FUTURE CLIMATE WEALTH OF NATIONS' WINNERS AND LOSERS

Overview: Past research

Mapping Climate Justice proposes a 3-dimensional environmental justice approach to share economic benefits and the burden of climate change right, just and fair around the globe. Scientific data is backed by ethical imperatives. Gross Domestic Product (GDP) gains and losses of a warming globe are captured to be distributed unequal around the world. The ethical climatorial imperative demands for an equalization of the gains of climate change around the globe in order to offset losses incurred due to climate change (Kant, 1783/1993; Puaschunder, 2017b, c; Rawls, 1971).

First, climate justice within a country should pay tribute to the fact that low- and high-income households carry the same burden proportional to their disposable income, for instance, enabled through a progressive carbon taxation, consumption tax to curb harmful behavior and/or corporate inheritance tax to reap benefits of past wealth accumulation that may have caused climate change (Puaschunder, 2017c).

Secondly, fair climate change change burden sharing between countries ensures those countries benefiting more from a warmer environment also bear a higher responsibility regarding climate change mitigation and adaptation efforts (Puaschunder, forthcoming).

Thirdly, climate justice over time is proposed in an innovative climate change burden sharing bonds strategy, which distributes the benefits and burdens of a warming earth Pareto-optimal among generations (Puaschunder, 2016a).

All these recommendations are aimed at sharing the burden but also the benefits of climate change within society in an economically efficient, legally equitable and practically feasible way now and also between generations.

Overview: Future research proposal

As a novel project, **Future Climate Wealth of Nations** is derived from climate flexibility defined as the range of temperature variation of a country. In a changing climate, temperature range flexibility is portrayed as a future asset for production flexibility and international trade of commodities leading to comparative advantages of countries.

A broad spectrum of climate zones has never been defined as asset and comparative edge in free trade. But future climate change will require territories being more flexible in terms of changing economic production possibilities on a warming globe. The more climate variation a nation state possesses, this novel project argues, the more degrees of freedom a country has in terms of GDP production capabilities in a changing climate.

Modeling and empirical validation: These preliminary insights aid in answering what financial flow and trade patterns we can expect given predictions the earth will become hotter. Climate variation based on cyclical changes or climate zones will become subject to scrutiny for associations with climate-based advantages and risks. Economic modeling, cross-sectional world country comparisons, time series and panel regressions will scrutinize temperature data in relation to production in order to derive inferences for future Climate Wealth of Nations.

Already now, the degree of climate flexibility is found to be related to human migration inflows. The previously defined climate change winner and loser index is blended with the novel insights on climate flexibility, leading to an unprecedented outlook on future Climate Wealth of Nations in a climate changing world (Puaschunder, forthcoming a).

Lastly, future climate change induced market changes are planned to be derived from scarcity of agriculture production. Individual commodities price distributions will become the foundation for commodity price expectation estimates in the environmental domain. Market prospects and

public policy recommendations are pursued in order to aid the greater goal to implement environmental justice now and for future generations.

THEORY

Climate justice *within* countries: In order to finance climate change mitigation and adaptation efforts, a diversified taxation scheme is proposed. To find a fair and just distribution of the burden of climate change, a taxation mix of (1) consumption tax, (2) progressive tax and (3) inheritance tax is recommended. Consumption tax can curb harmful emissions and directly nudge behavior towards sustainability. Yet to place a fair share of the burden of climate change mitigation upon society, these taxes have to be adjusted to the individual disposable income in order to not heavier charge low-income households. Retroactive taxation of past wealth accumulation at the expense of environmental damage can be enacted through inheritance tax of the corporate sector. Industries should be taxed, when a merger or acquisition or a board member change occurs, in order to reap benefits from past wealth accumulation that potentially caused carbon emissions.

Climate justice *between* countries: Following the introduction of the gains from climate change (Puaschunder, 2017a, d), the *Climate Justice in the 21st Century* endeavor proposes a model to distribute the benefits of a warming earth in a fair way. Based on legal subsumptions and ethical imperatives, argumentations of the those countries having better means of protection and conservation of a stable climate, lead to the pledge of climate change winners having to bear a higher weight of climate stabilization efforts. Drawing on the conclusion of the climatorial imperative – advocating for the need for fairness in the distribution of the global earth benefits among nations based on Kant's (1783/1993) imperative to only engage in actions one wants to experience being done to oneself – the redistribution of climate gains and losses is argued philosophically and ethically to alleviate climate inequality (Puaschunder, 2017a, b, c, forthcoming a).

MODEL

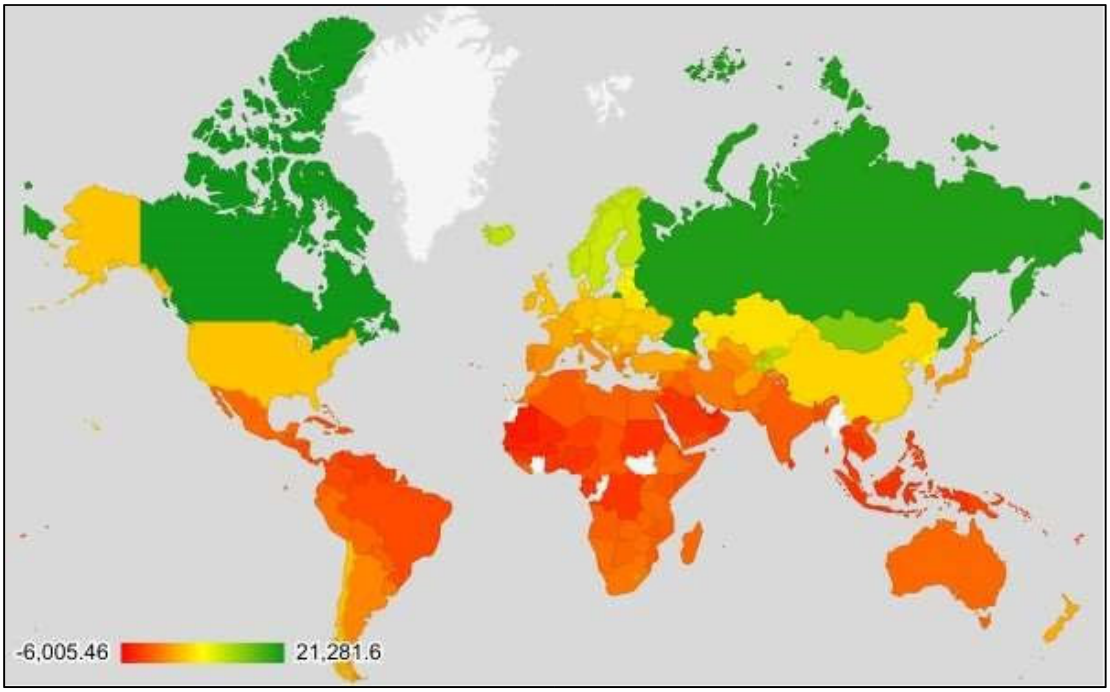
A macroeconomic cost-benefit analysis aids to find the optimum solution on how to distribute climate change benefits and burden within society and over time. Based on the mean temperature of world countries and the optimal temperature for Gross Domestic Production (GDP) measured by agriculture, industry and service sector productivity as well as the GDP composition per country, the optimal temperature condition for economic productivity can be derived per country.

RESULTS

Given data of the average temperature per country around the world as well as climate projections of the year 2100 under a business as usual path, the world is found to macro-economically benefit from climate change more until 2100 than lose (Puaschunder, 2016a, b, c, d). Graph 1 holds Climate Change Winners (**Green** & **Yellow**) and Losers (**Orange** & **Red**). These overall gains are distributed highly unequally around the world.

Green countries are those that have the most time ahead until reaching the optimal temperature for GDP production by climate, **yellow countries** have some time ahead. **Orange** and **red countries** will have run out of time by 2100 for GDP productivity by temperature. Winning and losing from a warming earth is significantly positively correlated with self-reported CO_2 emissions, leading to the conclusion that the countries with the longest time horizon regarding a warming earth lack motivation to mitigate global climate change. Detected climate-induced migration streams and financial flows manifest that different part of the earth are affected differently by a warming earth resulting in differing climate change mitigation and adaptation

efforts.



Graph 1: Climate change winners and losers around the world

Based on a 187 country-strong dataset, a significantly positive inflow of migrants was found into the climate change winner countries (Puaschunder, forthcoming a). A statistically significant correlation highlights a positive Foreign Direct Investment (FDI) inflow into the territories that have more time ahead towards temporal peak condition for GDP production (Puaschunder, forthcoming a). No significant remittances flow to climate change loser countries is found. The results underline the need to redistribute the gains from climate change to offset losses incurred from global warming and demand for a recognition of climate refugees under the Geneva Convention.

Having found that there are gains from a warming earth demands to transfer benefits into areas of the world that will be primarily losing from climate change (Chichilnisky, 1996, 2016; Chichilnisky et al., 1998; Chichilnisky & Heal, 2000). Having shed light on the gains of a warming earth allows for the redistribution of climate change benefits to those areas of the world that will be losing from a warming earth. In the implementation, a climate change bonds but also taxation strategies are recommended (Chichilnisky, 1996, 2016).

In order to avoid governmental expenditure on climate change hindering economic growth (Chichilnisky, 2007, 2010, 2016); the 'Climate in the 21st Century' idea offers a new way of funding climate change mitigation and adaptation policies but also the transition to renewable energy through broad-based climate stability bonds-and-taxation mix that also involve future generations (Puaschunder, forthcoming a; World Bank 2015 Report, 2015).

In order to finance climate change abatement, a climate bonds financing mix could subsidize the current world industry for transitioning to green solutions. Sharing the costs of climate stabilization between and across generations is a Pareto-optimal strategy to immediately instigate climate action without curbing today's economic growth potentials (Chichilnisky et al., 1998; Chichilnisky & Heal, 2000; Chichilnisky & Sheeran, 2018).

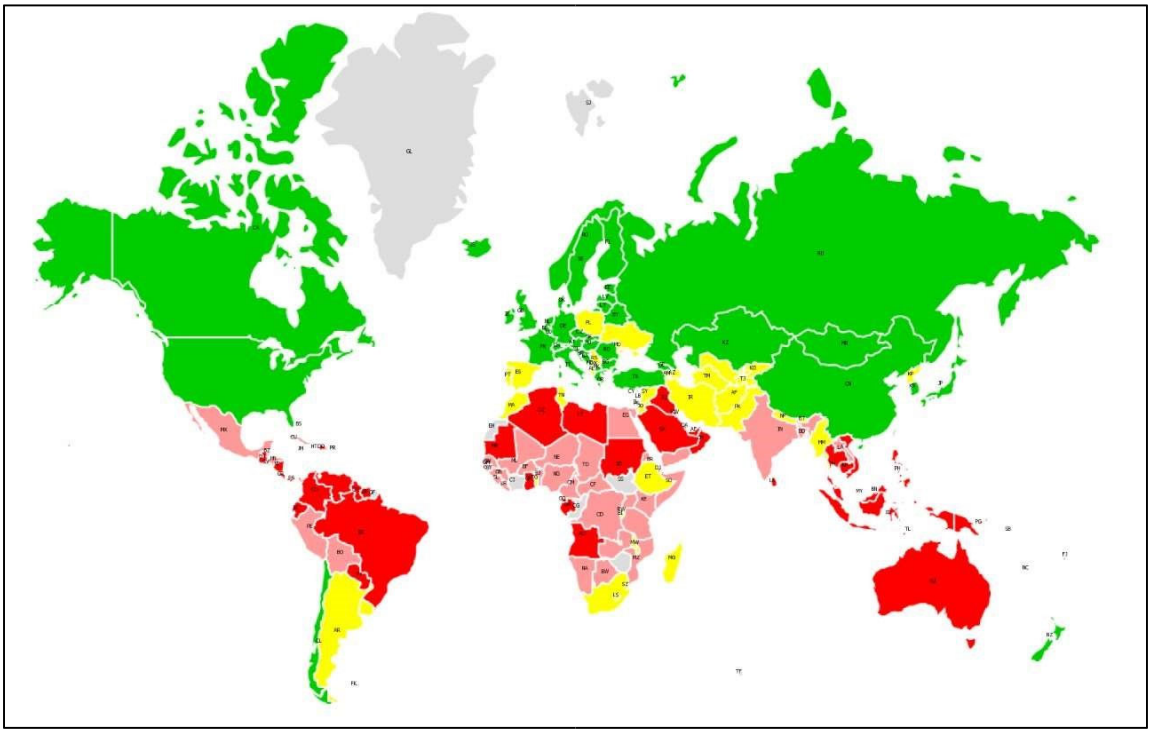
DISCUSSION AND IMPLICATIONS

Tax-and-bonds transfer strategy

As for redistributing the gains of a warming globe in order to offset losses incurred by global warming, a climate change bonds-and-tax finance strategy is proposed to bear the burden of climate change in a right, just and fair way within society, around the globe and over time (Puaschunder, 2017a, b, c).

In **climate change winner countries weighted by GDP per capita** (Graph 2 **Green** & **Yellow**), **taxation** should become the main climate stability financialization strategy. Foremost, the industries winning from a warming climate should be taxed. Regarding concrete climate taxation strategies, a carbon tax on top of the existing taxation should be used to reduce the burden of climate change and encourage economic growth through subsidies. Within a country, high and low income households should face the same burden of climate stabilization adjusted for their disposable income. Finding the optimum balance between consumption tax adjusted for disposable income through a progressive tax scheme will foster tax compliance in the sustainability domain.

Governments in **global warming loser countries weighted by GDP per capita** (Graph 2 **Orange** & **Red**) should receive **tax transfers in the present from the winning countries**. The climate change loser countries should also **borrow by loans or issuing of bonds** to be paid back by future generations. Taxing future generations is justified as future generations avoid higher costs of climate change long-term damages and environmental irreversible lock-ins. Overall this tax-and-transfer mitigation policy thus appears as a Pareto-improving fair solution across the world and among different generations.



Graph 2: Climate change tax-and-bonds transfers strategies around the world

Tax-and-bonds transfers could be used to incentivize industry actors for choosing clean energy. The revenues raised from taxation and bonds would thereby be allocated to subsidize corporations choosing clean energy. This market incentive could shift the general race-to-the-bottom regarding price cutting behavior and choosing dirty, cheap energy to a race-to-the-top hunt for subsidies for going into clean energy and production.

Concluding, climate change winning countries are advised to use taxation of the gains in sectors to raise revenues to offset the losses incurred by climate change. Climate change losers should issue bonds to be paid back by taxing future generations. Climate justice within a country should also pay tribute to the fact that low- and high income households share the same burden proportional to their dispensable income, for instance enabled through a progressive carbon taxation. Those who caused climate change could be regulated to bear a higher cost through carbon tax in combination with retroactive billing through a corporate inheritance tax to reap benefits from past wealth accumulation that contributed to global warming.

Future Climate Wealth of Nations

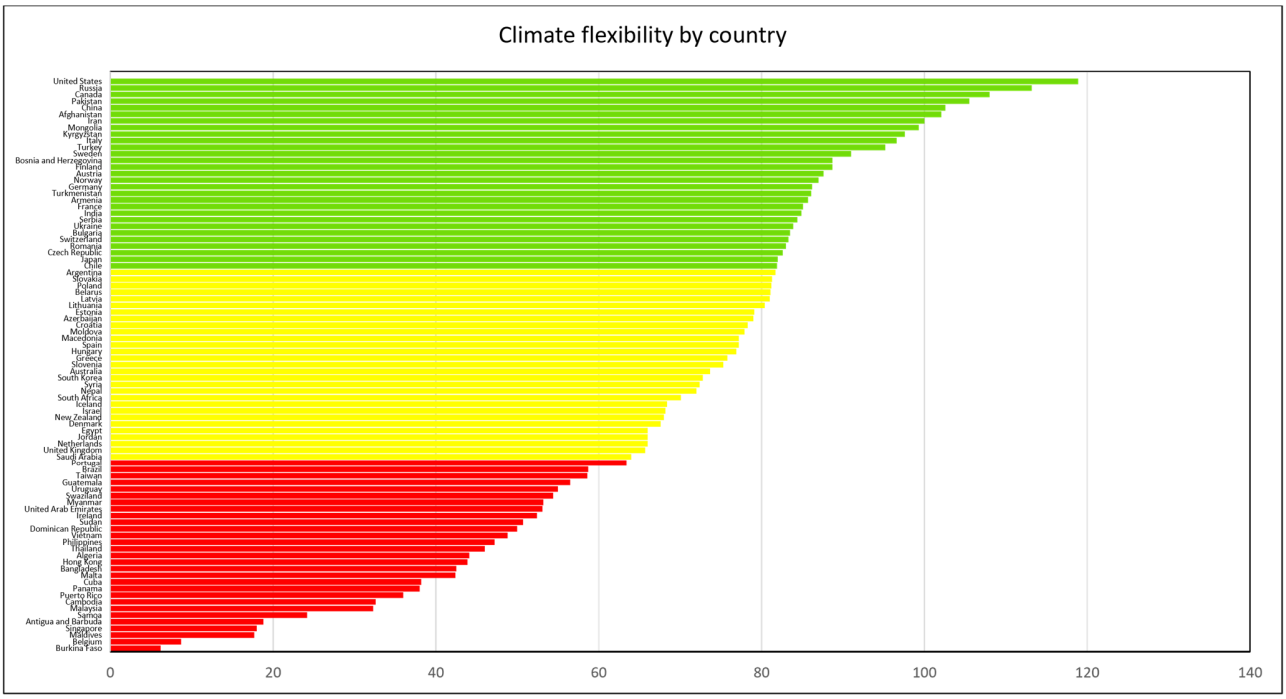
THEORY

Future Climate Wealth of Nations proposes climate flexibility as the range of temperature variation of a country, which determines climate flexibility and trade assets of the future. Economic production possibilities are determined by temperature flexibility. The more climate variation, the more degrees of freedom in temperature variability a country can offer.

RESULTS

Graph 3 exhibits climate flexibility by country determined by the temperature range based on the List of Countries by Extreme Temperatures.[1]

[1] https://en.wikipedia.org/wiki/List_of_countries_by_extreme_temperatures



Graph 3: Climate flexibility by country

The United States (US) leads on climate flexibility with a temperature range of r=118.9°C based on [-62.2 having been the lowest temperature ever recorded in the US and 56.7°C the highest temperature ever recorded in the US], followed by Russia r=113.2°C based on [-67.8; 45.4°C], Canada r=108°C based on [-63; 45°C], Pakistan r=105.5°C based on [-52; 53.5°C], China r=102.6°C based on [-52.3; 50.3°C], Afghanistan r=102.6°C based on [-52.2; 49.9°C], Iran r=100°C based on [-46; 54°C], Mongolia r=99.3°C based on [-55.3; 44°C], Kyrgyzstan r=97.6°C based on [-53.6; 44°C], Italy r=96.6°C based on [-49.6; 47°C], Turkey r=95.2°C based on [-46.4; 48.8°C], Sweden r=91°C based on [-53; 38°C], Bosnia and Herzegovina r=88.7°C based on [-42.5; 46.2°C], Finland r=88.7°C based on [-51.5; 37.2°C], Austria r=87.6°C based on [-47.1; 40.5°C], Norway r=87°C based on [-51.4; 35.6°C], Germany r=86.2°C based on [-45.9; 40.3°C], Turkmenistan r=86.1°C based on [-36; 50.1°C], Armenia r=85.7°C based on [-42; 43.7°C], France r=85.1°C based on [-41; 44.1°C], India r=84.9°C based on [-33.9; 51°C], Serbia r=84.4°C based on [-39.5; 44.9°C], Ukraine r=83.9°C based on [-41.9; 42°C], Bulgaria r=83.5°C based on [-38.3; 45.2°C], Switzerland r=83.3°C based on [41.8; 41.5°C], Romania r=83°C based on [-38.5; 44.5°C], Czech Republic r=82.6°C based on [-42.2; 40.4°C], Japan r=82.1°C based on [-41; 41°C] and Chile r=81.9°C based on [-37; 44.9°C].

In the medium climate flexibility range are Argentina with r=81.7°C based on [-32.8; 48.9°C], Slovakia r=81.3°C based on [-41; 40.3°C], Poland r=81.2°C based on [-41; 40.2°C], Belarus r=81.1°C based on [-42.2; 38.9°C], Latvia r=81°C based on [-43.2; 37.8°C], Lithuania r=80.4°C based on [-42.9; 37.5°C], Estonia r=79.1°C based on [-43.5; 35.6°C], Azerbaijan r=79°C based on [-33; 46°C], Croatia r=78.3°C based on [-35.5; 42.8°C], Moldova r=77.9°C based on [-35.5; 42.4°C], Macedonia r=77.2°C based on [-31.5; 45.7°C], Spain r=77.2°C based on [-30; 47.2°C], Hungary r=76.9°C based on [-35; 41.9°C], Greece r=75.8°C based on [-27.8; 48°C], Slovenia r=75.3°C based on [-34.5; 40.8°C], Australia r=73.8°C based on [-32.8; 41°C], South Korea r=73.7°C based on [-23; 50.7°C], Syria r=72.4°C based on [-23; 49.4°C], Nepal r=72°C based on

[-26; 46°C], South Africa r=70.1°C based on [-20.1; 50°C], Iceland r=68.4°C based on [-37.9; 30.5°C], Israel r=68.2°C based on [-14.2; 54°C], New Zealand r=68°C based on [-25.6; 42.4°C], Denmark r=67.6°C based on [-31.2; 36.4°C], Egypt r=66°C based on [-15; 51°C], Jordan r=66°C based on [-16; 50°C], Netherlands r=66°C based on [-27.4; 38.6°C], United Kingdom r=65.7°C based on [-27.2; 38.5°C], and Saudi Arabia r=64°C based on [-12; 52°C].

The least climate flexibility have Guatemala r=56.5°C based on [-11.5; 45°C], Uruguay r=55°C based on [-11; 44°C], Swaziland r=54.4°C based on [-6.7; 47.7°C], Myanmar r=53.2°C based on [-6; 47.2°C], United Arab Emirates r=53.1°C based on [-1; 52.1°C], Ireland r=52.4°C based on [-19.1; 33.3°C], Sudan r=50.7°C based on [-1; 49.7°C], Dominican Republic r=50°C based on [-7; 43°C], Vietnam r=48.8°C based on [-6.1; 42.7°C], Philippines r=47.2°C based on [-5; 42.2°C], Thailand r=46°C based on [-1.4; 44.6°C], Algeria r=44.1°C based on [7.2; 51.3°C], Hong Kong r=43.9°C based on [-6; 37.9°C], Bangladesh r=42.5°C based on [2.6; 45.1°C], Malta r=42.4°C based on [1.4; 43.8°C], Cuba r=38.2°C based on [0.6; 38.8°C], Panama r=38°C based on [2; 40°C], Puerto Rico r=36°C based on [4; 40°C], Cambodia r=32.6°C based on [10; 42.6°C], Malaysia r=32.3°C based on [7.8; 40.1°C], Samoa r=24.2°C based on [11.1; 35.3°C], Antigua and Barbuda r=18.8°C based on [16.1; 34.9°C], Singapore r=18°C based on [19; 37°C], Maldives r=17.7°C based on [17.2; 34.9°C], Belgium r=8.7°C based on [30.1; 38.8°C] and Burkina Faso r=6.2°C based on [41; 47.2°C].

Climate flexibility is prospected to open a gate for productivity. Countries with climate flexibility are likely be productive grounds for agriculture, industry and service production at all different temperature levels.

The relation of climate flexibility and market prospects was investigated. Based on the determined climate flexibility, the range of temperature variability – as retrieved and calculated based on the List of Countries by Extreme Temperatures[2] – was related to human migration. When investigating the relation of human migration and climate flexibility in 86 countries of the world, a highly significant correlation ($r_{Pearson}(86)=.319$, $p<.002$), is found between being climate flexible and human migration inflows.

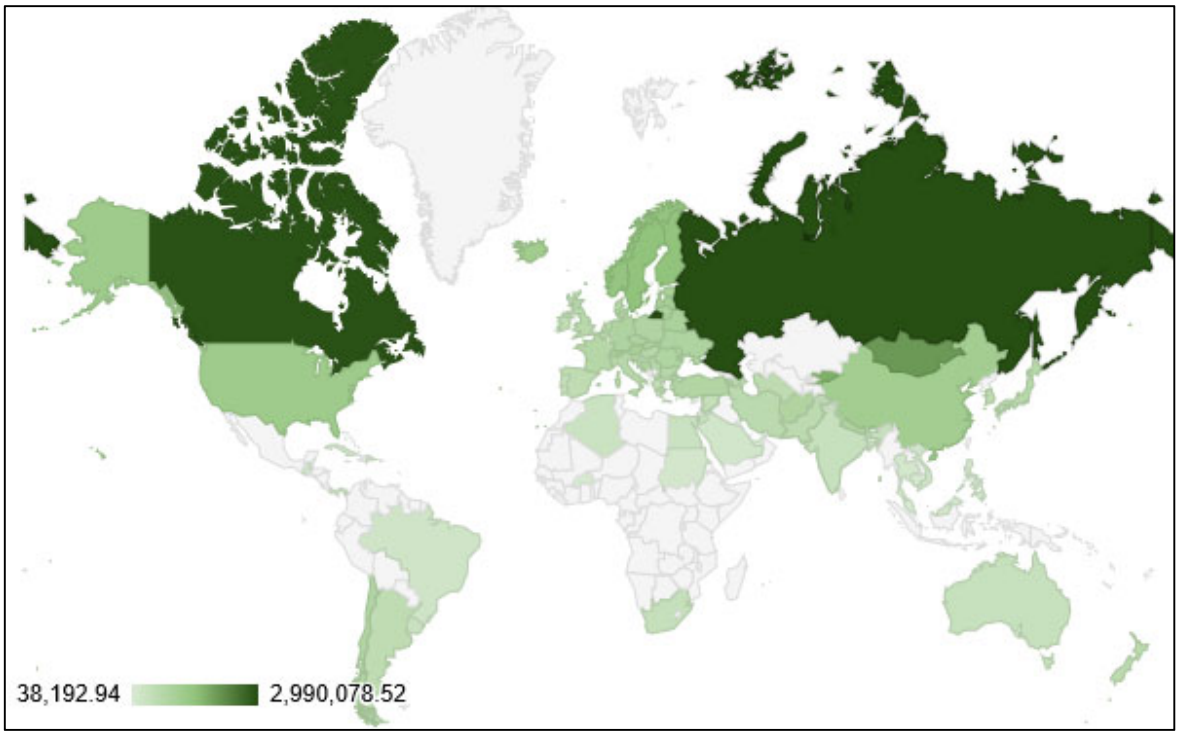
The insights gained from the climate change winners and losers model and the climate flexibility model are blended into a Future Climate Wealth of Nations' Winners and Losers model. This model pays attention to the GDP prospects of countries around the globe in a changing temperature as well as the climate flexibility based on individual country's latitude and altitude naturally determining extreme temperatures. The novel Future Climate Wealth of Nations' Winners and Losers (W_xWL_{TT}) Index derives from the factoring of the Climate Change Winner and Loser (WL_{TT}) Index as defined by Puaschunder (forthcoming a) and the climate flexibility index (Wx). The Future Climate Wealth of Nations' Winners and Losers (W_xWL_{TT}) Index derives from equation.

$$W_xWL_{TT} = W_x * WL_{TT} \quad \text{(Equation 1)}$$

If applying the new W_xWL_{TT} Index to a world dataset, Graph 4 reveals as dark green colored countries those nation states that can expect to be climate flexible climate change winning territories, whereas the light green colored countries are the climate inflexible climate change losing territories.

Graph 4: Future Climate Wealth of Nations' Winners and Losers

[2] https://en.wikipedia.org/wiki/List_of_countries_by_extreme_temperatures



Limitations of this model may stem from the different time perspectives as climate change winners and losers are projections in 2100 and climate flexibility is measured on past temperature recordings. In addition, the temperature extremes should be controlled for outliers and over time temperature fluctuations separated from special temperature differences.

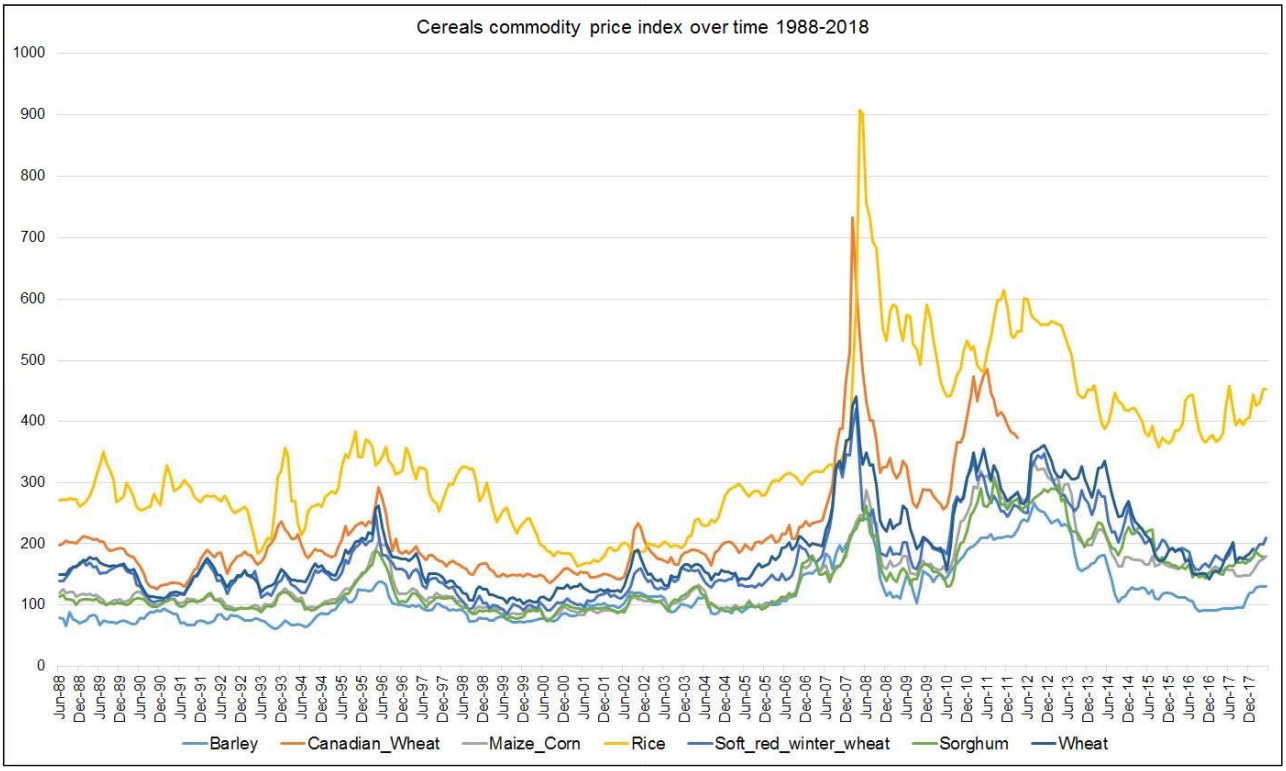
FUTURE RESEARCH ENDEAVORS

Future research may address (1) temperature range variations' economic impact, (2) commodity price estimates based on scarcity, (3) economic peak temperature for production re-estimates.

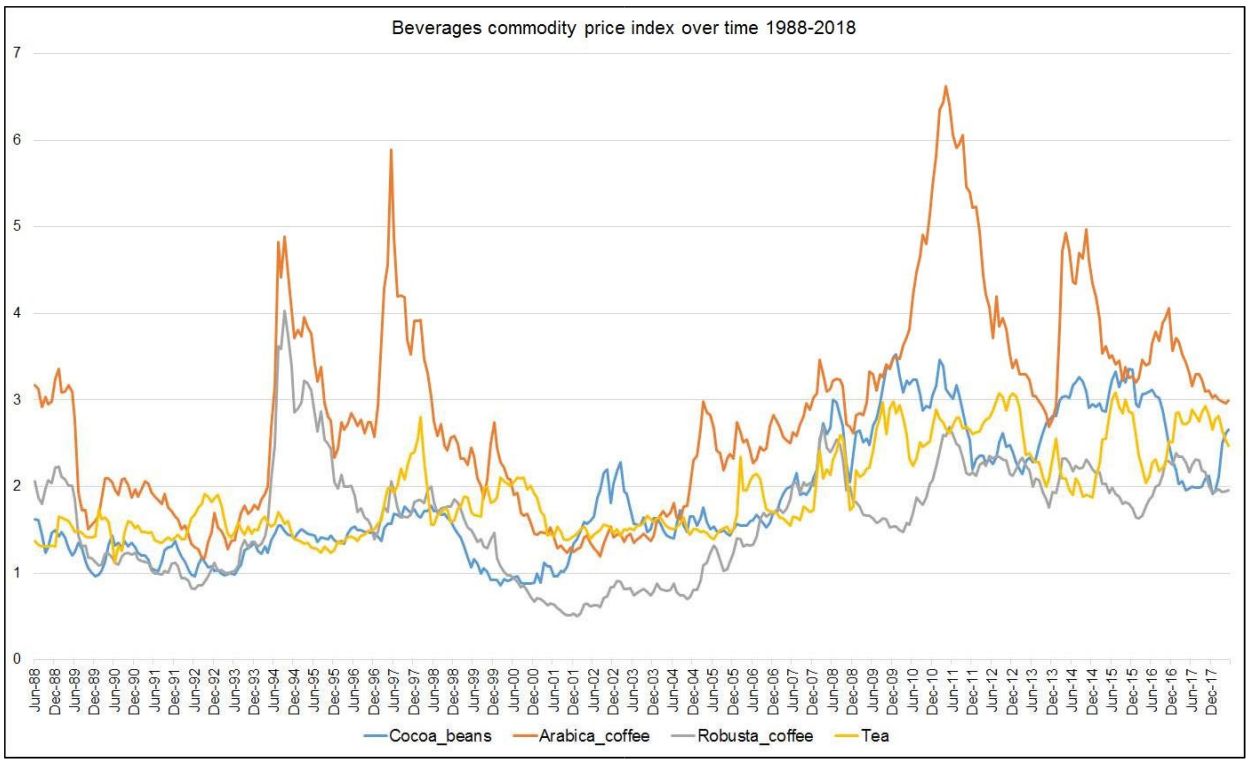
(1) Temperature range estimates should be refined and connected to economic output. Does the economic output of countries with a vast temperature range based on latitude and altitude differ from countries with cyclical temperature changes?

(2) Contemporary attention to global warming is assumed to affect commodity and beverage prices hyperbolically at extinction (see Graphs 5 and 6). As exhibited in Graph 5, commodity prices of cereals have been overinflated since 2008 and have not adjusted to pre-recession levels. A significant deviation for commodity prices is found after 2000 in relation to other products.

Graph 5: Commodity price index retrieved from Index Mundi



Graph 5: Cereals commodity price index over 1988-2018



Graph 6: Beverage commodity price index over 1988-2018

Highly significant independent t-tests comparing the price index per crop prior to 2000 and thereafter consolidate the extraordinary price rise in commodities. Out of all commodity indices for food and beverage reported in the Index Mundi database[3] with sufficient data points, Robusta coffee was the only good with nonsignificant price increases for the period after the turn of the millennium. To cross-validate the findings, price indices for gasoline, medical care, fast food, soda, jewelry, new cars and computers[14] were tested and no stringent pattern of increased prices could be found for these goods and services since turn of the millennium. Given the back-testing results consolidating inflated commodity prices since the turn of the millennium, future prospects of price deviations based on the extinction temperature will be drawn as stylized, hypothetical estimation.

(3) Future research may re-estimate economic peak temperatures for production based on past commodity price data and future economic growth extrapolations in a warming climate. This will aid in refining the climate change winners and losers based on cardinal temperature and climate flexibility.

[3] https://www.indexmundi.com/commodities/?commodity=wheat&months=360
https://people.duke.edu/~rnau/411infla.htm

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