

Commentary

Climate change and economic growth: Some critical reflections

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Abstract: Global warming may affect the economic development and, thus, the welfare of people around the world. Therefore, the economic effects of a changing climate should be known in order to be able to design appropriate policy responses. In the economics literature, one research field empirically analyzes the growth effects of global warming. But often those studies do not account for economic variables that have turned out to be significant in explaining economic growth. In addition, they frequently fail to check for the robustness of their outcomes. This can give rise to biased results regarding the growth process and, therefore, does not necessarily reflect the true data-generating process. Hence, the question comes up: how valid and reliable the results are. Therefore, economic analyses should be undertaken that study the robustness of the results as regards the integration of fundamental economic variables. When policy recommendations are made on how to deal with global warming, we argue that they should be based on robust results only. If that does not hold, economic policy risks being inadequate, giving rise to substantial welfare losses.

Keywords: global warming; economic development; robustness; policy recommendations

JEL: O40; Q50

1. Introduction

The question of which factors cause economic growth has been as old as economics as a scientific discipline (for a short survey, see, e.g., Greiner [1]). Using modern econometric methods to detect the forces of economic growth started in the 1950's with a seminal paper written by Solow [2], who implicitly builds on Tinbergen [3], who was the first to integrate a time index in the aggregate production function. Solow's great merit was to show how a measure of the technical progress can be estimated from real-world data accounting for that part of GDP growth that is not explained by increases in capital and labor input.

In the following decades, numerous empirical studies have been undertaken aiming to enhance our understanding of the process of economic growth. But researchers often limit their analyses to only a limited number of explanatory variables so that the question arises how reliable and valid their results are. As regards that problem, Leamer states that "We must insist that all empirical studies offer convincing evidence of inferential sturdiness. We need to be shown that minor changes in the list of variables do not alter fundamentally the conclusions, nor does a slight reweighting of observations, nor correction for dependence among observations, etcetera, etcetera" [4]. Thus, Levine and Renelt [5] perform an extreme-bounds analysis based on Leamer [6], where they investigate which variables always exert a statistically significant effect, independent of which other variables are included in the regression in explaining economic growth (for details as to that analysis, see Levine and Renelt [5]). They find that only a few variables are robust as defined by them, such as the investment share, trade, and the initial level of GDP.

The economist Sala-i-Martin [7] argues that the extreme-bounds analysis is too restrictive since it allows only a zero-one labeling, i.e., a variable is either robust or it is not. Rather, he suggests to call a variable robust if 95% of the density of an estimated coefficient lies to the right or to the left of zero. Proceeding like that, he finds additional variables to be robust, like political variables, for example. Bruns and Ioannidis [8] analyze whether the forces of economic growth change over time or whether they remain the same, independent of which time period is considered. They find that inferences on growth determinants are not stable across time periods. Nevertheless, variables such as the investment share and trade are statistically significant in the more recent growth period until 2010, too.

2. Climate change and economic growth

The accumulation of greenhouse gases (GHGs) like carbon dioxide and methane in the atmosphere will affect the global climate, and changes in the climatic conditions are likely to influence the economic system of societies. For example, more extreme weather events may cause economic damages and require resources that cannot be used for consumption and/or for investment. However, even if there is very strong evidence that the accumulation of GHGs raises the average surface temperature on the earth and can lead to more extreme weather events (see e.g., Arias [9]), it must be stated that the climate system is an extremely complex system such that there is strong uncertainty as regards its sensitivity, see e.g., Meinshausen et al. [10] and Sherwood et al. [11]. An example is provided by Greiner and Semmler [12], who have shown that feedback mechanisms affecting the Albedo of the earth can lead to multiple equilibria in a standard growth model where a simple zero-dimensional climate model has been integrated.

The uncertainty regarding the economics of climate change may be still larger, which is reflected by the wide range for the estimates of climate-related damages. This holds for specific sectors in the economy (see, e.g., Nocera et al. [13] and Neumann et al. [14]) and for the macroeconomy as well [15–17]. Newell et al. [18] estimate 800 specifications with the GDP growth rate and, alternatively, the level of GDP as the dependent variable that is explained by the temperature, by the change of the temperature, by precipitation, by time-fixed effects, and by country-specific time trends. They find that growth models are associated with large uncertainties, reflected by the fact that the 95% confidence interval for GDP impacts in 2100 ranges from GDP losses of 84% to gains of 359%. GDP level models, however, go along with less uncertainty and have a smaller 95% confidence interval between -8.5% and $+1.8\%$, centered around losses between 1% – 3% . Despite that uncertainty, it can be expected that changes in climatic conditions may have effects on the growth rates of aggregate GDP, and empirical studies should deal with that problem.

However, studies that empirically analyze the relation between climate change and economic growth often focus on only physical factors, such as temperature and precipitation, and neglect economic variables that have turned out to be important in generating economic growth, thus giving rise to the problem of omitted

variables. From an econometric point of view this can lead to inconsistent estimations of the coefficients when the explanatory variables are correlated with the residuals. Even if that problem can be overcome technically in fixed effects panel regression models by introducing dummies, the problem of missing economic variables remains such that the estimated model may not be a good proxy for the true data-generating process and may not yield the true effect of climate variables. Thus, Barker [19] points out that the relation between economic growth and the temperature change, detected in growth regressions, does not turn out to be robust. He tests the outcome of the paper by Colacito et al. [20] and shows that the removal of a small number of observations drastically changes the qualitative effect of climate change on economic growth. Hence, removing data before 1990 would have raised the estimate by almost three times, meaning that global warming would almost eliminate economic growth in the USA. In addition, taking into account non-linearities can alter the result, too, and may generate positive growth effects of higher temperatures. This shows that the estimation outcome is sensitive with respect to the data and as concerns the estimation method. The same holds for missing economic variables. In market economies, the growth of GDP is the outcome of decisions of individuals and of firms that act intentionally to achieve economic goals. Therefore, econometric models that intend to explain growth should be based on sound economic theory and contain economic explanatory variables, as demanded by Rosen [21]. When economic variables exert a statistically significant effect on economic growth and are not included in the estimation, their effect may be reflected by the coefficients of the climate-related variables and, thus, distort their true effects.

The scholars Dell et al. [22] and Burke et al. [23] represent two other frequently cited papers that study the relation that exists between economic growth and climate change. Dell et al. [22] regress annual growth on annual average temperatures for 127 countries from 1961 to 2003 and obtain a statistically significant negative effect of higher temperatures on economic growth in poor countries where the income falls short of the median, whereas the outcome for rich countries turns out to be insignificant. Burke et al. [23] analyze 166 economies from 1961 to 2010 and conclude that 77 percent of all countries would be poorer with temperature increases than without increases, and 5 percent of countries would be poorer in 2100 than they are today because of a rise of global temperatures. But the economist Barker [24,25] shows that those papers are characterized by flaws, just as the paper by Colacito et al. [20]. Hence, the paper by Dell et al. [22] resorts to an untenable method of classifying countries by income, and the results are influenced by arbitrary methodological choices and by a small number of observations with unusual characteristics [24]. As regards the paper by Burke et al. [23], Barker [25] demonstrates that the paper leaves out inconvenient results, presents misleading charts to confuse readers, and fails to report obvious robustness checks. In addition, it is shown by simulations that the statistical significance of

their results is inflated.

Similarly, Greiner et al. [26] have demonstrated for European economies that climate change is not a robust statistically significant variable in explaining economic growth, while institutional and economic variables, such as the rule of laws, the fiscal variable, and the output gap, are statistically significant and robust. However, that study does not distinguish between northern and southern countries, which may affect the outcome, as shown by Jacob et al. [27] and by Pala [28]. Hence, more elaborate estimation strategies that allow for heterogeneity may turn out to be necessary, as applied, for example, by Owusu et al. [29] in estimating public debt sustainability for European countries.

Further, it should be noted that resorting to fossil sources of energy is promoting economic growth and development, and many countries, therefore, refuse to stop their use. For example, the G20 countries could not agree to phase out fossil fuels [30], and the African Energy Chamber (AEC) pointed out that oil and gas play an instrumental role in the development of African economies, and African producers of those resources will not agree to a phase-out of those resources [31]. An et al. [32] point out that oil cooperation between economies has great potential and will be pursued in the future. Mutalimov et al. [33] show with the help of a mathematical model that Eastern Russian small enterprises will continue to raise their emissions over the next 20 years. This results from the fact that the enterprises benefit a lot from mineral extraction and from the fact that they have to increase their profits.

3. Conclusion

The philosopher Kant has stated that theory without empirics is empty and empirics without theory is blind: “Gedanken ohne Inhalt sind leer, Anschauungen ohne Begriffe sind blind” [34]. In market economies, the growth of aggregate GDP is the result of decisions of individuals and of firms that act intentionally to achieve economic goals. Hence, econometric models explaining growth should be based on sound economic theory and contain economic explanatory variables. Neglecting the latter and positing that growth solely depends on climatic factors can lack important aspects and may yield a biased picture of the real world. Thus, the outcomes of such models should be considered with care. That holds in particular when the emphasis is put on the exact numerical values of the estimated coefficients rather than on their qualitative contents, e.g., whether an explanatory variable exerts a positive or negative effect on the dependent variable. Focusing on the exact numbers would imply a perception of knowledge and precision that the models cannot deliver and may generate inadequate policy measures and, in the end, huge welfare losses.

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References

1. Greiner A. Fiscal Policy and Economic Growth. Ashgate Publishing Company; 1996.
2. Solow RM. Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*. 1957; 39(3): 312. doi: 10.2307/1926047
3. Tinbergen, Jan. "On the theory of long-term economic development (German)." *Weltwirtschaftliches Archiv*. 1942; 55: 511-549.
4. Leamer, E.E. "Sensitivity Analyses Would Help." *American Economic Review*. 1985; 75(3): 308-313.
5. Levine, R., Renelt, D. "A sensitivity analysis of cross-country growth regressions." *American Economic Review*. 1992; 82(4): 942-963.
6. Leamer, E.E. "Let's Take the Con Out of Econometrics." *American Economic Review*. 1983; 73(1): 31-43.
7. Sala-i-Martin X. I Just Ran Four Million Regressions. National Bureau of Economic Research; 1997. doi: 10.3386/w6252
8. Bruns SB, Ioannidis JPA. Determinants of economic growth: Different time different answer? *Journal of Macroeconomics*. 2020; 63: 103185. doi: 10.1016/j.jmacro.2019.103185
9. Arias PA. "Technical Summary." In: *Climate Change 2021: The Physical Science Basis*. Cambridge University Press: Cambridge; 2021.
10. Meinshausen M, Meinshausen N, Hare W, et al. Greenhouse-gas emission targets for limiting global warming to 2 °C. *Nature*. 2009; 458(7242): 1158-1162. doi: 10.1038/nature08017
11. Sherwood SC, Webb MJ, Annan JD, et al. An Assessment of Earth's Climate Sensitivity Using Multiple Lines of Evidence. *Reviews of Geophysics*. 2020; 58(4). doi: 10.1029/2019rg000678
12. Greiner A, Semmler W. Economic growth and global warming: A model of multiple equilibria and thresholds. *Journal of Economic Behavior & Organization*. 2005; 57(4): 430-447. doi: 10.1016/j.jebo.2005.04.007
13. Nocera S, Tonin S, Cavallaro F. The economic impact of greenhouse gas abatement through a meta-analysis: Valuation, consequences and implications in terms of transport policy. *Transport Policy*. 2015; 37: 31-43. doi: 10.1016/j.tranpol.2014.10.004
14. Neumann JE, Willwerth J, Martinich J, et al. Climate Damage Functions for Estimating the Economic Impacts of Climate Change in the United States. *Review of Environmental Economics and Policy*. 2020; 14(1): 25-43. doi: 10.1093/reep/rez021
15. Keller, K., Nicholas, R. "Improving Climate Projections to Better Inform Climate Risk Management." *The Oxford Handbook of the Macroeconomics of Global Warming*. Oxford University Press: Oxford; 2015. pp. 9-18.
16. Nordhaus W, Moffat A. A Survey of Global Impacts of Climate Change: Replication, Survey Methods, and a Statistical Analysis. National Bureau of Economic Research; 2017. doi: 10.3386/w23646
17. Botzen WJW, Deschenes O, Sanders M. The Economic Impacts of Natural Disasters: A Review of Models and Empirical Studies. *Review of Environmental Economics and Policy*. 2019; 13(2): 167-188. doi: 10.1093/reep/rez004
18. Newell RG, Prest BC, Sexton SE. The GDP-Temperature relationship: Implications for climate change damages. *Journal of Environmental Economics and Management*. 2021; 108: 102445. doi: 10.1016/j.jeem.2021.102445
19. Barker, D. "Temperature and U.S. Economic Growth: Comment on Colacito, Hoffmann, and Phan." *Econ Journal Watch*. 2022; 19(2): 176-189.
20. Colacito R, Hoffmann B, Phan T. Temperature and Growth: A Panel Analysis of the United States. *Journal of Money, Credit and Banking*. 2018; 51(2-3): 313-368. doi: 10.1111/jmcb.12574
21. Rosen RA. Temperature impact on GDP growth is overestimated. *Proceedings of the National Academy of Sciences*. 2019; 116(33): 16170-16170. doi: 10.1073/pnas.1908081116
22. Dell M, Jones BF, Olken BA. Temperature Shocks and Economic Growth: Evidence from the Last Half Century. *American Economic Journal: Macroeconomics*. 2012; 4(3): 66-95. doi: 10.1257/mac.4.3.66
23. Burke M, Hsiang SM, Miguel E. Global non-linear effect of temperature on economic production. *Nature*. 2015; 527(7577): 235-239. doi: 10.1038/nature15725
24. Barker, D. "Temperature Shocks and Economic Growth: Comment on Dell, Jones, and Olken." *Econ Journal Watch*. 2023; 20(2): 234-253.
25. Barker, D. "Global Non-Linear Effect of Temperature on Economic Production: Comment on Burke, Hsiang, and Miguel." *Econ Journal Watch*. 2024; 21(1): 35-68.

26. Greiner A, Bökemeier B, Owusu B. Climate change and economic growth: Evidence for European countries. *American Journal of Economics and Sociology*. 2024; 00: 1–40. <https://doi.org/10.1111/ajes.12605>
27. Jacob D, Kotova L, Teichmann C, et al. Climate Impacts in Europe Under +1.5°C Global Warming. *Earth's Future*. 2018; 6(2): 264-285. doi: 10.1002/2017ef000710
28. Pala A. The relation between climate change and economic growth: the investigation of the regional differences with rcm model in eu-28 countries. *International Journal of Economic Sciences*. 2020; IX(1). doi: 10.20472/es.2020.9.1.008
29. Owusu B, Bökemeier B, Greiner A. Regime-based debt sustainability analysis: Evidence from euro area economies. *European Journal of Political Economy*. 2023: 102458. doi: 10.1016/j.ejpoleco.2023.102458
30. Arasu, S. "Group of 20 countries agree to increase clean energy but reach no deal on phasing out fossil fuels." Available online: <https://apnews.com/article/india-climate-change-g20-cop28-c25dd753a2f8f520261ec4858b921a1a> (accessed on 2 June 2024).
31. AEC. "We will not Sell-Out by Phasing Out: African Negotiations Urged to Fight for Africa." Available online: <https://energychamber.org/we-will-not-sell-out-by-phasing-out-african-negotiations-urged-to-fight-for-africa/> (accessed on 2 June 2024).
32. An J, Mikhaylov A, Jung SU. The Strategy of South Korea in the Global Oil Market. *Energies*. 2020; 13(10): 2491. doi: 10.3390/en13102491
33. Mutalimov V, Kovaleva I, Mikhaylov A, et al. Assessing regional growth of small business in Russia. *Entrepreneurial Business and Economics Review*. 2021; 9(3): 119-133. doi: 10.15678/eber.2021.090308
34. Kant I. *Kritik Der reinen Vernunft*. De Gruyter; 1923 (first print: 1787). doi: 10.1515/9783111496580