Comprehensive national accounting for carbon emissions

Geir B. Asheim[1], Rintaro Yamaguchi[2]

1. Introduction

It is known that development is sustainable if and only if the value of the change in real wealth is not declining. However, this capital-based indicator does not usually consider the effect of carbon emissions and climate change. In the presence of exogenous change, such as technological change or climate change and commitments under the Paris Agreement, the value of net investments (value of the change in capital assets) need to be significantly revised to serve as a forward-looking indicator of sustainability.

2. Theory

Our dual-capital model includes the following dynamics of manufactured capital K and the global atmospheric carbon stock S:

$$\dot{K}_i = F(K_i, E_i, S) - C$$
$$\dot{S} = E_i + E_{-i} - \delta S$$

The first-order conditions allow us to express current consumption changes in terms of changes in the present value of net investments in capital and carbon as well as the net national cost of changes in national emissions and the national SCC of changes in emissions elsewhere. With national accounting identities at hand, we obtain the expression for national saving:

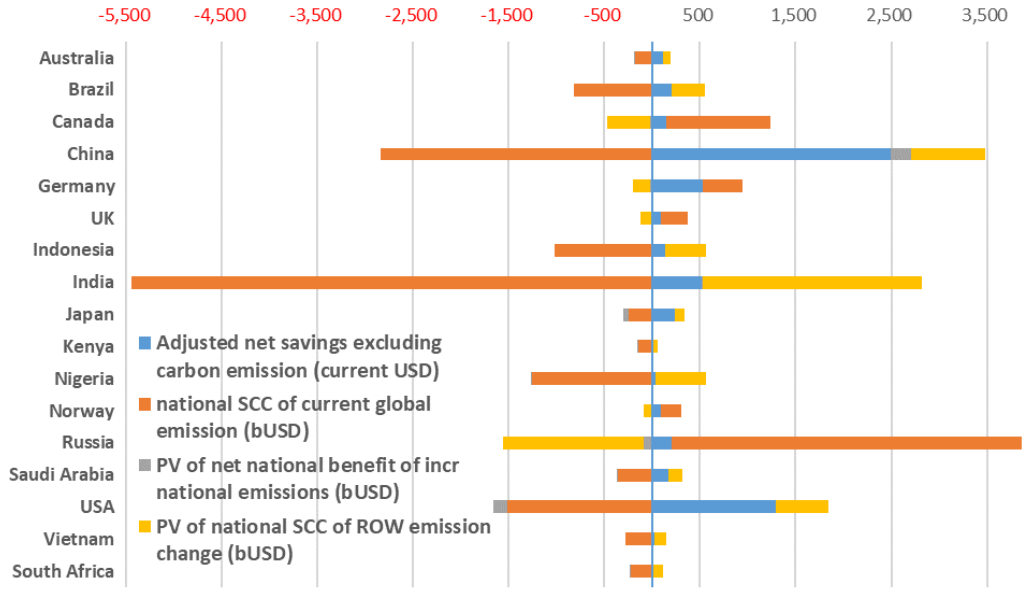
$$\underbrace{\int_0^\infty p_i^K \dot{C}_i \mathrm{d}t}_{\substack{\text{Approximate measure of national sustainability}}} = \underbrace{p_i^K(0)\dot{K}_i(0)}_{\substack{\text{Net investments into capital (genuine saving) (change in wealth)}}} - \underbrace{p_i^S(0)\dot{S}(0)}_{\substack{\text{National SCC of global } CO_2 \text{ accumulation}}} + \underbrace{\int_0^\infty p_i^E \dot{E}_i \mathrm{d}t}_{\substack{\text{PV of future net national benefit of increasing national emissions}}} - \underbrace{\int_0^\infty p_i^S \dot{E}_{-i} \mathrm{d}t}_{\substack{\text{PV of future national SCC of increasing ROW emissions}}}$$

which includes not only the national effect of current global emissions, but also the forward-looking terms that capture future expected paths of emissions nationally and in the rest of the world.

[1] University of Oslo, Norway
[2] National Institute for Environmental Studies (NIES). 16-2 Onogawa, Tsukuba 305-8506, Japan

3. Empirics

We then apply our theoretical results to major countries based on the World Bank data, combined with Climate Action Tracker (CAT) collates modelled emission pathways scenario, Gollier's mitigation cost modeling, and SCC calculations in various studies. The indicator of sustainability is significantly revised from just net investment into capital (adjusted net savings excluding carbon emissions).



We also perform sensitivity analyses with regard to the discount rate. It is only in developing countries (Brazil, Indonesia, India, Kenya, Nigeria, Vietnam, and South Africa) that unsustainability is implied for any of the discount rates chosen. The driving force here is high national SCC that is not fully recovered by future benefit of improved climate, despite relatively low future national mitigation costs. We conclude that national SCC of global CO2 is much more important than the global SCC for countries with low current per capita emissions.

4. Conclusion

In the age of climate change, the indicator of national sustainability needs to be revised to include forward-looking terms regarding costs and benefits of climate change mitigation and damage. Empirical application shows that the sustainability of developing countries is worse than the World Bank estimates, and is more affected by the global carbon emissions in the rest of the world than they themselves affect others.

References

Arrow, K., Dasgupta, P.S., Goulder, L.H., Mumford, K.J, and Oleson, K. (2012), Sustainability and the measurement of wealth, Environment and Development Economics 17, 317–353.

Gollier, C. (2022), The cost-efficiency carbon pricing puzzle, WP 952, Toulouse School of Economics.