

Aristotle wrote of climate's role in the political economy, but Montesquieu's observation is better known: climate bears on the spirit of the laws and "one distinguishes climates by degrees of latitude."<sup>1,2</sup> So inspired, and seeking to quantify climate's contribution to productivity, economists represent climate as  $|\text{latitude}|$ ,  $\varphi$ , in a multivariate, 132-nation model of GDP.<sup>3</sup> Others follow suit with great originality, e.g., assessing the impact of colonialism, affirming the importance of institutions, quantifying the long term effects of the African slave trade, and explaining regional variations in human behavior.<sup>4,5,6,7</sup> However,  $\varphi$ 's utility as a representation of climate is strictly limited. The primary forcing function of climate is insolation, which is linear in  $\varphi$  only if  $\varphi > 30^\circ$ .<sup>8</sup> In the tropics and lower sub-tropics, home to more than 4B people, insolation is materially constant, and climate variation is driven principally by  $\varphi$ -independent convection and surface effects. Representing climate as potential evapo-transpiration, a more realistic proxy than surface temperature, we show that  $\varphi$  explains 78% of climate's variance in the upper latitudes and  $\ll 1\%$  in the lower.<sup>9</sup> See Figure below.

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<sup>1</sup> Aristotle, *Politics*, Book VII, Part VII (c. 350 BCE)

<sup>2</sup> Montesquieu, *The Spirit of the Laws*: Part 3, Book 14: 233 (1748, Trans. )

<sup>3</sup> Hall, R.E., Jones, C.I. Why Do Some Countries Produce So Much More Output Per Worker Than Others? *The Quarterly Journal of Economics*. 1999; 114 (1): 83-116.

<sup>4</sup> Acemoglu, D., Johnson, S., Robinson, J. A., The Colonial Origins of Comparative Development: An Empirical Investigation *The American Economic Review*. 2001; 91 (5): 1369-1401.

<sup>5</sup> Acemoglu, D., Johnson, S., Robinson, J. A., Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution. *The Quarterly Journal of Economics*. 2002; 117 (4): 1231-1294.

<sup>6</sup> Nunn, N., The Long Term Effects of Africa's Slave Trades. *Quarterly Journal of Economics*. 2008; 123 (1): 139-176.

<sup>7</sup> Schulz, J.F., Bahrami-Rad, D., Beauchamp, J. P., Henrich, J. The Church, intensive kinship, and global psychological variation. *Science* 2019; 366 (6466): 1-12.

<sup>8</sup> Hartmann, D.L., *Global Physical Climatology: 2nd Edition*. Elsevier (2015).

<sup>9</sup> Zomer RJ, Trabucco A, Bossio DA, van Straaten O, Verchot LV, 2008. Climate Change Mitigation: A Spatial Analysis of Global Land Suitability for Clean Development Mechanism Afforestation and Reforestation. *Agric. Ecosystems and Envir.* 126: 67-80.

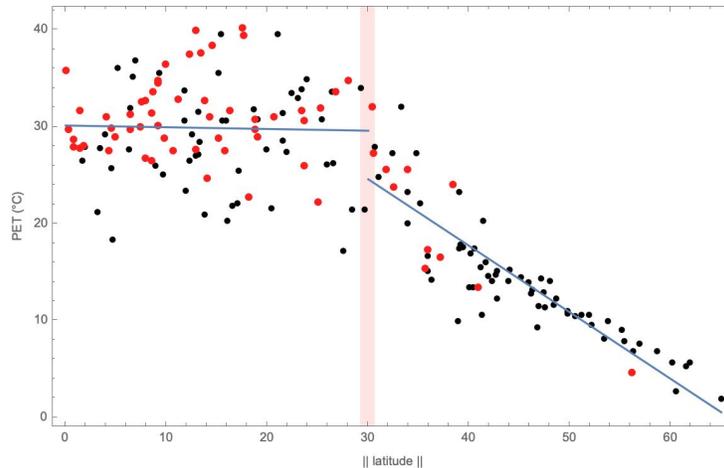


Figure: PET vs. Absolute Value of Latitude for 177 nations. The 63 nations colored in red are those investigated in Ref 4. A pale band is drawn at  $\varphi=30^\circ$  to visually separate the convection- and surface effect-driven zone from the insolation-driven zone. The straight lines are univariate fits obtained by the method of least squares in the respective zones, though the fit at low latitudes has a p-value of 0.3 and has no statistical significance.

The objects of those four aforementioned studies lie predominantly in the lower latitudes. So, though the studies' authors controlled for their proxy, they did not control for climate, which was their stated objective. Their dependent claims, then, are unfounded. Inasmuch as those studies are consequential, and one is among the 10 most-cited economics papers of the last quarter century, their reversal is consequential, too.<sup>4,10</sup> From economics to psychology, social scientists acknowledge that climate matters, but, as we have shown, prevailing methods fail to quantify its import. By way of remediation, we deploy a new representation of climate, geography, and natural resources in a compact, 177-nation model of the Human Development Index ( $R^2=73\%$ ), and we proscribe application of like methods in sub-global contexts.<sup>11</sup>

<sup>10</sup> Linnemer, L., Visser, M. The Most Cited Articles from the Top-5 Journals (1991-2015) . 2017. HAL .hal-01634432.

<sup>11</sup> UNDP. 2019. *Human Development Report 2019. Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century.* New York. <http://hdr.undp.org/en/content/human-development-report-2019>"

## Comments to the editor

This is a presubmission inquiry. The pdf includes one figure that may help get our point across. Every assertion is referenced, unless that assertion is the subject of the Article. What is unique about the submission is that it is at the confluence of physical science and social science. It draws on my expertise as a physicist (PhD Berkeley '83) and my co-author's expertise as an economic historian (Professor of History at MIT and President of the International Economic History Association) to identify and to resolve a methodological flaw that has contaminated 25 years of econometrics and continues to do so. The flaw is traceable to a gross misunderstanding of climate physics, a misunderstanding that has passed review by several Nobel laureates in economics, including two of 2019's. Having passed that review, and having been given the imprimatur of the National Bureau of Economics Research and the best journals, the method has been established as precedent and is unquestioned. The consequences have bearing across all the social sciences, and beyond that into policy making. We recognize that these claims are big, and big claims demand big evidence. Only by seeing the manuscript in its entirety could an expert in physical climatology or an expert in economics judge whether the argument made in 300 words is sound, and even then, such experts, who hold only half the cards so to speak, might well be swayed by precedent. I would trust the judgement of Larry Katz [lfkatz59@gmail.com](mailto:lfkatz59@gmail.com) (Professor of Economics at Harvard and editor of the Quarterly Journal of Economics) and Michael Oppenheimer [omichael@princeton.edu](mailto:omichael@princeton.edu) (Albert G. Milbank Professor of Geosciences at Princeton and long standing member of the IPCC) as to whether a full manuscript was deserving of Nature's review.

Note: We don't just point out what's wrong, we demonstrate how to do it right, in a global context such as that of Ref 3 and in sub-global contexts such as Refs 4-7. They are different and must be treated differently. This is a subtle point and cannot be made in the summary.