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Surveys

The changing climate of climate change economics

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ABSTRACT

Climate change economics is now four decades old. Much of what it has achieved as a field of academic enquiry can be linked back to issues of integrated assessment modelling. This paper shows that the standard approach is going through a major change in scope as of the last five years. The conventional focus on determining optimal mitigation paths based on modelling the social cost of carbon is being enlarged to embrace promising new waves of research. These are: (1) the economics of insurance against catastrophic risks; (2) the economics of trade and climate; and (3) the economics of climate change adaptation. The paper helps to bridge the gap between economics and climate policy by showing that the analytical toolkit of climate change economics has shifted towards more realistic representations of climatic policy.

1. Introduction

"Can we control carbon dioxide?"

William Nordhaus's seminal work on the economics of climate change came out in 1975. In the forty years since, economists have approached climate change research from the perspective of integrated assessment modelling. Despite two inflexions in the research agenda in 1992 (when William Cline published *The economics of global warming*) and 2006 (with the *Stern Review*), the bulk of the discussion has revolved around technical issues such as intertemporal discounting. As of the last five years, a new wave of scholarly work has come out that is broadening the scope of the debate.

This paper presents the most recent literature to show that a narrow focus on integrated assessment modelling, issues of intertemporal discounting, and emission mitigation is being expanded to include the following waves of research: (1) the economics of insurance against catastrophic risks; (2) the economics of trade and climate, including topics such as border adjustments and carbon leakage; and (3) the economics of climate change adaptation. The paper builds upon and adds to recent surveys that cover particular aspects of the debate (Dell et al. 2014 for identification of the causal link between the climate and the economy; Stern 2013 for economic models of climate change impacts; Di Falco, 2014 for agriculture and climate change) by providing a more encompassing review and advancing a new perspective on the state of the literature. The recent developments in climate change economics are helping to make it more relevant to policymakers.

As the ideal scenario of globally coordinated climate action becomes less attainable, increased attention is given in the policy arena to bottom-up approaches to climate cooperation. The 2009 Copenhagen climate summit signalled the rupture of a *universalistic* paradigm of action in which global coordination and an international enforcement system are seen as premises for the effective control of climate change. Despite strong political pressure by the public and some heads of state in the month leading to the meeting, results were bleak. A polarization between China and the United States prevented a binding commitment. Global targets were not set, and institutional progress turned out meagre.

In spite of the above, voluntary climate legislation moved forward in countries including China, Brazil, Argentina and other developing nations. In China, the 12th Five-Year Plan, published in 2011, includes targets to reduce the carbon intensity of GDP by 17% from 2005 levels by 2015. Emission trading systems are also being piloted in provinces such as Guangdong and in municipalities such as Beijing (Nachmany et al. 2014). In Brazil, crucial climate legislation was passed in 2009. Even without formal commitments at the international level, Brazil established a National Climate Policy which provides for reduction of emissions of around 35% of projections for 2020. What is the sense of China and Brazil unilaterally committing to emission reductions at the very moment when the global climate framework was reversing? How to explain such an initiative in the context of a recognized failure of international negotiations?

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Action at the national and subnational levels is gaining momentum. Climate policy is increasingly implemented by individual jurisdictions with a view to be subsequently coordinated with other parties at higher geographical scales. Sectorial negotiations, for example in energy, aviation, and forests, are also accelerating. The debate is thus shifting from a rigid universalistic approach to a paradigm of individual action subject to some degree of global coordination. This is what international relations scholars and political scientists have termed a "building blocks" (Falkner et al. 2010) or a "polycentric approach" (Ostrom, 2010).

The second section of this paper provides a short summary of the results of four decades of climate–economy modelling, presenting the controversy around the validity of using aggregated models to determine optimal emission paths. The third section introduces the first trend of the climate change economics literature: assessing the amount of insurance that society must be willing to pay for in order to prevent major climatic disasters. While research in this area is far from establishing a sound methodological basis to deal with the economics of catastrophic, small-risk events, it is reinvigorating the discussion about policy options.

The fourth section seeks to show that a universalistic approach to climate action—where all countries with significant emissions take binding commitments in a synchronic and coordinated way—has proven unfeasible both theoretically and in practice. This leads to the second trend in research: the economics of trade and climate (Section 5 of the paper). The premise that unilateral action will keep growing is the basis to a mounting interest for issues such as the impact of climate policy on competitiveness and the role of carbon border adjustments on inducing cooperation.

The last important trend is the rising interest for the economics of adaptation. While discussions of climate policy were for a long time compartmentalized between mitigation and adaptation, the latter was typically given much less attention. In the sixth section of the paper, the most recent literature on the economics of adaptation is summarized to show that adaptation is paving its way into mainstream analyses. Given the relevance of adaptation strategies especially for developing countries, this is likely to lead to a more fluid dialogue between climate economists and policymakers.

2. Four Decades of Economic Climate Modelling

This section presents the most important aspects of climate–economy models before examining the recent debates around their validity as decision tools. Scientific models are representations of reality on a small scale. Economic models take results from biophysical models on climate scenarios and their probability distributions to determine the best course of present action. First, a set of scenarios for the future costs of climate change is calculated: the costs of inaction, or the 'social cost of carbon'. Second, response costs are calculated, and they come in two main forms: reduction of emissions, and adaptation (usually calculated independently). Three sets of estimates are thus generated, the results of which are integrated into a cost-benefit framework to estimate the best course of action. Potential gains and losses are weighted up, and an optimal strategy is determined. A *shadow* carbon price is the final output.

What do these standard models tell us?

> "Very little. A plethora of integrated assessment models (IAMs) have been constructed and used to estimate the social cost of carbon (SCC) and evaluate alternative abatement policies. These models have crucial flaws that make them close to useless as tools for policy analysis: certain inputs (e.g. the discount rate) are arbitrary, but have huge effects on the SCC estimates the models produce; the models' descriptions of the impact of climate change are completely ad hoc, with no theoretical or empirical foundation; and the models can tell us nothing about the most important driver of the SCC, the possibility of a catastrophic climate outcome. IAM-based analyses of climate policy create a perception of knowledge and precision, but that perception is illusory and misleading" (Pindyck, 2013a).

The quote above sets the tone of disbelief that is building upon a specific type of economic model that until recently was considered the epitome of the profession: "the social cost framework is under fire", say economists Kenneth Arrow and colleagues (Revesz et al. 2014).

Robert Pindyck, who was until recently an outsider to climate change economics, criticizes the way these calculations are implemented. He asks a fundamental question (Pindyck, 2013b): what should be the price of carbon?, and replies that no one knows, least of all IAMs. For him, the best that can be taken from more than two decades of intense debate around the technicalities of these highly abstract models is a sort of scientific consensus on what the real social cost of carbon may be.[1]

Pindyck's position is not intended to lead to scepticism, but rather to direct the efforts of economists to a more pragmatic study of the economics of catastrophic risk management. While this is indeed an area of enquiry that has gained increased attention as shall be discussed in Section 3, the bulk of mainstream economics is still devoted to IAMs. When it comes to quantifying climate action, IAMs are virtually inescapable, as Pindyck (2013b) suggests. On his side is also Nicholas Stern (2013), who tacitly admits not to know better options than IAMs.

Climate–economy Modelling

William Nordhaus laid the foundational stone of climate change economics well before the first climate conference (Geneva, 1979) and the creation of the IPCC (in 1988). Yet economic models of climate change had to wait until 1992 to gain notoriety with the publication of William Cline's *The economics of global warming*. Climate–economy models such as Nordhaus's DICE (Dynamic Integrated Climate–Economy) then reigned supreme until shortly after the publication of the Stern Report in 2006.

The most salient result of William Nordhaus's climate modelling is the idea that the optimal policy should follow a ramp pattern, where social welfare maximization leads to relatively low investments in the short run, allowing time for the cost of a "backstop technology" to go down, and investments then rise linearly to reach a substantial level in the second half of the current century (Nordhaus 2008, p. 98).[2] This is in sharp contrast with the proposal advanced by the Stern Review, which called for a policy that cut emissions strongly in the short term, with costs up to ten times higher than in Nordhaus's ramp. Why such striking difference between "optimal" policies?

The answer has three parts. First, given that the expected impacts of climate change will take place over the next decades and centuries, the models typically work with extremely long timeframes, 600 years in the case of Nordhaus's and infinite in the case of Stern's. This feature of climate models helps to understand Pindyck's position on IAMs. The confidence level of estimates of GDP and greenhouse gas emissions for twenty years is very low. What to say of a horizon of six centuries?

Second, a time discount procedure must inevitably be employed with such timeframes. One dollar next year is worth less than the same amount today, as the capital saved today should grow according to a market interest rate. Likewise, investments made within 100 years cannot have the same way as those made today. A standardized procedure needs to be adopted for the values at different points in time to be comparable: intertemporal discounting.

[1] Martin Weitzman (2009, p. 18) argues that "[a]ll of this is naturally unsatisfying and not what economists are used to doing, but in rare situations like climate change where the Dismal Theorem applies we may be deluding ourselves and others with misplaced concreteness if we think that we are able to deliver anything much more precise than this with even the biggest and most-detailed climate-change IAMs as currently constructed and deployed".

[2] The findings of a panel formed in 2013 by the US government to synthesize the results of the main economic–climate models (US government 2013) are consistent with Nordhaus's DICE estimates.