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# Opportunities for advances in climate change economics

M. Burke  
*Stanford University*

M. Craxton  
*Stanford University*

C.D. Kolstad  
*Stanford University*

C. Onda  
*Stanford University*

H. Allcott  
*New York University*

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# Opportunities for advances in climate change economics

## **Abstract**

There have been dramatic advances in understanding the physical science of climate change, facilitated by substantial and reliable research support. The social value of these advances depends on understanding their implications for society, an arena where research support has been more modest and research progress slower. Some advances have been made in understanding and formalizing climate-economy linkages, but knowledge gaps remain [e.g., as discussed in (1, 2)]. We outline three areas where we believe research progress on climate economics is both sorely needed, in light of policy relevance, and possible within the next few years given appropriate funding: (i) refining the social cost of carbon (SCC), (ii) improving understanding of the consequences of particular policies, and (iii) better understanding of the economic impacts and policy choices in developing economies.

## **Disciplines**

Environmental Studies | Other Economics | Regional Economics

## **Comments**

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## **Authors**

M. Burke, M. Craxton, C.D. Kolstad, C. Onda, H. Allcott, E. Baker, L. Barrage, R. Carson, K. Gillingham, J. Graff-Zivin, M. Greenstone, S. Hallegatte, W.M. Hanemann, G. Heal, S. Hsiang, B. Jones, D.L. Kelly, R. Kopp, M. Kotchen, R. Mendelsohn, K. Meng, G. Metcalf, J. Moreno-Cruz, R. Pindyck, s. Rose, Ivan Rudik, J. Stock, and R.S.J. Tol

## CLIMATE ECONOMICS

# Opportunities for advances in climate change economics

Target carbon's costs, policy designs and developing countries.

By M. Burke<sup>1</sup>, M. Craxton<sup>1</sup>, C.D. Kolstad<sup>1\*</sup>, C. Onda<sup>1</sup>, H. Allcott<sup>2</sup>, E. Baker<sup>3</sup>, L. Barrage<sup>4</sup>, R. Carson<sup>5</sup>, K. Gillingham<sup>6</sup>, J. Graff-Zivin<sup>5</sup>, M. Greenstone<sup>7</sup>, S. Hallegatte<sup>8</sup>, W.M.Hanemann<sup>9</sup>, G. Heal<sup>10</sup>, S. Hsiang<sup>11</sup>, B. Jones<sup>12</sup>, D.L. Kelly<sup>13</sup>, R. Kopp<sup>14</sup>, M. Kotchen<sup>5</sup>, R. Mendelsohn<sup>5</sup>, K. Meng<sup>15</sup>, G. Metcalf<sup>16</sup>, J. Moreno-Cruz<sup>17</sup>, R. Pindyck<sup>18</sup>, S. Rose<sup>19</sup>, I. Rudik<sup>20</sup>, J. Stock<sup>21</sup> and R. Tol<sup>22</sup>

There have been dramatic advances in understanding the physical science of climate change, facilitated by substantial and reliable research support. The social value of these advances depends on understanding their implications for society, an arena where research support has been more modest and research progress slower. Some advances have been made in understanding and formalizing climate-economy linkages, but knowledge gaps remain (e.g., as discussed in (1, 2)). We outline three areas where we believe research progress on climate economics is both sorely needed, in light of policy relevance, and possible within the next few years given appropriate funding: refining the social cost of carbon (SCC), improving understanding of the consequences of particular policies, and better understanding economic impacts and policy choices in developing economies.

**REFINING THE SCC.** The SCC is an estimate of the monetized change in social welfare over all future time from one more tonne of carbon emitted today, conditional on a specific trajectory of future global emissions and economic and demographic growth (SCC is thus an estimate of costs avoided by not emitting an additional tonne). An understanding of the SCC is used in developing regulations directly or indirectly linked to climate change and is vital to building political support for domestic climate policies worldwide (3). The SCC is usually estimated using an integrated assessment model (IAM), although other methods such as expert elicitation are being explored. Widely-used values for the SCC have been criticized, with particular skepticism surrounding the empirical basis used by IAMs to project climate damages and, thus, the SCC (4). We highlight five promising research directions to refine SCC estimates, which might then improve how they are used in policy (e.g. (5)).

First, a better understanding of economic impact of extreme climatic events is required. Economists can build on advances in our physical understanding of these low-probability, high-damage events (6) to study how changing likelihoods could affect damage estimates.

Second, research is needed on how to represent potential damages that are poorly captured in typical economic output measures. Such "non-market" damages, which include potential costs of increased civil conflict, changes in human health, and biodiversity loss, could be sizeable (7), but are omitted from current damage estimates or are represented in an ad hoc way (e.g. as a simple multiple of market damages). Research should explore new methods for measuring key non-market outcomes (e.g. (8)), and should clarify how to incorporate accumulating evidence into IAMs.

Third, work is required on how aggregate economic output is affected by changes in the climate (9). How climate

change or the rate of change affect the level of output, the growth rate of output, the stock of capital, or some other metric, can have a major impact on the SCC since it is a measure of accumulated damage over time. Current evidence is mixed, and resolving the debate will be crucial.

The fourth area for research is adaptation, which has potential to drastically change the gross damages from climate change. It is one of the least explored areas of climate economics, and little guidance is available on how to build adaptation into damage functions. For example, how farmers may adapt agricultural practices may dampen agronomic estimates of damage from a change in climate. A frontier for research is how to connect impact estimates derived from historical short-run fluctuations in weather to potential future impacts from longer-run changes (incorporating adaptation) in climate. Rigorous methods for doing this are in their infancy, and urgently need improvement (10).

Finally, SCC-focused IAMs, the main tools for aggregating economic costs of mitigation and adaptation, and economic damage from changed climate to produce SCC estimates, need a more structured way of incorporating new information. Damage functions in IAMs can rely on studies completed over 20 years ago (11). The treatment of uncertainty in IAMs needs improvement, with research needed on the computational challenges of explicitly including decision making under uncertainty (12). Lastly, the choice in most existing IAM's to examine the well-being (utility) of a representative agent may be inappropriate if impacts differ greatly by region or by type of agent. Understanding nuances of how these models aggregate costs and benefits across disparate regions and populations is of particular importance.

**IMPROVING POLICY DESIGN.** Political resistance to carbon pricing in many jurisdictions, and the emergence of a piecemeal

<sup>1</sup>Stanford University, Stanford, CA, USA. <sup>2</sup>New York University, New York, NY, USA. <sup>3</sup>University of Massachusetts, Amherst, MA, USA. <sup>4</sup>Brown University, Providence, RI, USA. <sup>5</sup>University of California, San Diego, CA, USA. <sup>6</sup>Yale University, New Haven, CT, USA. <sup>7</sup>University of Chicago, Chicago, IL, USA. <sup>8</sup>World Bank, Washington, DC, USA. <sup>9</sup>Arizona State University, Tempe, AZ, USA. <sup>10</sup>Columbia University, New York, NY, USA. <sup>11</sup>University of California, Berkeley, CA, USA. <sup>12</sup>Northwestern University, Evanston, IL, USA. <sup>13</sup>University of Miami, Miami, FL, USA. <sup>14</sup>Resources for the Future, Washington, DC, USA. <sup>15</sup>University of California, Santa Barbara, CA, USA. <sup>16</sup>Tufts University, Medford, MA, USA. <sup>17</sup>Georgia Institute of Technology, Atlanta, GA, USA. <sup>18</sup>Massachusetts Institute of Technology, Cambridge, MA, USA.

1 approach to domestic and international cli-  
2 mate policy-making, mean that it is insuffi-  
3 cient to just study how to price the climate  
4 externality in a "first-best" world with no  
5 other economic distortions. Though many  
6 existing "second-best" policies, such as ef-  
7 ficiency standards and support for renewa-  
8 bles, are cost-ineffective relative to carbon  
9 pricing (13), they continue to be imple-  
10 mented for political, distributional, or other  
11 reasons.

12 Research must consider practical di-  
13 mensions of optimally designing and imple-  
14 menting such policies. First, more rigorous  
15 *ex post* empirical analysis of energy and  
16 environmental policies will be critical (14).  
17 Policies such as carbon pricing schemes,  
18 tradable obligations, fuel taxes, renewable  
19 portfolio standards, and energy efficiency  
20 standards are already in use in different  
21 countries and will become more common  
22 as countries try to operationalize their  
23 pledges in the UNFCCC process. But there  
24 is often little empirical evidence on individ-  
25 ual- or market-level responses to these pol-  
26 icies. Existing evidence suggests that be-  
27 havioral responses to a given policy can  
28 drive a wedge between *ex ante* engineer-  
29 ing estimates of program costs and bene-  
30 fits, and *ex post* estimates of true costs and  
31 benefits (15). More evidence with rigorous  
32 analysis is sorely needed on a range of mit-  
33 igation and adaptation policies.

34 In the long term, the costs of addressing  
35 climate change using current technologies  
36 could be very large, making technological  
37 progress critical. A large body of work on  
38 the rate and direction of innovation exists,  
39 but research is needed on what combina-  
40 tions of R&D and climate policies shape the  
41 innovation and diffusion of low carbon tech-  
42 nologies (16).

#### 43 **BEYOND ADVANCED ECONOMIES.**

44 Much of the existing research on climate  
45 damages or policies has focused on the  
46 developed world. This is problematic, both  
47 because developing countries currently  
48 represent the majority of the world's popu-  
49 lation and greenhouse gas emissions, and  
50 because the nature of impacts and context  
51 for policy choice could differ greatly relative  
52 to developed regions.

53 A first key research need is to rigorously  
54 quantify how vulnerability to climate  
55 change shifts as countries develop and the  
56 structure of their economies change, a  
57 question on which evidence is mixed (7).  
58 Attention to the burden borne by low-in-  
59 come households will be important, as little  
is known about how changes in climate and

climate policy affect these households'  
productivity and livelihoods. Growing avail-  
ability of expenditure surveys in these  
countries, potentially combined with re-  
motely-sensed measures of livelihoods  
(17), could allow rapid progress.

Emerging economies will play an essen-  
tial role in the success of mitigation efforts,  
given their projected demographic and eco-  
nomic growth. Thus a second key research  
agenda will be to better understand climate  
mitigation options in the developing world.  
Carbon mitigation proposals have faced  
opposition in many developing countries  
because of concern that they could hamper  
growth by constraining energy supply and  
increasing costs (although a few middle in-  
come countries are experimenting with car-  
bon pricing). Yet, since tax evasion rates  
are lower for energy taxes compared to in-  
come taxes (18), implementing a carbon  
tax may allow developing-country govern-  
ments to simultaneously achieve climate  
policy goals and raise revenue. Research  
is needed on the feasibility of different pol-  
icy tools in different political and institutional  
contexts, since the appropriateness of pol-  
icies may differ in countries with heavily sub-  
sidized fossil fuels, high rates of tax eva-  
sion, and large informal and state-owned  
sectors. An understanding of how innova-  
tion policy can be effective, and, more  
broadly, of how to make low-carbon tech-  
nologies adoptable in the developing world,  
is also essential.

Our list of research priorities is not com-  
prehensive and likely debatable. Others, in-  
cluding some of the authors, might empha-  
size other priorities (e.g., research on  
temporal discounting, international policy  
cooperation and coordination, or political  
economy). But what is crystal clear is that  
society is hampered in using natural sci-  
ence knowledge of climate change due to  
gaps in the knowledge of economic and so-  
cial dimensions of climate change. A much  
more substantive research program on the  
economics of climate change is essential,  
otherwise effective policy solutions with  
broad societal support will remain elusive.  
Future research must continue to include  
data-intensive empirical work to strengthen  
the foundations upon which policy-relevant  
"end products" are based (such as the  
SCC), along with research aimed at defin-  
ing and reframing key questions.

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