LETTER

REPLY TO GEIGER AND STOMPER:

On capital intensity and observed increases in the economic damages of extreme natural disasters

Matteo Coronese[a], Francesco Lamperti[a,b], Klaus Keller[c], Francesca Chiaromonte[a,d,1], and Andrea Roventini[a,e,1]

We thank Geiger and Stomper (1) for the opportunity to clarify and further test the robustness of the results in Coronese et al. (2). Their comments reveal misinterpretations of our study and propose an alternative (but untested) hypothesis. Here we redress these misinterpretations and test their hypothesis.

Geiger and Stomper (1) state that Coronese et al. (2) "does not provide conclusive evidence for increasing damages due to rising climate extreme intensity but likely reports trends in capital coefficients" and advocate the use of capital stock (CS) instead of gross domestic product (GDP) as a control variable. First, we note that Coronese et al. (2) document a sharp increase in the economic damages of extreme natural disasters that is consistent with a climate change signal, but do not claim a direct attribution—which would require careful additional studies. Second, we uphold the use of GDP as a control variable (3). EM-DAT accounts for direct and indirect damages; thus a variable proxying most economic activities is more appropriate. Moreover, as noted in Coronese et al. (2), CS is difficult to measure (4, 5). Estimates typically inferred from investments into buildings and a few types of machinery are problematic and potentially inaccurate. Nonetheless, we considered CS estimates from the Penn World Tables and fitted quantile regressions for the model proposed by Geiger and Stomper (1); namely,

$$\mathrm{Da}_i = \alpha + \beta t_i + \gamma \mathrm{CS}_{c(I_i),t_i} + \delta \mathrm{CS}_{c(I_i),t_i} \times t_i. \qquad [1]$$

Results (Table 1) show that the trends in Coronese et al. (2) persist even when using CS as a control. We suspect that increasing geographical resolution may help proxying what is placed at risk by a disaster more than picking between CS and GDP.

Geiger and Stomper (1) also state that the main findings in Coronese et al. (2) "are not robust to excluding data about the 1960s" because statistical significance and trend magnitude estimates decrease when excluding those years. They argue that a decreased trend estimate "is at odds with the observed acceleration in global warming and with independent evidence for increases in climate extreme intensity." Since our analyses track a small number of extreme events, shortening the time series is bound to impact statistical significance (6). The decreased trend when excluding the 1960s may be due to factors that are hard to pinpoint based on the data at our disposal, e.g., larger natural variability or increasing adaptation in more recent decades (7). We note, however, that SI appendix in Coronese et al. (2) documents rather robust signs, sizes, and behaviors—and reiterate that Coronese et al. (2) do not claim direct attribution to climate change.

Geiger and Stomper (1) observe that "high percentiles tend to form a subsample of events in very rich and/or large countries," which is entirely expected, and remark that damages in those countries are affected "also by the extremeness of socioeconomic exposure," which is true—but comparability across countries is achieved by controlling for wealth at risk (see above). Finally, Geiger and Stomper (1) question whether Coronese et al. (2) "actually documents global trends." Coronese et al. (2) analyzed a large dataset of worldwide events reporting global results and some interesting regionally resolved findings (e.g., based on climatic zones; figure 3 and SI appendix, table S5 in ref. 2). As more data become available, analyses at finer regional resolution are, of course, auspicable and may provide further insights.

[a]Institute of Economics and EMbeDS-Economics and Management in the Era of Data Science, Scuola Superiore Sant'Anna Pisa, 56127 Pisa, Italy; [b]RFF-CMCC European Institute on Economics and the Environment, Centro Euro-Mediterraneo sui Cambiamenti Climatici, 20144 Milan, Italy; [c]Department of Geosciences, The Pennsylvania State University, University Park, PA 16802; [d]Department of Statistics, The Pennsylvania State University, University Park, PA 16802; and [e]Observatoire Français des Conjonctures Economiques, SciencesPo, BP 85 06902, Sophia Antipolis, France

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[1]To whom correspondence may be addressed. Email: fxc11@psu.edu or andrea.roventini@santannapisa.it.

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Table 1. Quantile and OLS (mean) regressions for model 1

	Quantile				
Variable	80th	90th	95th	99th	OLS
Intercept	17.065*** (3.61)	40.07** (16.905)	34.832 (49.947)	140.864 (224.5)	13.552 (60.632)
Trend	−0.343*** (0.072)	0.763 (0.53)	5.258*** (1.644)	28.19*** (9.874)	1.525 (1.571)
Capital stock	0.007 (0.006)	0.041** (0.02)	0.126*** (0.034)	0.412 (0.433)	0.016** (0.008)
Capital stock × trend	<0.001* (<0.001)	<0.001 (<0.001)	−0.001 (0.001)	0 (0.01)	<0.001 (<0.001)
Fit quality	$R^1 = 0.059$	$R^1 = 0.11$	$R^1 = 0.152$	$R^1 = 0.25$	$R^2 = 0.026$

Results are shown on $n = 9{,}495$ disasters that occurred between 1960 and 2014 (damages in USD million). Quantile regression estimates are obtained through the modified Barrodale–Roberts algorithm (6). Standard errors (in parentheses) are produced with $r = 1{,}000$ bootstrap samples [joint resampling of response and predictor pairs (8)]. Fit quality is indicated by R^1 (9) for quantile regressions and by R^2 for ordinary least squares (OLS). *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$ (two tailed).

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