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In June 2008, Verlyn Klinkenborg, a *New York Times* columnist, wondered if "any phrase in the English language ever spread more quickly than 'carbon footprint'?"[1] Prior to 2006, public references to carbon footprints were almost nonexistent. But, between 2006 and 2008, carbon footprints seized public attention: Google searches for the term increased seven-fold, newspaper articles referencing the concept jumped seventeen-fold, and peer-reviewed scholarly articles addressing carbon footprints rose more than twenty-three-fold. Carbon calculators and carbon offset programs proliferated on the Internet. In the face of a climate crisis, the carbon footprint promised to engage individuals in addressing climate change. Then, just as quickly as the carbon footprint seized public attention, the concept began to fade away. By 2011, media coverage of and Google searches for "carbon footprint" were lower than in 2007 and many online carbon calculators grew dated. It is tempting to dismiss the rise and fall of the carbon footprint as symptomatic of concerns regarding climate change more broadly: after the economic downturn in 2008 and the continued politicization of climate change science, concerns over climate change, including carbon footprints, were pushed into the twilight of the issue-attention cycle, especially in the United States (US).[2] To draw that conclusion, however, would mean overlooking a dynamic and alternative arena of climate change politics and policy. Indeed, scholarly studies concerned with the carbon footprint concept have increased rapidly since 2006 (see Figure 1).

Carbon footprints have become an important arena for climate change governance that extends "'beyond' the realms of the international climate regime." As Okereke et al. have argued, such alternative "initiatives and practices significantly affect how we conceptualize and understand the nature of global

* I am grateful for helpful comments from Beth DeSombre, Samuel Barkin, and three anonymous reviewers. I also appreciate Anli Yang's and Isabella Gambill's research assistance.

1. *New York Times*, June 24, 2008.
2. Downs 1972; Kahn and Kotchen 2010; Nisbet 2011, 62.

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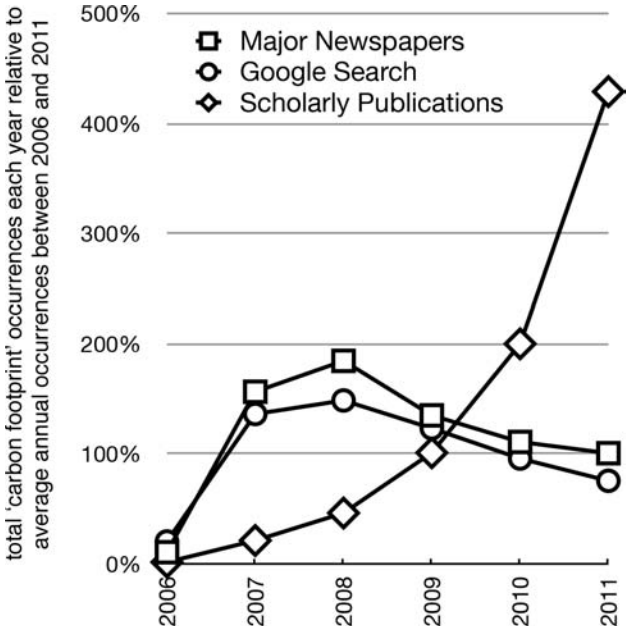

Figure 1
Occurrences of 'carbon footprint' each year relative to average annual occurrences between 2006 and 2001 in major world newspapers, Google searches, and scholarly publications respectively.

Each curve is normalized to its own average. Major newspaper coverage is based on Lexis-Nexus searches of nine English newspapers worldwide; Google search data is drawn from google.trends.com; scholarly publications is based Science Direct, Web of Science, and Google Scholar searches.

climate governance."[3] To the extent that scholars have considered the carbon footprint specifically, it has been examined in the context of a suite of approaches to carbon accounting that encourage individual action on climate change.[4] Although some scholars have warned of the risks of the "individualization of responsibility," which privileges individual action over collective action, most recent analyses have viewed carbon footprints and other such calculative devices as important to "'lift[ing] the veil' on the social, economic, and ecological relations that underpin the experience of consumption."[5] Drawing on a science studies approach to consider the contingent nature of calculative devices—

3. Okereke et al., 2009, 58.
4. Bridge 2010; Paterson and Stripple 2010.
5. Maniates 2002; Bridge 2010.

such as carbon footprints—and governmentality studies to examine the intrinsic relationship between how problems are framed and remedied, this article advances an analysis that builds on previous studies of carbon accounting, but extends them in two important ways. First, I argue that the significance of the carbon footprint is not limited to the individualization of climate governance; efforts to define and deploy carbon footprints have also contributed to an important conceptual shift towards consumption-based approaches in emissions accounting. Second, whereas other scholars have drawn on carbon footprints to shift analysis "downstream" to individual action, I consider how the evolution of carbon footprints at the individual level intersects with discussions of emissions responsibilities and mitigation at national and international scales.[6]

This article is organized around a conceptual history of the carbon footprint that draws on scholarly research, media coverage, online carbon footprint calculators, and related gray literature produced by non-governmental organizations in the US and United Kingdom since the mid-1990s. It is organized into four parts. First, I develop the conceptual framework for the analysis, based on calculative devices and governmentality studies. Second, I examine the first generation of carbon footprint calculators, which focused primarily on emissions from direct energy use. This approach—which I label Carbon Footprint 1.0—prioritized fossil-fuel emissions in its assessment and stemmed from the broader concept of the ecological footprint. Third, I examine the development of carbon footprint analysis as a vehicle for consumption-based carbon accounting. This approach—which I label Carbon Footprint 2.0—expanded the scope and potential policy remedies for addressing emissions. Fourth, I consider how these approaches to consumer-oriented carbon footprints intersect with broader discussions regarding international climate change policy.

Theoretical Framework: Accounting Processes and Governmentality Studies

Carbon has become a commodity that is counted, traded, and offset at scales ranging from the individual consumer to the nation-state since the mid-1990s. Carbon dioxide (CO_2) equivalencies have become the unit of exchange for a range of greenhouse gas emissions.

In recent years, scholars have studied the growth of climate change governance and carbon markets with attention to the proliferation of actors and venues that have helped render carbon "a coherent object of governance."[7] Such studies have examined the political economy of greenhouse gas consumption, drawn on science and technology studies to consider the hybrid social-material natures of carbon offsets, and governmentality studies to investigate the prac-

6. Bridge 2010; Lövbrand and Stripple 2011; Stripple and Lövbrand 2010.
7. Lövbrand and Stripple 2011, 188.

tices and processes of climate governance.[8] This paper draws on two theoretical frameworks to approach the recent history of carbon footprints: a science studies approach to calculative processes and a governmentality studies approach to the relationship between rationalities and technologies of governance.

As Callon has argued, the short history of carbon markets—and, by extension governance—is a story of the dynamic and changing relationship between economics, science, and politics, which hinges on calculative tools.[9] Central to the development and functioning of carbon markets are the calculative processes that render carbon governable. Callon and Muniesa offer three steps for examining calculative processes, which I will describe as identification, transformation, and extraction in the context of calculating carbon footprints. *Identification* asks which entities are to be taken into account. Such entities have to be "detached" and "moved, arranged, and ordered in a single space" to answer the question: What activities count toward a carbon footprint? *Manipulation* includes the processes by which those entities are subject to transformations that establish the relationship between them. In this case, such transformations answer the question: How do these entities contribute to the carbon footprint? Lastly, *extraction* is the generation of a new entity that results from the "manipulations effected in the calculative space and, consequently, links the entities taken into account." Most importantly, the calculation "has to be able to leave the calculative space and circulate elsewhere in an acceptable way (without taking with it the whole calculative apparatus)."[10] Such an approach demands considering how the process of calculating carbon emissions is a product of the complex and creative interactions between the economic, scientific, and political, which has implications for how responsibility for climate change is allocated, who bears the costs of mitigation, and what types of policy options are considered.[11]

To examine the relationship between how a carbon footprint is calculated and emissions are governed, this article draws on several precepts from governmentality studies. First, it considers the practices of governance that are manifest in venues other than the state alone by focusing on consumer-oriented carbon footprint calculators, which are a product of non-governmental organizations, corporations, scholars, and the state. Second, this approach considers the relationship between what Miller and Rose describe as "rationalities" and "technologies." In short, how a problem is conceptualized and the tools for intervening are designed amount to distinct but interdependent activities.[12] As Miller and Rose explain, this means considering the "intrinsic links between a way of repre-

8. Bumpus and Liverman, 2008; Lohmann 2005; Lövbrand and Stripple 2011; Lovell and Liverman 2010; MacKenzie 2009; Paterson and Stripple 2010; Stripple and Lövbrand 2010; Paterson and Stripple 2012; Blok, 2010.
9. Callon 2009, 542.
10. Callon and Muniesa 2005, 1231.
11. Callon 2009, 542–544.
12. Miller and Rose 2008, 19–20.

senting and knowing a phenomenon, on the one hand, and a way of acting upon it so as to transform it, on the other."[13] Lastly, this approach considers the ways that "modes of power" gain significance as they are "linked up with other comparable or similar modes." Such an approach leads to the question: How do efforts to establish consumer-oriented carbon footprints for individuals and households intersect with efforts to calculate and assign responsibility for carbon footprints for a product, a corporation, or a nation-state?[14]

This approach builds on the work of other scholars who have adopted governmentality studies to approach what Lövbrand and Stripple (2011) call the "analytics of carbon accounting." Lövbrand and Stripple consider three forms of carbon governance: the national carbon sink, the carbon credit, and the personal carbon budget. Their approach shifts the focus of climate policy studies away from large-scale policy and political negotiations to consider the "techniques, tools, and methods that have turned carbon into a coherent object of governance."[15] Paterson and Stripple adapt this analytical approach to consider how individualized carbon practices, such as footprints, offsets, and diets, have rapidly emerged as an important form of governance—"the conduct of carbon conduct"—affecting individual carbon behavior. As they explain, rather than serving to draw attention from collective efforts to address climate change, such practices "articulate individuals as agents managing their own carbon practice in relation to an articulated global public goal of minimizing climate change."[16] But what these studies have not fully addressed, as Lövbrand and Stripple acknowledge, is how such approaches to counting carbon—whether at the individual level or in the international community—play into the politics and policy choices central to climate governance.[17]

This analysis of carbon footprints extends such studies of the analytics of carbon accounting in two ways that engage the political and policy implications of counting carbon. Studies that have considered the carbon footprint have often understood it as a well-defined and static concept that allows individuals to both contextualize their contributions to climate change and take action to address those emissions. Although such analyses are important, they overlook the ways in which carbon footprints have been developed conceptually over time. Since the late 1990s, the carbon footprint has been a dynamic concept, which has helped precipitate new attention to consumption-based approaches to carbon accounting. Thus, carbon footprints are not important simply for their functional value in engaging individuals in carbon governance, but as a site of conceptual innovation in the analytics of carbon accounting. Second, many studies of the analytics of carbon accounting are stratified, examining concepts such as emissions credits or off-sets at different scales, such as the corporation

13. Miller and Rose 2008, 15.
14. Miller and Rose 2008, 20–21.
15. Lövbrand and Stripple 2011, 187.
16. Paterson and Stripple 2010, 359.
17. Lövbrand and Stripple 2011, 198.

or the nation-state, but giving less attention to the relationships between them. Following Miller and Rose's call to consider how modes of analysis gain importance as they are "linked up with other comparable or similar modes" at different scales, this paper considers how the evolution of carbon footprints has intersected with discussions of emissions responsibilities and mitigation at the global level.[18] Instead of viewing discussions over how carbon is counted as settled, I examine how different approaches to counting carbon have significant implications for how responsibility for emissions are allocated and the policy tools available to address such emissions.

Carbon Footprint 1.0: Carbon Footprint as a Subset of the Ecological Footprint

Carbon footprints have become so ubiquitous in discussions of climate change it is easy to take the term for granted, but the concept has a short history. Important moments in this history include: In 2001, the World Resources Institute launched one of the first carbon calculators on the Internet at SafeClimate.net. In 2003, Carbonfund paired an online carbon footprint calculator with its carbon offset program to encourage individual action. In 2005, BP, the energy company, ran television advertisements in the US and Europe that asked consumers, "What is your carbon footprint?" Despite these efforts, attention to the concept was slow to develop. Only after the surge of attention to global warming in 2006 did public interest in carbon footprints begin to grow, peaking in 2008 when more than a dozen online carbon footprint calculators were available on the Internet from non-governmental organizations, such as The Nature Conservancy and Carbonfund.org, governmental agencies, such as the US Environmental Protection Agency, and corporations, such as BP. The concept reflected a well-developed body of scientific and social scientific knowledge regarding fossil fuels, CO_2 emissions, and climate change. Initially, SafeClimate adopted the term "carbon dioxide footprint," but "carbon footprint" became the default nomenclature by 2002.[19] In turn, by emphasizing energy-related carbon emissions, the concept discounted other lesser-understood or indirect ways in which individuals contributed to climate change.

A survey of twelve popular carbon footprint calculators revealed that all followed a basic calculative methodology deployed by the Safeclimate.net calculator in 2001.[20] Callon and Muniesa offer a useful framework for examining the calculative process underlying these first-generation calculators.[21] The types of activities *identified* as relevant were those that produced carbon emissions from the burning of fossil fuels, such as home electricity use, home heating, and car

18. Miller and Rose 2008, 21.
19. World Resources Institute 2001.
20. Based on a survey of twelve carbon footprint calculators returned by a Google search for "carbon footprint calculator" on July 1, 2008.
21. Callon and Muniesa 2005, 1231.

and air travel. By relying on household utility records or personal estimates (e.g., kilowatt-hours used, therms burned, miles driven), such usage could be estimated relatively easily and accurately, and thus detached and moved into a common calculative space. Once accounted for, each activity could be *manipulated* using greenhouse gas intensity data for electricity generation (at the local, regional, or national level) and fuels (natural gas, fuel oil, propane, gasoline, jet fuel, etc.) to determine equivalent CO_2 emissions. For instance, given annual mileage and vehicle type, the calculator could divide the mileage by the vehicle's fuel efficiency (drawn from a government database) and multiply the fuel consumption by the greenhouse gas intensity of gasoline to estimate emissions. The final result, summing up the consequences of the identified activities, was reported as a single figure, a carbon footprint measured in tons of CO_2 emissions, which individuals were encouraged to *extract* as a basis for better understanding their contribution to climate change (how did their emissions compare to friends or a national average?) and for reducing or offsetting emissions (how much would a more fuel-efficient car reduce their footprint?). For the average US household, Carbon Footprint 1.0-based calculators reported a footprint of 23.3 tons of CO_2.[22]

What explains the scope of these first-generation carbon footprint calculators? In part, the carbon footprint was derivative of the ecological footprint, a broader concept that had been developed in the 1990s to account for an individual's resource consumption and waste assimilation requirements in terms of the corresponding land area necessary to provide water, food, shelter, goods, and energy.[23] Most comparisons of the ecological and carbon footprints have focused on the major difference: the ecological footprint was conceived of in spatial terms (hectares of land), but the carbon footprint is measured in units of mass (such as tons of CO_2).[24] Carbon footprint calculators also borrowed from the ecological footprint in three ways that have drawn less attention. First, the ecological footprint highlighted the value of a metric that was scalable (ecological footprints were calculated for individuals, cities, nations, and the globe) and comparable (how did the ecological footprint of a New Zealander compare to an American)? Second, the ecological footprint encouraged the strategy of carbon offsets, in which land was managed to sequester carbon emissions. Third, SafeClimate.net described its approach as a subset of the ecological footprint.[25] Whereas the ecological footprint focused broadly on energy consumption, the

22. This figure was calculated based on emissions factors reported for the American Forests, Bonneville Environmental Foundation, CarbonCounter.org, Conservation Fund, SafeClimate, and TerraPass carbon calculators in Padgett et al. 2008. Average household data was drawn from statistics from Energy Information Administration, Bureau of Transportation, and US Census Bureau as follows: average household heating (692 therms of natural gas), electricity (11,480 kilowatt hours), passenger vehicle miles per household (24,633 miles at 21.7 miles per gallon), and air travel per household (8007 air miles).
23. Wackernagel and Rees 1996, 63–79.
24. Jarvis 2007; Wiedmann and Minx 2007.
25. World Resources Institute 2004a.

carbon footprint was a narrower metric, which included only emissions linked to fossil-fuel use for heating, transportation, and electricity generation. These became the default categories for most carbon footprint calculators.

The careful observer would have ascertained the limitations of early carbon footprint calculators: they were both limited in scope and accuracy. Although SafeClimate.net described the carbon footprint as "the effect you . . . have on the climate in terms of the total amount of greenhouse gases you produce (measured in units of carbon dioxide)," it acknowledged that the calculators accounted for only 40 percent of emissions.[26] Emissions resulting from other activities, such as the consumption of food, the purchase of clothing or appliances, or attending a movie, were omitted. In part, such omissions were practical: for consumers, quantifying such activities could be difficult (compared to reading a utility bill or estimating annual auto mileage); for calculators, translating such a wide array of potential data—from the consumption of fruits and vegetables to paying for mobile phone service—into emissions was a challenge.

Calculators also adopted different approaches to assessing the emissions consequences of activities such as electricity generation (were emissions intensity data aggregated at the national, state, or utility level?), air travel (how were the radiative forcing effects of jet contrails handled?), and gasoline consumption (did emissions data include upstream refining of the fuel?). In most cases, as Paterson and Stripple have noted, calculators defaulted to the simplest methodology.[27] Estimating the carbon footprint for electricity consumption, household heating, and travel using emissions factors from five carbon footprint calculators resulted in estimates that ranged from 22.5 to 25.8 metric tons of CO_2.[28] Such uncertainties and variation received little attention on carbon footprint websites, however. Instead, how carbon footprints were reported emphasized their precision and validity. SafeClimate.net, like other calculators, reported the footprint as a single figure, not as a range or with a margin of error (although the supporting documentation usually described the footprint as an "estimate"). In this way, the carbon footprint tapped into what Theodore Porter has described as the "prestige and power of quantitative methods"—by reducing climate change to a specific figure meaningful at an individual level.[29] Compared to most discussions of climate change policy, which hinged on the uncertainties inherent in long-term projections of the earth-climate system, the carbon footprint was seemingly concrete; it was data an individual could act on.

This strategy aligned with the entrepreneurial efforts of both nongovernmental organizations and government agencies to make the global problem of climate change tractable for individuals. As a result, carbon footprints

26. Ibid.
27. Paterson and Stripple 2010, 350.
28. Padgett et al. (2008) note that the inconsistency across calculators is one of the chief obstacles to their value to individuals seeking to address climate change.
29. Porter 1995, viii.

became a well-publicized tool by which individuals could both assess their contribution to global warming and take action to address it. Most calculators placed such results in a comparative context. For some Americans, the realization that their footprint was fifteen times greater than that of the average Indian would be motivation to take action. To encourage such action, carbon footprint calculators most often emphasized consumer-based actions, such as improving energy efficiency or offsetting carbon emissions. For instance, SafeClimate.net highlighted switching to green electricity providers, purchasing more efficient products and appliances, or choosing a more fuel-efficient vehicle.[30] The EPA calculator promoted EnergyStar appliances and products, such as refrigerators, furnaces, light bulbs, and windows.[31] Carbon offset providers aggressively linked carbon footprint measurements with offset options. "It's simple," explained Carbonfund.org. "Estimate your carbon footprint. Donate to offset it." For $68.82, Carbonfund.org promised to offset 12.5 metric tons of carbon.[32]

I label this approach to counting carbon, which emphasizes activities associated with fossil-fuel use, as Carbon Footprint 1.0. It succeeded in translating a problem that turns on a global commons, invisible emissions, and future consequences to a scale that was meaningful for individuals. Approaching Carbon Footprint 1.0 as a form of government rationality makes clear that this approach is important not just for enabling the "conduct of carbon conduct," but also for constraining how individuals have understood their conduct in relation to carbon emissions.[33] In general, Carbon Footprint 1.0 reduced climate change to an energy problem. Thus, in the case of individuals, carbon footprint calculators encouraged consumer-based actions, such as improving energy efficiency (through purchasing high-efficiency light bulbs, appliances, or vehicles) or adopting household solar technology (without considering the carbon consequences of manufacturing and installing such a system). Such a framework, however, offered little basis for or reason to consider other approaches, such as changing diet, retaining appliances until the end of their useful life cycle, or changing waste management strategies. Carbon Footprint 1.0 remains an important approach to individual climate governance: in 2012, nine of the ten most popular carbon footprint calculators still followed this basic methodology.[34]

Carbon Footprint 2.0: Greenhouse Gas Emissions as an Extension of Economic-Input Analysis

Even while public interest in carbon footprint calculators grew after 2006—as it was popularly described as a way to allow individuals to do their part in the fight against climate change—academics, corporations, and policymakers were

30. World Resources Institute 2004b.
31. USEPA Office of Atmospheric Programs 2007.
32. CarbonFund.org 2004.
33. Paterson and Stripple 2010, 348.
34. This is based on a review of the top ten calculators returned by a Google search for "carbon footprint calculator" conducted on September 10, 2012.

actively reconsidering the concept. Scholars warned that the proliferation of carbon footprints had resulted in inconsistent and potentially conflicting approaches to greenhouse gas accounting that would undermine the value of the metric.[35] Several concerns informed such warnings: First, were discrepancies among carbon footprint calculators that resulted from different assumptions regarding the emissions consequences of various modes of travel, heating, and electricity generation.[36] Second, most existing carbon footprint inventories omitted emissions associated with the consumption of food, goods, and services. Concerns about such emissions grew after studies suggested that common consumer products, such as beef, had significant carbon footprints.[37] Third, scholars had begun to demonstrate that trade-related emissions—described as "carbon leakage"—might have consequences for international climate policy.[38] Efforts to address shortcomings in existing carbon footprint methodology and to extend the scope of carbon footprint analysis contributed to the advent of consumption-based approaches to greenhouse gas inventories—which I label Carbon Footprint 2.0.

A leading example of this newer generation of consumer-oriented calculators is the CoolClimate Carbon Footprint Calculator.[39] It took a different approach than Carbon Footprint 1.0 calculators to establishing the calculative space important to a carbon footprint. Instead of *identifying* specific sectors most important to the carbon footprint, the CoolClimate Calculator identified all household expenditures as relevant. To assess the consequences of household expenditures, the calculator *manipulated* such data by translating income into estimated household expenditures across economic sectors, using data on average household spending (based on household size, income, and geographical location). Such expenditures were then combined with greenhouse gas intensity data for specific economic sectors to yield estimated emissions in CO_2. Summing up the emissions associated with each economic sector yielded the household's carbon footprint. The CoolClimate Carbon Footprint Calculator reported that the average US household has a carbon footprint of 49 tons of CO_2 (more twice the average footprint reported by Carbon Footprint 1.0 calculators). The *extraction* of this figure was not as simple as in the case of Carbon Footprint 1.0, however. Although this result was presented without reference to the uncertainties inherent in the analysis, individuals were encouraged to refine the initial estimate by providing more specific information, such as detailing a range of activities and consumption habits. These included those common in Carbon Footprint 1.0 calculators, such as travel, home heating, and electricity, and additional categories, such as calories of food consumed (meat, dairy, fruits and vegetables, etc.), dollars of goods purchased (clothing, furniture, other

35. Wiedmann and Minx 2007; Weidema et al. 2008, 3.
36. Padgett et al. 2008, 112–13.
37. Koneswaran and Nierenberg 2008.
38. Babiker 2005; Mongelli et al. 2006; Paltsev 2001; Peters and Hertwich 2008.
39. CoolClimate Network 2011.

goods), or dollars of services paid for (health care, entertainment, education, etc.).

This broader framework for generating knowledge about activities relevant to climate governance was related to the expanding scope of the "conduct of carbon conduct." Most obviously, the broader scope of activities identified as relevant to climate change contributed to a wider range of potential individual actions. For instance, the CoolClimate calculator recommended nineteen potential actions ranked by economic savings, including going on a low-carbon diet, upgrading vehicle efficiency, and telecommuting to work. In comparison to Carbon Footprint 1.0 calculators, options such as purchasing green energy or offsetting emissions were ranked lower because they generate no economic benefit for the individual. Moreover, unlike Carbon Footprint 1.0, which only included emissions related to energy use, Carbon Footprint 2.0's recommendations weighed reductions from energy use against the indirect emissions resulting from consuming new goods and services. For instance, in the case of purchasing a fuel-efficient automobile, it factored in emissions from reduced fuel consumption, but also indirect emissions associated with sourcing, manufacturing, and disposing of the automobile. Lastly, Carbon Footprint 2.0 made evident the challenges of translating individual action into significant change. For instance, implementing a top recommendation, such as changing diet, would only reduce the average household's footprint by 3.5 percent.

Scholarly research on life-cycle analysis informs the approach of Carbon Footprint 2.0 calculators. In 2007, industrial ecologists Thomas Wiedmann and Jan Minx called for a reconceptualization of carbon footprint methodology that was grounded in scholarly research in industrial ecology and extended economic input-output analyses. In place of the limited approach represented by Carbon Footprint 1.0, they suggested a more comprehensive approach to carbon footprints that included "the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product."[40] By defining emissions in reference to activities, this definition implicated a wide range of actors in climate governance, including individuals, households, cities, or nations, since activities might include burning fuel to heat an individual home or fuel to heat the homes of a nation. By defining emissions in reference to products, this definition also included the emissions that were embodied in, or the consequence of, products or services, which might be consumed by an individual, manufactured by a company, or traded across national borders.

The approach that Wiedmann and Minx called for has emerged as the foundation for new approaches to counting carbon at the household, institutional, and national scales. Notably, such approaches shared a common calculative approach grounded in economic input-output analysis. The most prevalent approach to life-cycle analysis has been *process-based,* meaning that assessing a

40. Wiedmann and Minx 2007.

carbon footprint required identifying and measuring the physical inputs and outputs related to emissions at all stages, from production of raw materials, through manufacturing, and including use and ultimate disposal. But such an approach is laborious, particularly when the goal is to aggregate emissions from consumption, whether for a household or nation.[41] The turn toward consumption-based accounting depended upon a complementary methodology, grounded in *economic input-output analysis.* Input-output analysis is a field of economics that dates to the 1930s. Put simply, it quantifies the interactions between different sectors of the economy by measuring the consequences of a unit of activity in one sector of the economy, such as purchasing an automobile, in other sectors of the economy, such as mining, manufacturing, advertising, shipping, or retail. This approach can be extended to estimate the environmental consequences of activities in each of those sectors (an extended input-output analysis), such as greenhouse gas emissions, which are reported as the emissions per unit of economic activity.[42] The most important advantage of economic input-output analysis is that comprehensive life-cycle analyses can be completed relatively efficiently by drawing on input-output datasets detailing economic activity (and related environmental impacts) that are economy wide and based on government statistics, without the product-by-product or activity-by-activity analysis necessary in a process-based approach. Such an approach comes at the expense of accuracy, however: extended input-output datasets are updated infrequently, the data is aggregated by economic sector, and there may be inconsistencies across datasets that complicate comparisons.[43] The CoolClimate Footprint Calculator employed a hybrid approach, using input-output analysis to estimate the initial footprint, which could then be refined with additional information and, in some cases, process-based analysis.[44]

Approached as a form of governance, Carbon Footprint 2.0 significantly expanded the scope of activities relevant to carbon governance and the array of potential strategies for mitigating climate change. In the case of the individual, it shifted attention from energy consumption—through conservation, efficiency, and off-setting—to considering those activities and, in addition and relative to, the consequences of consuming food, goods, products and other services. For many individuals, the most significant step to reducing their footprint would not be changing home heating or travel, but changing dietary habits. The result was an expanded suite of strategies for addressing climate change, but also the realization that significant change is difficult when nearly every action is subject to "the conduct of carbon conduct."

Since 2008, such consumption-based approaches to counting carbon have been gaining attention. The CoolCarbon Footprint Calculator has become the basis for other calculators, such as that deployed by the World Wildlife Fund.

41. For explanations of process-based LCA, see Wiedmann and Minx, 2007; Cox 2011.
42. Wiedmann 2009; Green Design Institute, 4–5.
43. Fischer 2011. For examples of extended economic input-output data, see http://www.eiolca.net/
44. CoolCalifornia.org 2013.

Numerous corporations have taken steps to extend their emissions assessments beyond direct energy consumption, to consider the emissions consequences of individual products and related supply chains. For instance, a hybrid approach to carbon footprint assessment—drawing on both process-based and economic input-output analysis—underlies the Greenhouse Gas Protocol Product Standard, developed by the World Resources Institute in 2011 to guide corporate assessments of individual products. In addition, consumption-based approaches to greenhouse gas accounting have been a focus of recent scholarship and gained attention in international policy discussions. For instance, governments and institutions, including the state of Oregon, the British Parliament, and the World Trade Organization, have engaged in formal discussions regarding consumption-based greenhouse gas inventories.

A Transition from Carbon Footprint 1.0 to 2.0?

The comparison of Carbon Footprint 1.0 and 2.0 demonstrates that carbon footprints have done more than just engage individuals in climate change; they have also served as sites of innovation with respect to how carbon emissions are assessed. To fully understand the significance of this alternative arena of carbon governance, however, it is necessary to consider how it intersects with broader discussions of climate politics and policy. As Miller and Rose argue, such "modes of power" gain significance as they are "linked up with other comparable or other similar modes."[45] Governmentality studies highlights "how traces are left, linkages formed, connections established and some degree of stability is achieved in an assemblage."[46] The research on consumption-based approaches to allocating greenhouse gas emissions has been embedded in broader shifts in climate change politics and policy. This is not to suggest that developments at the individual level have driven this transition; instead it is to suggest that these shifting approaches to the analytics of carbon accounting at different scales are interrelated. Considering these synergies offers the opportunity to consider how the "analytics of carbon" play into the politics and policy choices central to climate governance.[47]

Although the allocation of responsibility for international carbon emissions under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol is more comprehensive (including domestic agriculture, land use change, and other categories), it aligns with the scope of Carbon Footprint 1.0 in important ways. The protocol assigned nation-states responsibility for direct emissions resulting from activities within the boundaries of the nation-state and its territory; similarly, Carbon Footprint 1.0 assigned individuals responsibility for emissions associated with household energy con-

45. Miller and Rose 2008, 21.
46. Miller and Rose 2008.
47. Lövbrand and Stripple 2011, 198.

sumption and travel. The protocol did not assign nation-states responsibility for emissions embodied in the trade of food, goods, and services; similarly, Carbon Footprint 1.0 omitted household consumption of food, goods, and services. There are two exceptions: nation-states and individuals are responsible for 1) indirect emissions resulting from imports or purchases of electricity and 2) emissions from the combustion of imported fossil fuels (exporting nations only bear responsibility for the domestic emissions associated with fossil-fuel production).[48] At the global level, this approach is based on the premise that nation-states should be responsible for the emissions directly associated with domestic economic activities. Following this methodology, the EU claimed in 2008 that it was on track to successfully meet its obligations under the Kyoto Protocol; the EU-15's emissions were 6.9 percent below the 1990 baseline. Although that drop was partly a result of the global economic recession, EU officials emphasized the success of both the EU's energy policies and the Kyoto Protocol.[49] Nonetheless, during the same time period, global greenhouse gas emissions grew 40 percent.[50]

These divergent trends highlight one of the most important political compromises and problematic structural features of the Kyoto Protocol: the two-tier system that distinguishes between developed and developing countries' responsibility for greenhouse gas emissions under the principle of common but differentiated responsibility. Specifically, as a result of political compromise, developing countries, such as China, Brazil, and India, were exempt from the initial round of greenhouse gas reduction commitments, since they had done less to contribute to global warming historically, while developed countries, such as the US and the EU, were meant to commit to emissions reductions. Since the late 1990s, scholars had warned that distinction could lead to "carbon leakage," whereby greenhouse-gas–intensive activities would be shifted from developed to developing countries.[51] A series of studies after 2006 revealed that such trade-related emissions were an important factor in global carbon emissions.[52] For instance, a 2010 study indicated that 23 percent of China's 2004 emissions were driven by export-oriented activities, most of which met demand in developed countries; for some developed countries, imports—unaccounted for under Carbon Footprint 1.0—increased domestic emissions by 20–50 percent.[53]

When climate change negotiations broke down in Copenhagen in 2009 over the divide between developed and developing countries, Carbon Footprint 2.0 gained in political relevance. As Davis and Caldeira explain, "to the extent that constraints on emissions in developing countries are the major impediment to effective international climate policy, allocating responsibility for some

48. Intergovernmental Panel on Climate Change 1996.
49. Europa 2010.
50. Data drawn from World Resources Institute-CAIT Database 2010.
51. Paltsev 2001.
52. Mongelli et al. 2006; Peters and Hertwich 2008; van Asselt and Brewer 2010.
53. Davis and Caldeira 2010.

portion of these emissions to final consumers elsewhere may represent an opportunity for compromise."[54] Yunfeng and Laike put the point sharply in a study of China's export-related greenhouse gas emissions, arguing that "those who consume the goods made in China should also share responsibility."[55] For example, under Carbon Footprint 1.0, if the US converted its fleet of automobiles to hybrid automobiles made in China, the US would see a decrease in emissions from fuel consumption, while the emissions associated with manufacturing the vehicles would be assigned to China. Under Carbon Footprint 2.0, however, the emissions consequences of the vehicles' lifecycle would be assigned to the US. As a result, argue Yunfeng and Laike, "in the global environmental negotiations, China should claim the consumption-based CO_2 accounting system."[56]

Although the most prominent argument for consumption-based accounting is based on more equitably distributing responsibility for emissions between developed and developing countries, proponents also argue that such a shift offers other advantages. First, Carbon Footprint 2.0 is grounded in a calculative process that can more consistently account for consumption-related emissions at multiple scales, from the individual to the nation-state. Second, Carbon Footprint 2.0 addresses the problem of orphaned international emissions, such as those from international shipping and transport, since those emissions are allocated based on the consumption of those services (rather than falling through the cracks as they do in Carbon Footprint 1.0 approaches, since they occur outside the boundaries of any one country).[57] Third, Carbon Footprint 2.0 provides a more comprehensive assessment of emissions associated with a wider range of fuel sources, particularly biofuels. Under Carbon Footprint 1.0, biofuels are often treated as renewable and, therefore, zero-carbon at the point of combustion; in contrast, a Carbon Footprint 2.0 approach considers associated emissions across the lifecycle of biofuels.[58] Fourth, Carbon Footprint 2.0 is amenable to a carbon tax, since it potentially allows for the taxation of goods and services based on carbon emissions (which is important in the case of imports from a country without a carbon tax).[59] Finally, Carbon Footprint 2.0 helps expand the scope of policy initiatives beyond energy management—largely focused on directly reining in fossil-fuel emissions through energy efficiency, alternative energy development, and transportation policy—to include a wider array of consumption-based approaches—such as reducing food waste, increasing the durability of goods, changing recycling and waste management practices, and addressing trade policy.[60]

The concerns raised in response to Carbon Footprint 2.0 approaches are

54. Davis and Caldeira 2010, 5690.
55. Yunfeng and Yang 2010, 356.
56. Yunfeng and Laike 2010, 356.
57. Stockholm Environmental Institute 2011.
58. U.K. House of Commons 2012.
59. *New York Times*, August 25, 2012.
60. U.K. House of Commons 2011.

both methodological and pragmatic. First, unlike the international protocols for reporting emissions under the UNFCCC, which have been codified and formally recognized by the international community, Carbon Footprint 2.0 remains under-developed as a calculative process.[61] Second, adopting a Carbon Footprint 2.0 approach would increase the burden on developed countries, further complicating support for climate policy in countries such as the US. Third, while Carbon Footprint 2.0 does shift responsibility for emissions from exporters (often developing countries) to importers (often developed countries), such a shift could create new barriers to trade. If carbon is priced sufficiently high, developed countries may expand domestic production to the potential disadvantage of developing countries' export economies.[62] Such concerns help explain why countries such as China and India have been slow to embrace Carbon Footprint 2.0. The most pointed objection to Carbon Footprint 2.0 has been advanced by those concerned with the political consequences for the international policy process. Some policymakers have suggested that integrating Carbon Footprint 2.0 methodology into climate governance could be a "huge distraction" to international negotiations and such an "attempt would delay an effective solution on climate change potentially for years or even decades."[63] With an eye toward a post-Kyoto framework, they urge policymakers to forge ahead and negotiate a global emissions reduction treaty based on existing calculative processes codified under the UNFCCC.

Conclusion

This paper has described two broad approaches to calculating carbon emissions—Carbon Footprint 1.0, which prioritizes emissions from fossil-fuel and electricity use, and Carbon Footprint 2.0, which also includes indirect emissions through consumption-based analysis—both of which are relevant to climate governance at scales ranging from the individual consumer to international climate policy. Where other studies have focused on the role of carbon footprints in enabling individual action on climate change, this analysis reveals that the carbon footprint has been a dynamic site of policy experimentation and innovation, which has emerged in conjunction with changes in the politics and policy of carbon accounting. As this article demonstrates, there is an intrinsic relationship between the calculative processes underlying carbon accounting and potential policy strategies. This is important to future efforts to forge climate policy in two respects.

First, how carbon is counted has implications for how actors, from consumers to nation-states, approach mitigating those emissions. Carbon Footprint 1.0 emphasizes strategies aimed at curbing energy-related emissions by improv-

61. U.K. House of Commons 2012.
62. Eckersley 2010; Shrubsole 2011, 7–9.
63. U.K. House of Commons 2012.

ing energy efficiency, promoting alternative energy sources, and changing transportation policy, while omitting emissions associated with the consumption of food, goods, and services. As a result, Carbon Footprint 1.0 does not weigh energy efficiency gains against related economic activities, such as sourcing, manufacturing, or transporting such goods and services. Carbon Footprint 2.0, in contrast, not only includes the emissions reductions due to displacing fossil-fuel consumption with solar panels, for example; it also includes the emissions resulting from the lifecycle of the panels. This approach highlights other potential policy levers related to the consumption of goods, products, and services, such as changing dietary habits and agricultural policies, improving waste management and recycling practices, and adopting policies aimed at affecting consumer habits, such as lengthening the life cycle of durable goods.

Second, how carbon is counted has important implications for the allocation of responsibility for climate change. By accounting for emissions embedded in consumption and trade, Carbon Footprint 2.0 offers an alternative framework for negotiating the joint responsibility that consumers and producers or importing nations and exporting nations bear for emissions. Rather than simply allocating responsibility at the site of energy use, as is generally the case under Carbon Footprint 1.0, or the ultimate site of product consumption, as is suggested by Carbon Footprint 2.0, these approaches in combination offer an opportunity to distribute responsibility for carbon emissions more equitably, as has been suggested by other scholars.[64] The basis for such a compromise is an area that demands further discussion, both among scholars and policymakers. Some observers have argued that initiating such discussions will only serve to delay efforts to address climate change. Indeed, it is unlikely that Carbon Footprint 2.0 will displace Carbon Footprint 1.0 in the international climate regime. But, equally important, it is unlikely that Carbon Footprint 2.0, which has already gained relevance at the individual, product, corporate, and global level, can be kept on the sidelines of international policy discussions. This paper demonstrates that how to count carbon remains an unsettled issue that urgently requires further interdisciplinary discussion and analysis.

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64. Davis and Caldeira 2010; Yunfeng and Laike 2010.

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