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Estimates of economic and environmental damages from tipping points cannot be reconciled with the scientific literature

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> Tipping points reduce global consumption per capita by around ... 1.4% upon 6 °C warming, based on a second-order polynomial fit of the data — Dietz et al. (1).

As Nobel laureate Solow said to Congress when criticizing economic models for failing to anticipate the "Great Recession," "Every proposition has to pass a smell test: Does it really make sense?" (2). The methods and conclusions in Dietz et al. (1) do not make sense.

Earth last experienced 6 °C warming in the Eocene epoch, ≈40 million years ago (3). Asserting consumption would be just 1.4% lower with all tipping points breached, i.e., critical elements of the current climate destroyed—while also being much larger than today—is inconceivable, and impossible to reconcile with scientific literature (3–6).

Dietz used the nonmarket damages function from the Model for Evaluating Regional and Global Effects (MERGE) of GHG reduction policies (7) as a "sensitivity check" (ref. 1, *SI Appendix*). MERGE does not include tipping points; how then can it provide a sensitivity check?

Furthermore, MERGE assumed that damages were quadratic, for no better reason than "if damages change quadratically with temperature, the calibration requires only a single point," point (2.5 °C, 2%) (7). This makes no sense. The damages figure came from mid-1990s government environmental expenditure, but the temperature figure was entirely arbitrary because mid-1990s warming was 0.5 °C, not 2.5 °C.

Dietz uncritically reproduced Manne's assumptions: "The catastrophic warming temperature [of 17.68 °C] is derived from the assumption that economic losses rise quadratically, and are calibrated to a loss of 2% at 2.5 °C warming" (ref. 1, *SI Appendix*).

Using temporally consistent mid-1990s warming of 0.5 °C yields point (0.5 °C, 2%) forcing catastrophic damages at ≈3.5 °C. Scientists anticipate severe cascading damages at 3.5 ◦C (5, 6, 8, 9) but further emphasizes the inappropriateness of assuming quadratic damages.

Fig. 1 compares two quadratics—through point (2.5 °C, 2%) and point (0.5 °C, 2%)—and our suggested logistic. Dietz's multiplicative quadratic-nonmarket-damages-modified utility function tautologically generates a fall in utility of 2% at 2.5 °C in high-income countries calibrated to Manne's "speculative" coordinate, point (2.5 °C, 2%) (ref. 1, *SI Appendix*). However, a quadratic calibrated through point (0.5 °C, 2%), and our suggested logistic, which logistic approximates Manne/Dietz's quadratic to 0.6 °C, also yielding catastrophic damages at ≈3.5 °C, show that Dietz's conclusions would have been entirely different had they used more appropriate functions or points. It makes no sense to use a quadratic, whose third and higher derivatives are zero, to emulate tipping points, let alone one fitted to Manne's arbitrary coordinates.

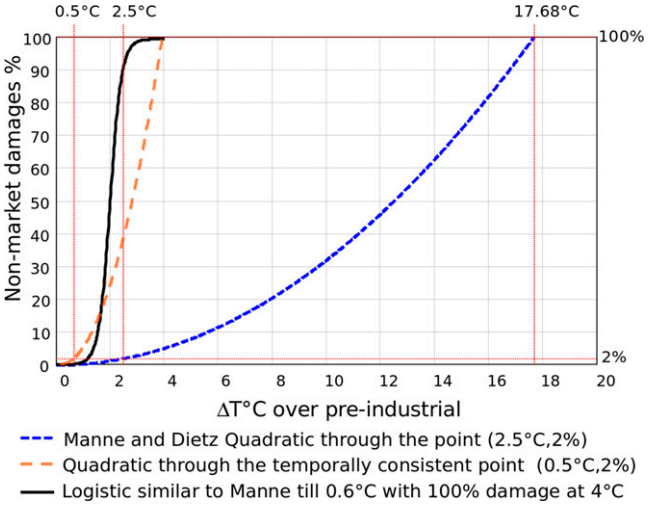

Fig. 1. Manne and Dietz's actual quadratic nonmarket damage function ($0.0032 \cdot \Delta T^2$) versus a temporally consistent quadratic ($0.08 \cdot \Delta T^2$), and compared to a logistic alternative ($100/[1 + e^{12/5} \cdot (2 - \Delta T)]$). The point (0.5 °C, 2%) is the correct mid-1990's warming when environmental expenditure was 2%. Point (2.5 °C, 2%) is an arbitrary value without apparent basis. (ref. 1, *SI Appendix*).

Dietz et al. is also based on papers which are themselves highly questionable. For example, Anthoff et al. (10) concludes that losing the Atlantic Meridional Overturning Circulation (AMOC) would actually increase global GDP. This defies good sense and scientific research predicting a "catastrophic" (6) decline in food production.

We conclude that Dietz has done nothing to narrow the "huge gulf between natural scientists' understanding of climate tipping-points and economists' representations of climate catastrophes" (8). Future loss calculations by economists must be developed, not in isolation from climate scientists, but in close collaboration with them.

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