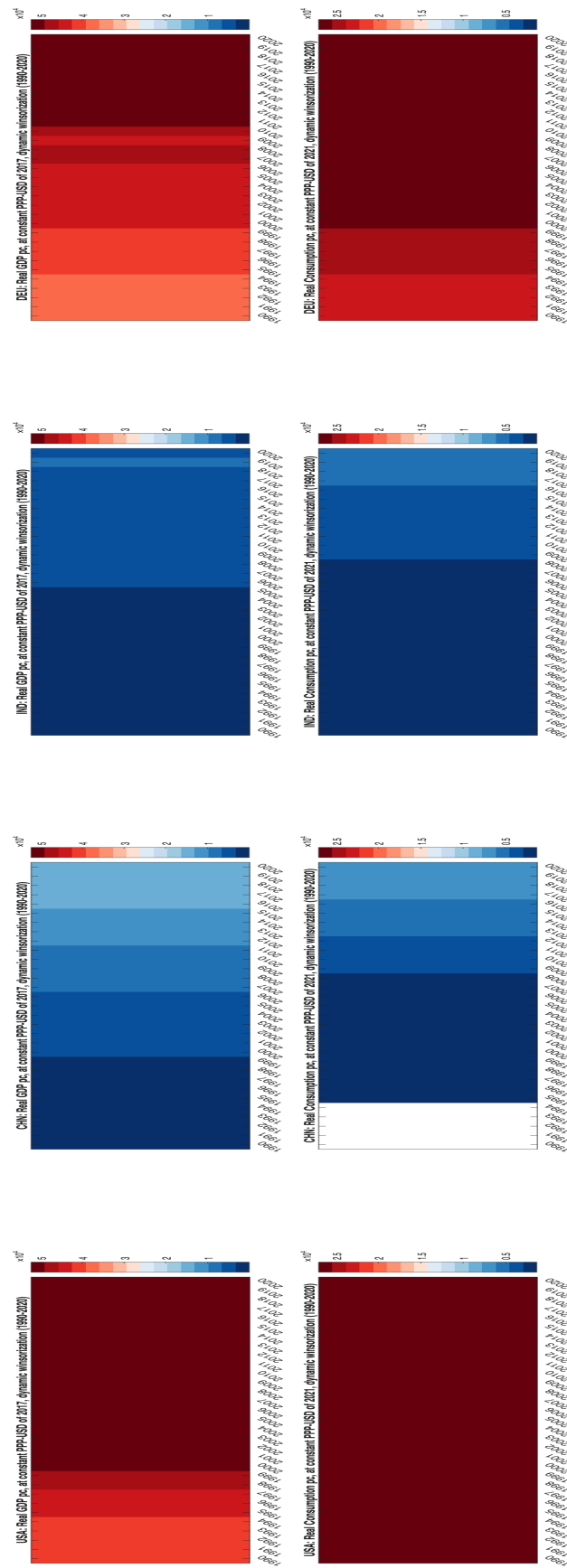


Figure A4: Greening prosperity stripes: original (top row) in ‘discounted’ PPP-USD of 2017 vs refined (bottom row) in ‘discounted’ PPP-USD of 2021; 1990-2020, World Bank annual data, dynamic winsorization at 5% and 95% of the respective global panel data distributions

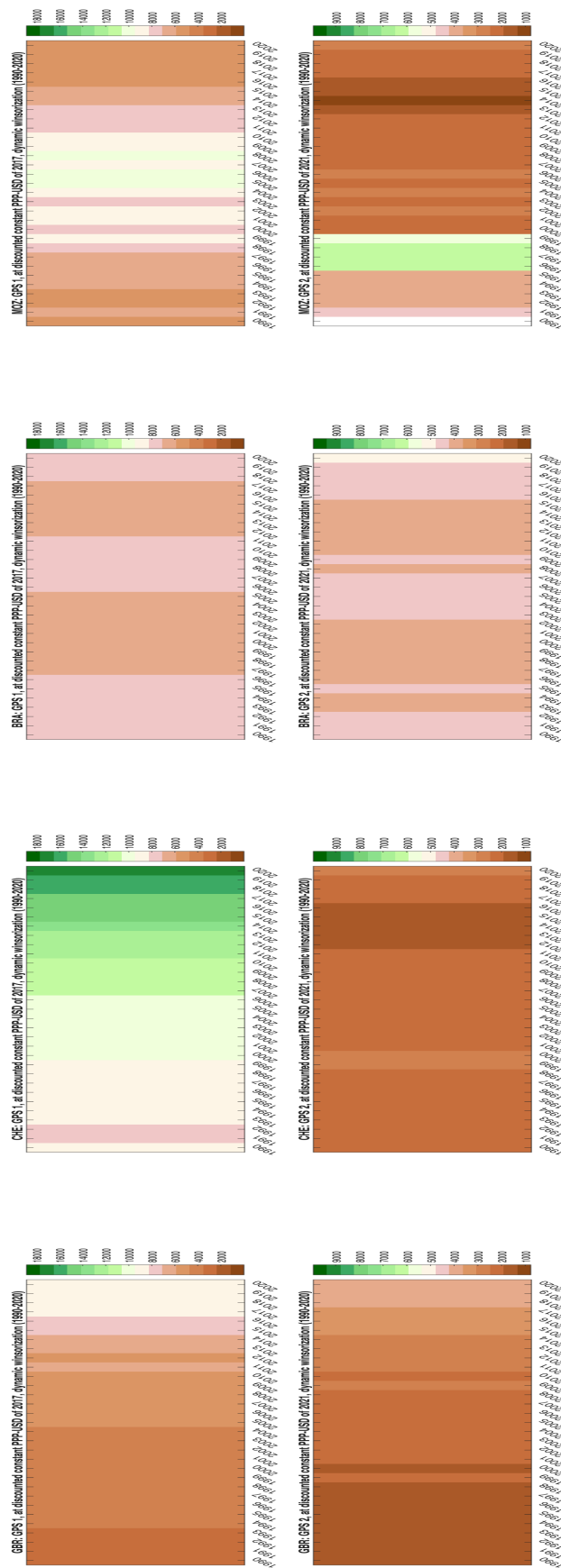


Figure A5: Production-based CO2 emissions pc (top row) vs consumption-based CO2 emissions pc (bottom row) in metric tons; 1990-2020, World Bank annual data, dynamic winsorization at 5% and 95% of the global panel data distributions

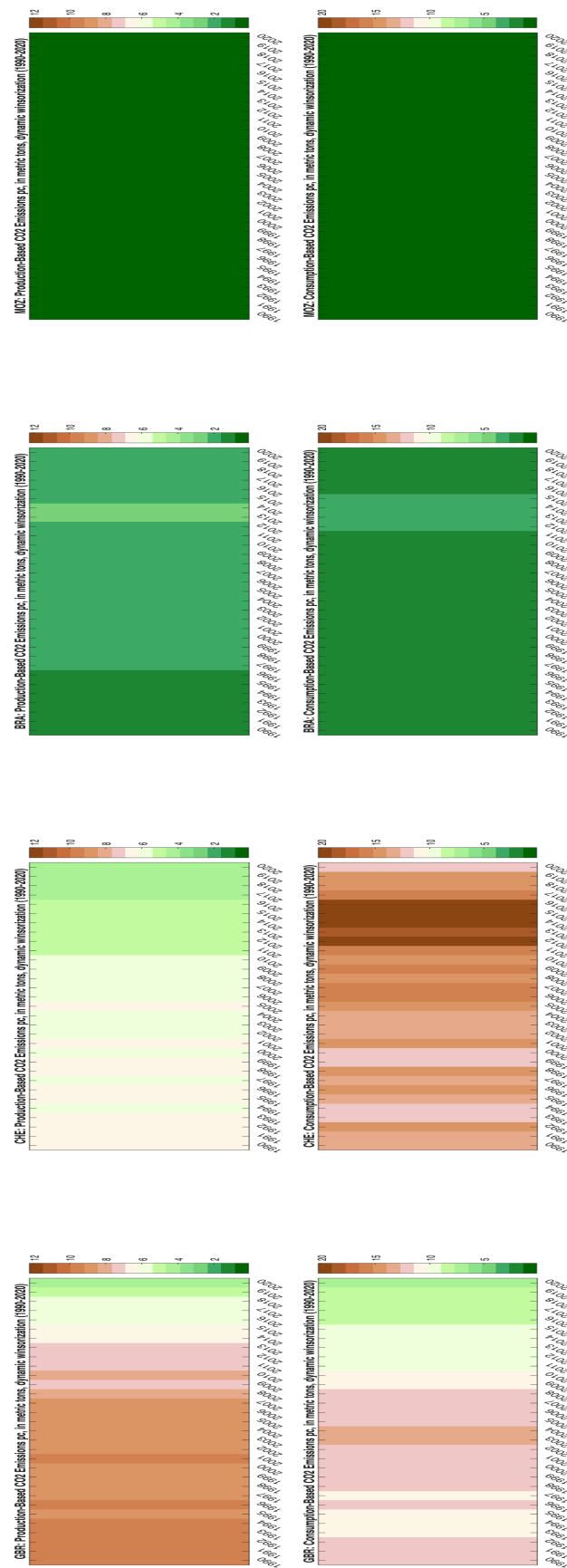


Figure A6: Real GDP pc at PPP in international USD of 2017 (top row) vs real consumption pc at PPP in international USD of 2021 (bottom row); 1990-2020, World Bank annual data, dynamic winsorization at 5% and 95% of the respective global panel data distributions

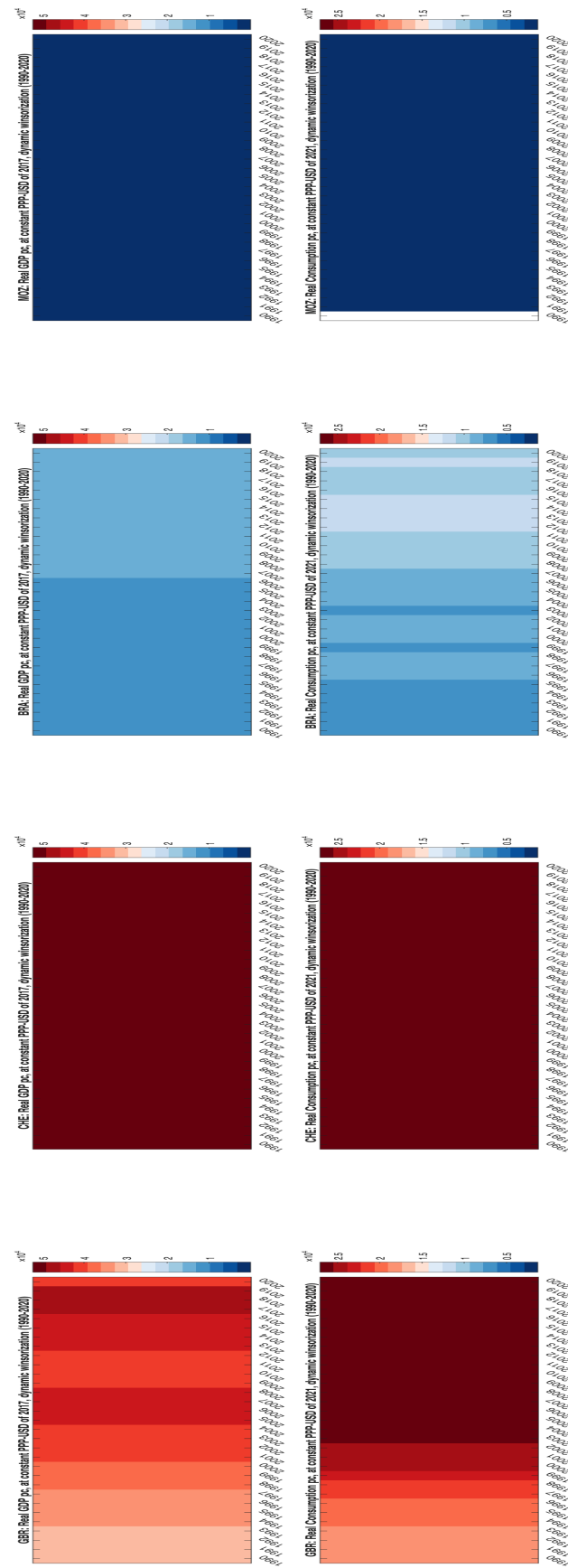


Figure A7: Japan: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

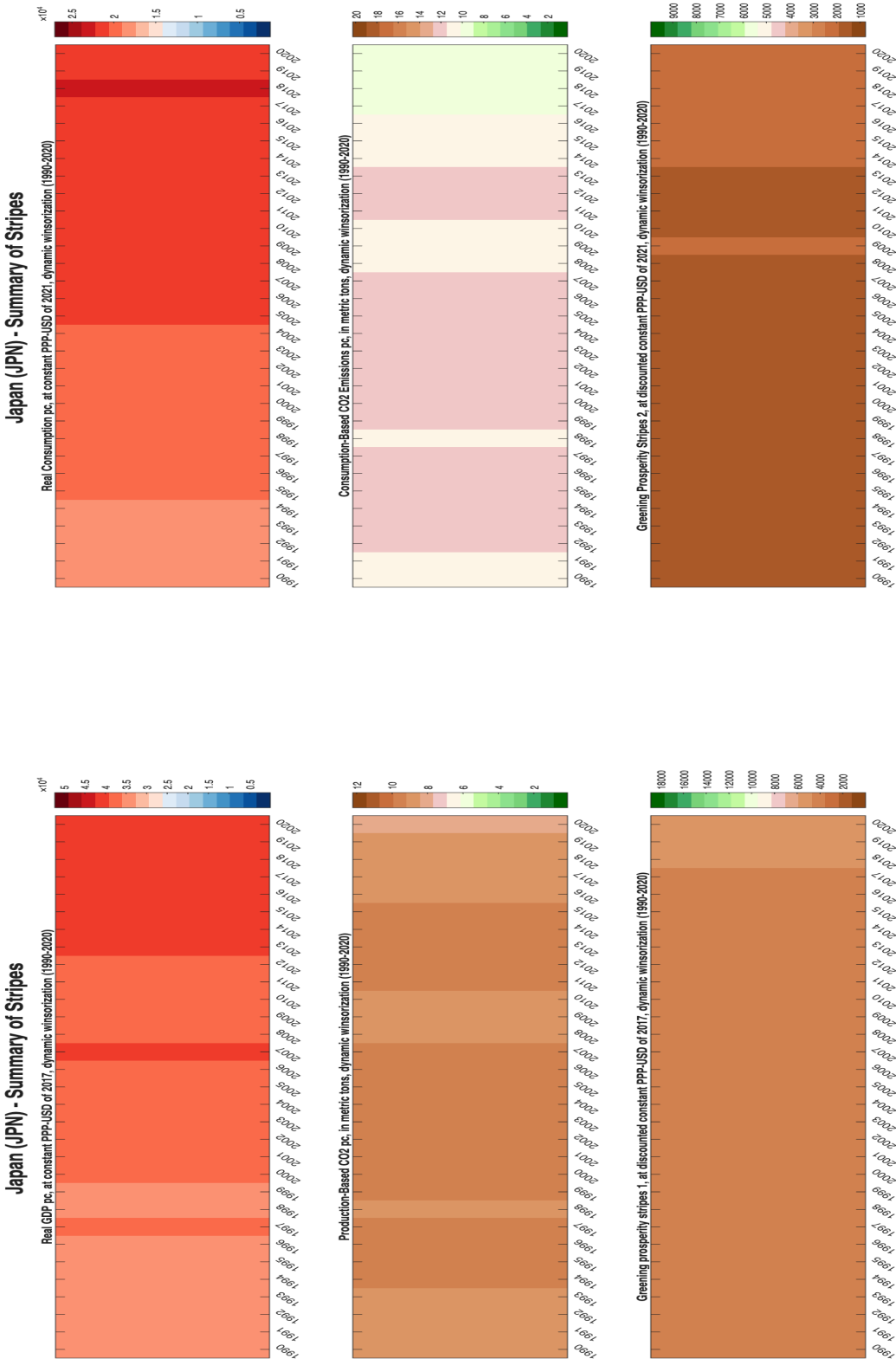


Figure A8: Australia: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

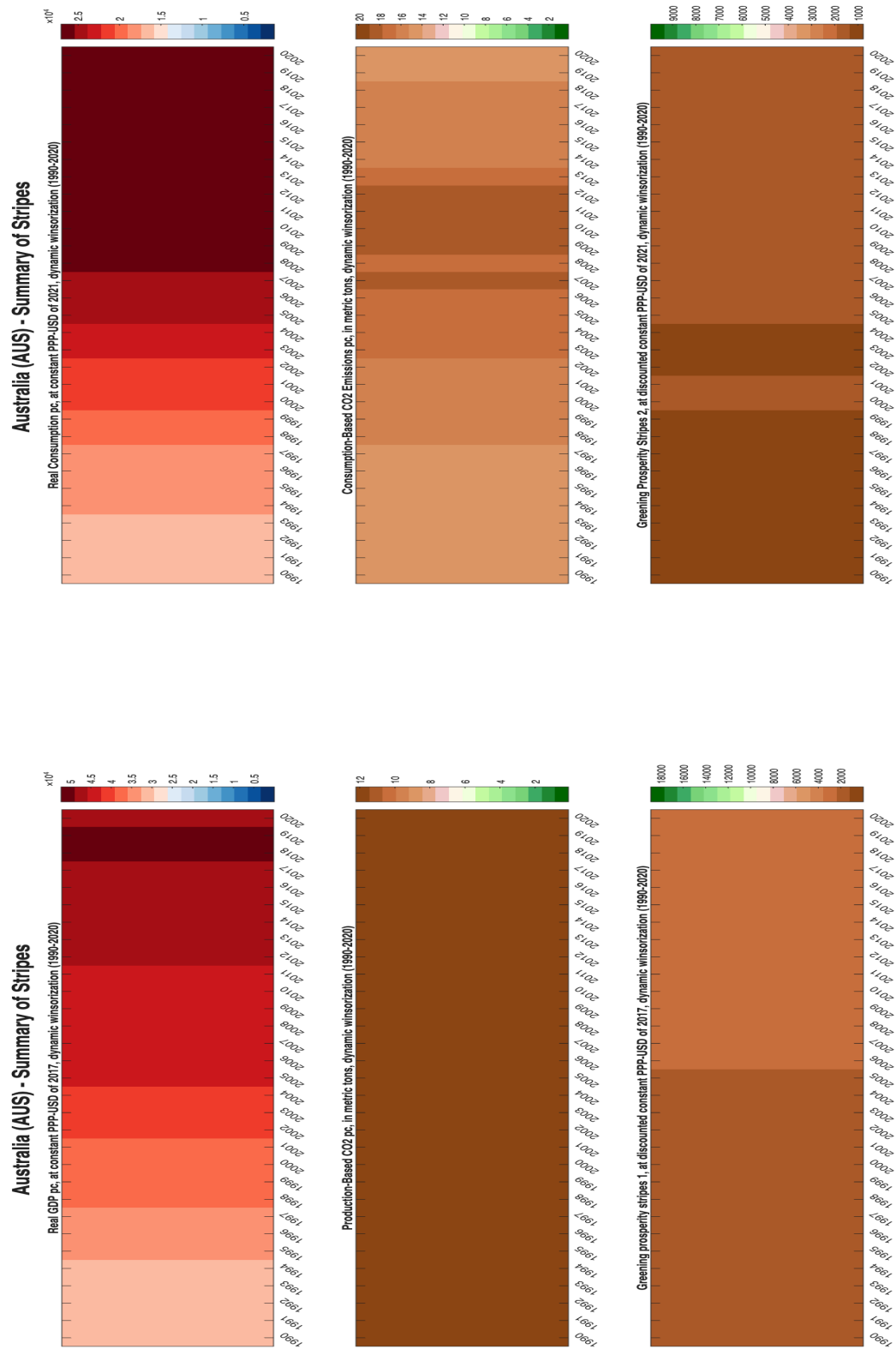


Figure A9: Canada: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

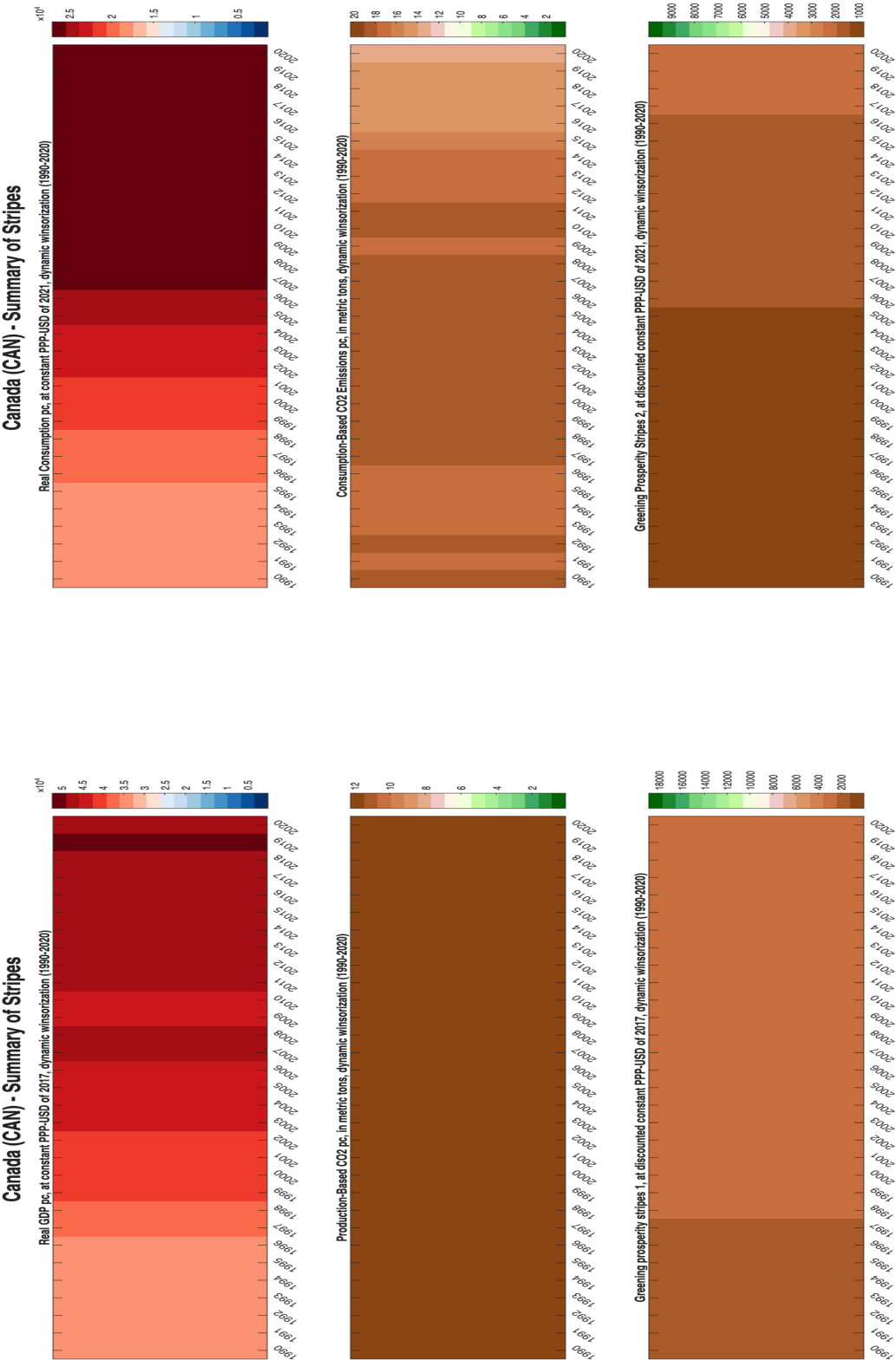


Figure A10: Poland: Summary of Stripes, Static Winsorization at 5% and 95% Using the 2020 Distributions - Production-Based (left column) vs Consumption-Based (right column)

