

Article

# Climate Change and Economics 101: Teaching the Greatest Market Failure

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**Abstract:** In this paper, we explore how principles of economics courses prepare undergraduate students to think about climate change. We collected a comprehensive list of twenty-seven introductory economics textbooks in the United States and analyzed their coverage of climate change. Our finding shows that not all texts touch upon climate science, and a small subset deviates from the scientific consensus on the human causes of climate change. All texts conceptualize climate change as a problem of carbon emission's negative externalities and the preferred market-based solutions, such as emission trading and Pigouvian tax. Besides externality, some authors include various useful points of engagement through GDP (Gross domestic product) accounting, economic growth, collective action problems, cost–benefit analysis, and global inequality. In the end, we provide suggestions for economics educators to innovate the current introductory curriculum to better cope with the climate crisis.

**Keywords:** climate change; externality; economic textbooks; economics education

## 1. Introduction

Among all social sciences, economics is considered as the most politically powerful discipline, exerting influences through its professional authority, institutional positions in the government, and cognitive infrastructure of policymaking [1,2]. The economics of climate change, ranging from the quantification of potential impacts to the design of policy instruments, has played a significant role in our understanding and responses to climate change [3]. Meanwhile, economics education is also influential in shaping young generations' views on climate change. While only a small fraction of undergraduate students chooses economics as their major, about 40% of them—more than one million each year—take some types of introductory economics course in the United States [4,5]. Those students' views on climate change could be affected directly by discussions of climate issues—the focus of this article—or indirectly, for example by introducing students to “the economic way of thinking”. On the one hand, there is empirical evidence of an “indoctrination effect”—that economics classes can lead students to behave more like self-interested economic agents [6–10]. Some critics argue that the current introductory economics, as it is dominated by neoclassical principles, can potentially undermine the pursuit of sustainability [11–14]. On the other hand, many economists would contend that learning economics is indispensable for understanding why climate change is such a difficult challenge and how individuals and societies might respond.

In this article, we provide a descriptive account of the state of climate change insights in economics textbooks. For economics educators who prefer a balanced and wide treatment of climate change in

their textbook, this paper provides an overview of the accuracy and scope of this topic across a wide range of commonly used textbooks. This content analysis was first conceived by one of the authors, Yoram Bauman, in 2000, when he was shocked by a textbook describing global warming as a hoax. Bauman revisited this issue in his online “Grading Economics Textbooks on Climate Change” report in 2010, with three more rounds of updated reviews in 2012, 2014, and 2017. The reviews have led to some lively discussions and, in some cases, to actual changes in textbook contents [15–18]. Based on his qualitative analyses, Bauman (2017) concludes that “the treatment of climate change in economics textbooks is getting better.”

Building on Bauman’s work, this article takes a deeper dive into this topic by using a more comprehensive set of books and discussing potential curricular innovations. To our knowledge, our project is the first attempt to audit climate change content of economics textbooks in the literature. We have two main goals: (1) To present a comprehensive assessment on how climate change is discussed in introductory economics textbooks, and (2) to highlight various ways that educators can engage with climate issues in the curriculum. Our analysis demonstrates that the current coverage of climate change is quite narrowly focused: For most texts, climate change only appears in the “externalities” or “environmental economics” chapters. Some authors, however, have made innovative changes to bring the subject more to the fore throughout the curriculum.

The article will proceed with a section on our data and research method. We will then discuss the representation of climate science, the externality framework, and other points of engagement in the texts. To conclude, we will provide some thoughts on options for innovation.

## 2. Data and Methods

In our analysis, we focused on only the textbooks for traditional two-semester principles courses that cover both microeconomics and macroeconomics. This means that our selection excluded single-semester “essentials of economics” textbooks, intermediate and advanced textbooks, and textbooks for graduate studies. We also excluded textbooks published outside of the United States.

With these criteria, we followed Lopus and Paringer’s (2012) collection—the most comprehensive list of principles of economics textbooks—to construct our dataset [19]. We included all books in Lopus and Paringer’s list, except Taylor and Weerapana, as we failed to obtain an instructor’s copy. We also added two new textbooks: Acemoglu, Laibson, and List (2015) and Karlan and Morduch (2018) to our data. In total, we had the latest version of twenty-seven textbooks, all but Samuelson and Nordhaus published after 2013. It is also worth noting that several texts were written by prominent economists such as Daron Acemoglu, Paul Krugman, Gregory Mankiw, and William Nordhaus.

We also obtained rough estimates of market share data from a publisher. The usage and popularity of these textbooks vary significantly. Most notably, two texts—McConnell, Brue, and Flynn and Mankiw—comprise about 40% of the market; another four texts (by Bade and Parker; Case, Fair, and Oster; Krugman and Wells; and Hubbard and O’Brien) account for an additional 27%; the remaining texts have market shares under 5%.

Table 1 summarizes basic information about the textbooks in our analysis.

In our analysis, we outlined the various thematic categories under which climate change appears in these texts, as shown in Table 2. This was done through keyword searches using the Bookshelf software from VitalSource. We searched for terms like “climate change”, “global warming”, “carbon”, “emission”, “pollution”, “ecological”, and “sustainability” to identify relevant sections of each book. We also used the table of contents and the index in each textbook. To interpret what counts as “relevant” to climate change, we looked at the coverage of climate change science, the economic analysis of climate change, as well as segments that related to climate policies. We are confident that we captured the sections related to climate change in the texts. To ensure the accuracy of the coding process, two of the authors conducted coding separately, and then compared results to detect discrepancies.

**Table 1.** Background information on the introductory economics textbooks.

Author	Book Title	Publisher	Year	Edition
Acemoglu, Laibson, and List	Economics	Pearson	2018	2
Arnold	Economics	Cengage	2016	12
Bade and Parkin	Foundations of Economics	Pearson	2018	8
Baumol and Blinder	Economics: Principles and Policy	Cengage	2016	13
Boyes and Melvin	Economics	Cengage	2016	10
Case, Fair, and Oster	Principles of Economics	Pearson	2017	12
Chiang	Economics: Principles for a Changing World	Worth	2016	4
Colander	Economics	McGraw-Hill	2017	10
Cowen and Tabarrok	Modern Principles: Economics	Worth	2015	3
Dolan	Introduction to Economics	BVT	2016	6
Frank, Bernanke, Antonovics, and Heffetz	Principles of Economics	McGraw-Hill	2016	6
Gwartney, Stroup, Sobel, and Macpherson	Economics: Private and Public Choice	Cengage	2018	16
Hall and Lieberman	Economics: Principles and Applications	Cengage	2013	6
Hubbard and O'Brien	Economics	Pearson	2017	6
Karlan and Morduch	Economics	McGraw-Hill	2018	2
Krugman and Wells	Economics	Worth	2015	4
Mankiw	Principles of Economics	Cengage	2015	7
McConnell, Brue, and Flynn	Economics: Principles, Problems, and Policies	McGraw-Hill	2015	20
McEachern	Economics: A Contemporary Introduction	Cengage	2017	11
Miller	Economics Today	Pearson	2018	19
O'Sullivan, Sheffrin, and Perez	Economics: Principles, Applications and Tools	Pearson	2017	9
Parkin	Economics	Pearson	2018	13
Samuelson and Nordhaus	Economics	McGraw-Hill	2010	19
Schiller and Gebhardt	The Economy Today	McGraw-Hill	2015	14
Sexton	Exploring Economics	Cengage	2016	7
Slavin	Economics	McGraw-Hill	2014	11
Tucker	Economics for Today	Cengage	2017	9

**Table 2.** Climate change contents in introductory economics textbooks.

Author	ALL	A	BP	BB	BM	CFO	Ch	Co	CT	D	FB AH	GS SM	HL	HO	KM	KW	Ma	MBF	Mc	Mi	OSP	P	SN	SG	Se	SI	T	
IPCC Scientific Consensus				X			X	X			X			X	X	X					X	X		X				
Climate Science as Not Settled												X							X	X							X	
Emission Trading		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pigouvian Tax	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coase Theorem	X	X	X	X		X	X		X	X	X		X	X	X	X	X	X	X		X	X	X		X		X	
GDP and the Environment	X	X	X	X		X	X		X	X	X	X		X	X		X	X	X	X	X	X	X		X		X	
Economic Growth				X		X		X		X			X	X		X		X			X		X	X		X		
Collective Action Problem							X	X					X									X						
Global Inequality						X	X								X	X					X		X					
Cost-Benefit Analysis			X	X			X	X		X						X						X						
Climate Change Adaptation												X															X	

The abbreviations are authors' initials. The textbooks appear in Table 1's alphabetical sequence.

### 3. Representation of Climate Change Science

The fourth Intergovernmental Panel on Climate Change (IPCC) report (2007) states that “most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations” [20]. The latest IPCC report (2014) further strengthened the above language from “very likely” to “extremely likely”—the scientific consensus has been established for quite a long time [21]. A review of various studies shows that 90%–100% of publishing climate scientists endorse the consensus position that humans are the dominant cause of global warming [22]. The public; however, is less certain. According to Leiserowitz et al., only a little over half of Americans believe that global warming—if it is happening—is caused mostly by human activities [23]. This gap between climate scientists and the general public has troubled policymakers and stirred lively scholarly debates.

In our analysis, we first asked whether economics textbooks help narrow or widen this divide. Besides the economics of climate change, many texts included some brief language to convey the science of climate change. In our audit, 10 out of the 27 books clearly presented the idea of a scientific consensus about climate change; thirteen books did not discuss climate science. Somewhat alarmingly, there were four texts that focused on the idea that climate science was not settled. For example:

*“There is disagreement on whether humans have contributed to the problem . . . ”* Tucker (2014), p. 391

*“Though the science is not yet fully resolved, fossil fuel used to power the likes of automobiles and electricity generators produces carbon dioxide, which mixes with other greenhouse gases that could contribute to climate change.”* McEachern (2017), p. 377

*“While there is general agreement among scientists that higher levels of carbon dioxide contribute to global warming, there is continuing debate about the form of the relationship.”* Gwartney, Stroup, Sobel, and Macpherson (2018), p. 693

*“In recent years, certain scientific research has suggested that emissions of carbon dioxide and various other so-called greenhouse gases might be contributing to atmospheric warming.”* Miller (2016), p. 723

These quotes, though not denying climate change, do not accurately represent the level of consensus in the scientific community. Tucker (2014) even includes a passage on the Climategate incident, but does not mention that multiple investigations found no evidence of fraud or scientific misconduct:

*“And this was even before the incident that has become known as Climategate, whereby intercepted emails of climate change scientists showed the likely suppression of evidence not favorable to their view and obstacles put in the way of those more skeptical of climate science . . . ”* Tucker (2014), p. 391

From a longitudinal perspective, textbook authors seem to be taking climate change more seriously and covering it more accurately since Bauman’s first audit in 2010. Outright climate skepticism, such as the following quotes, were removed in more recent versions.

*“Other scientists are skeptical about both the temperature change and its causes . . . Skeptics also point out that the same computer models predicting global warming in the next generation predicted a much larger increase in temperature for the previous century than actually occurred.”* Shiller (2009)

*“[T]he Earth has experienced both warming and cooling trends in the past, and the current warming trend may well be unrelated to the emissions of carbon dioxide and other greenhouse gases into the atmosphere.”* Gwartney, Stroup, Sobel, and Macpherson (2008), pp. 777–778

Overall, there is still room for improving the science contents of climate change in most of these books.

#### 4. Climate Change Economics: The Externality Framework

Now we turn to the treatment of climate change economics in these books. Although the terms “climate change” or “global warming” appear in all textbooks, the depth of the coverage varies significantly. In Arnold (2016), for example, the word “climate change” only had one trivial appearance in the entire text; other texts engaged the topic at length in multiple chapters. Despite the difficulty in generalizing across these texts, we did observe some overarching patterns.

Nicholas Stern once described climate change as “the greatest market failure the world has ever seen.” All textbooks use the framework of “externalities”—a form of market failure—to conceptualize climate change. The externality framework places climate change in chapters such as “Externalities: When the Price Is Not Right” in Cowen and Tabarrok (2015), “Externalities, Environmental Policy, and Public Goods” in Hubbard and O’Brien (2015), and “Market Failures: Public Goods and Externalities” in McConnell, Brue, and Flynn (2015). In the few cases where textbooks were organized by substantive concerns, climate change usually fell into the chapter on “environmental economics”, (e.g., Tucker (2014) and Miller (2016)), which again mainly deals with externalities.

This arrangement has two implications. The first is about the overall coverage of climate change in these textbooks. Among the texts, Colander (2013) was the anomaly whereby global warming appeared in Chapter 1 (p. 18) in an “Economics and Global Warming” text box. Colander explains how the policy debate about global warming is an example of economists engaging in “normative economics” to study what the goals of economic policy should be. Other than Colander, climate change was relegated to later chapters, after the introduction of markets in perfect competition. To be clear, this situation is not unique to climate change. Introductory textbooks are often organized by economic concepts—supply and demand, elasticity, preferences, etc.—not by social issues. Yet, this design has pedagogical implications. The sequence may inadvertently lead students to think of climate change as a minor aberration in an otherwise perfectly functioning, efficient economic system; it may also allow climate change to be easily skipped by instructors due to its location in the textbook.

Secondly, the externality framing focuses on the idea that societies do not pay the “true” costs of burning fossil fuels. The related chapters often start by discussing that the optimal level of pollution should not be zero, but should be determined by using marginal analysis to compare the benefits and costs of emissions. Once we know the optimal emission level, the economic solution is to “internalize” the externalities, leaving market forces to achieve the policy goal. In the case of climate change, this means putting a price on carbon. In this regard, all textbooks stress the key message that incentive-based regulations are more efficient than command-and-control regulations.

Almost all texts devoted significant attention to the two most common incentive-based regulations: tradable emission rights (cap-and-trade) and Pigouvian tax. This treatment is in line with the consensus of environmental economists [24,25]. Besides tradable pollution rights and Pigouvian taxes, 21 of the 27 books also covered the Coase Theorem, in which designating property rights serves as a powerful tool to solve environmental problems.

Most texts did not express a preference between cap-and-trade and carbon taxes. Notable exceptions were McConnell, Brue, and Flynn (2015), which claims that “many economists have concluded that a cap-and-trade system would not be the best way to curb CO<sub>2</sub> emissions in the United States” and Karlan and Morduch (2018), which claims that “most economists, regardless of political philosophy, believe that a carbon tax is a simpler and more transparent and efficient solution than cap-and-trade”.

The policy discussions in these chapters were often significantly outdated. For example, Hall and Lieberman (2013) still talks about the Kyoto Protocol; McConnell, Brue, and Flynn (2015) claims that the SO<sub>2</sub> cap-and-trade system is working well even though the market collapsed in the early 2010s [26]. Most texts gave students little, if any, exposure to the real-world climate policies in effect, for example, in California, which started its cap-and-trade program in 2013 and recently extended it beyond 2020; in China, which has piloted regional carbon markets since 2013 and established a national system in 2017; or in British Columbia, which has had a carbon tax since 2008.

## 5. Climate Change beyond Externalities

The externality framework provides a coherent and powerful way to think about the climate. But such an all-encompassing issue also intersects with many other economic theories and practical concerns. As shown in Table 2, some books already include various useful points of engagement. Here we discuss additional topics that some textbook authors have used to engage with climate change beyond the typical “externalities” and “environmental economics” chapters.

### 5.1. GDP Accounting, Economic Growth, and Climate Change

Climate change is arguably as much a macroeconomic issue as a microeconomic one. The externality framework, however, mostly features in the micro section, leaving climate issues absent in the macro section. The section on GDP accounting is a natural place to bring climate change into the macroeconomic curriculum. Although many textbooks include a few paragraphs on how GDP does not include external costs such as pollution, the language is usually quite vague. In contrast, Case, Fair, and Oster (2014), Krugman and Wells (2015), and McEachern (2017) present a good treatment of this topic by referencing Muller, Mendelsohn, and Nordhaus’s seminal paper on environmental accounting in national accounts [27]:

*“[F]or some industries in the United States, like stone mining and coal-powered electricity generation, including properly valued air pollution in the national income and product accounts as an offset to the value of the marketed goods produced by these industries would make the contribution of these industries to our nation’s GDP negative!” (Case, Fair, and Oster 2014, p. 436)*

Parkin (2016) also has a good treatment of the “Green GDP” debate between Joseph Stiglitz and the mainstream of the economics profession. While Stiglitz gives more emphasis to the consequences of an inappropriate accounting framework, both sides agree that carbon emissions should be taken into accounts.

GDP accounting leads us to the topic of economic growth. About half of the textbooks grapple with the question of whether economic growth is compatible with fighting climate change. Many books specifically devote a few paragraphs to reject the Malthusian view on the limits to growth. For example, Krugman and Wells (2015) argue that long-run economic growth and curbing greenhouse gas emissions can go hand in hand. The popular textbook by McConnell, Brue, and Flynn (2015) dedicates a specific section to the question “Is Growth Desirable and Sustainable?” (p. 585), in which they lay out the anti-growth argument and then defend growth:

*“The connection between growth and environment is tenuous, say growth proponents. Increases in economic growth need not mean increases in pollution... limiting growth is the wrong solution. Growth has allowed economies to reduce pollution, be more sensitive to environmental considerations...”*

On the other hand, a few authors are more cautious about the desirability of economic growth. They stress that the type of economic growth matters, as shown in the following quotes:

*“Yet the desirability of further economic growth for a society that is already quite wealthy has been questioned on several grounds.” (Baumol and Blinder 2016)*

*“Growth has costs, and economics requires us to look at both costs and benefits . . . the wrong type of growth may produce undesirable side effects, including global warming and polluted rivers, land, and air.” (Colander 2013)*

Nevertheless, the critique of economic growth is negligible overall in the texts we examined. The vibrant discussions on “post-growth” and “degrowth” in ecological economics [28–31] has not made much impact in shaping the mainstream economics curriculum.

### 5.2. Climate Change as a Collective Action Problem

Economics can yield valuable insights to examine climate change through the lens of collective action. Both Colander (2013) and Hall and Lieberman (2013) note that international actions are constrained by the free-rider problem. Colander argues that climate actions often fall short: “Because there is no world government that can force countries to comply with any global effort to address carbon emissions, any policy has to be voluntary, making it easy for one country to opt out (free ride).” From another angle, Parkin (2016) describes cutting global carbon emissions as a “prisoners’ dilemma” and notes that the Nash equilibrium is for all countries to keep increasing their emissions even though everyone would be better off if everyone cut their emissions. Many texts also introduce the concept of “the tragedy of the commons”: that individuals’ self-interested behaviors can lead to the demise of common goods such as the climate.

Some textbooks go beyond explaining why countries are slow to take action and also discuss why countries can cooperate on some occasions. In our dataset, there were six books that mentioned the contribution of Elinor Ostrom, the 2009 Nobel Laureate, who wrote extensively about the polycentric model of climate governance [32,33]. This treatment complicates the narrowly-defined rational actor model by bringing norms and institutions into economic analysis. While relating climate change to the tragedy of commons, for example, Chiang (2014) cites Ostrom to suggest that tragedy is not always the destiny: when certain institutional conditions are met, user management of common pool resources typically is successful.

### 5.3. Climate Change and Global Inequality

In recent years, many scholars and activists have adopted a “climate justice” framework [34,35], going so far as to argue that equity should be fundamental in climate change policy research [36]. This topic is uncommon in the textbooks, but those that do discuss it take one of two different approaches.

The first approach concerns the fact that countries have made, and continue to make, vastly unequal contributions to the problem. Krugman and Wells (2015) note this issue in one succinct sentence: “historically, the wealthy nations have been responsible for the bulk of these emissions because they have consumed far more energy per person than poorer countries.” Focusing on trade, Case, Fair, and Oster (2014) have a thoughtful discussion linking carbon emissions to consumption, not just production:

*“[A recent study] found that in 2004, 23 percent of the greenhouse gas emissions produced by China were created in the production of exports. In other words, these emissions come not as a result of goods that China’s population is enjoying as its income rises, but as a consequence of the consumption of the United States and Europe . . . trade with China may be a way for developed nations to avoid their commitments to pollution reduction.”* (p. 680)

In contrast, a couple of books (e.g., Slavin (2014) and Tucker (2014)) hint at the argument that the U.S. should act only when China also acts.

A second approach to inequality is to note that countries face different impacts from climate change and possess different capacities to adapt. O’Sullivan, Sheffrin, and Perez (2014) bring home the message that poor populations and countries are, and will be, hurt the most by referencing Dell, Jones, and Olken (2012) on climate change’s unequal impact on economic development [37].

*“[T]he adverse effects of increases in temperature seem to afflict mainly the poor countries, most of whom are dependent on agriculture. Rich countries do not suffer from increases in temperature.”* (p. 164)

The majority of texts; however, simply do not link climate change with inequality.

#### 5.4. Climate Change and Cost–benefit Analysis

*The Stern Review* is arguably the most significant analysis of the economics of climate change in this century [38]. The Review has been cited more than 10,000 times and generated a great number of responses and critiques. In a nutshell, Nicholas Stern endorsed strong climate action, arguing that the costs can be kept to 1% of global income, while the benefits are at least 5% and possibly 20% of global income.

Despite its high visibility, we only found four textbooks that mention this report. Among them, Parkin (2016) has the most thoughtful treatment, in which he juxtaposes the Stern Review with contrarian views from Bjørn Lomborg. The topic is a suitable place to introduce students to the logic of cost–benefit analysis, as well as economists' efforts to quantify the impacts of climate change [39–41]. No text challenges the use of cost–benefit analysis framework to consider climate change.

The cost–benefit analysis of climate change is, in part, a question of how today's society, through the choice of discount rates, weighs the costs and benefits to be realized by future generations. Chiang (2014) discusses this intergenerational perspective by saying that "...small changes in emissions today may have little effect on the current generation, but will have sizable effects many decades out." He also taps into the behavioral economics literature to describe that we tend to overvalue present benefits relative to future costs, thus not taking enough action.

#### 5.5. Climate Change Adaptation

Finally, while policy responses to climate change have two dimensions—mitigation and adaptation—most texts focus only on the former. Only two books mention adaptation as a viable response. Tucker (2014) describes adaptation as a last resort of inaction, noting that "in the end, we may find ourselves left to adapt to climate change, abandoning low-lying lands, accepting millions of immigrants from those countries, switching to hot weather crops . . ." Gwartney, Stroup, Sobel, and Macpherson (2018), on the other hand, argue that adaptation is the superior strategy, as mitigation is expensive. Neither book faithfully reflects the current literature on the economics of climate adaptation. At the macro-level, economists have been studying the vulnerability of various countries, and at the micro-level, they look into how people adapt to heat stress, rising food prices, natural disasters, etc.

### 6. Conclusions

In this paper, we collected a comprehensive list of twenty-seven introductory economics textbooks and conducted a descriptive analysis of their coverage of climate change. Our findings show that not all texts touch upon climate science, and a small subset exhibits significantly less confidence in the human causes of climate change than the scientific consensus. Regarding the treatment of climate change economics, the texts adopt the "externality framework" to conceptualize climate change as a problem of carbon emission's negative externalities. The preferred solutions are market-based policies—such as cap-and-trade or carbon taxes—to internalize the external costs. Beyond externalities, some authors link climate change with macroeconomics (e.g., GDP accounting or economic growth), collective action problems, and cost–benefit analysis. Only a few authors go beyond mitigation to consider adaptation. Overall, we may have seen a gradual improvement over time in the coverage of climate change, but some texts remain unsatisfactory: the second-biggest seller in the United States, the book by McConnell, Brue, and Flynn, is a notable example that contains mistakes and outdated information.

We see this paper as a way to help initiate the critical discussion on how economics educators best teach climate change in the introductory courses. Many questions remain to be addressed. For example, how is climate change actually taught in relation to the textbook contents? Do students take the climate change content at face value? How does the treatment of climate change compare with other subjects (e.g., tariffs or minimum wage)? Our analysis should be understood as a "conversation starter" and we look forward to further exploration in this area.

This paper ultimately relates to a deeper question—how should we teach introductory economics courses? This issue is certainly outside the scope of this article. While we are sympathetic to the call for pluralism in economics curriculum [42,43], we also recognize the dominance of the neoclassical framework is likely to persist in the near future. In this conclusion, we offer some brief suggestions that do not necessitate a radical change in the curriculum.

A first step would be giving more prominence to climate change in introductory texts. On this point, Acemoglu's call for strong emphasis on growth and development in principles courses is instructive [44]. Climate change, like growth and development, is an area that many economists are researching and debating right now. By highlighting these topics, textbook authors and instructors can relate to students' concerns, spark new interests, and motivate students to pursue further knowledge. In other words, teaching climate change can help instructors teach economics better. To make this change, it is necessary to update the textbooks to better reflect state-of-the-art research from climate change economics [45,46]. We also suggest featuring climate change more broadly in addition to the basics of the externality framework. Section 5 highlights many useful points for further engagement, through which students can obtain a more sophisticated understanding of climate change.

A second step is to focus more on the connection between inequality and climate issues. Discussions of global mitigation efforts could be informed by information about different countries' historical responsibility for carbon emissions, as well as the unequal burden born by poor people in developing countries. Issues of free-riding and the tragedy of the commons are indeed relevant, as demonstrated in Section 5.2, but this storyline fails to recognize that inequality has always been a focal point in international climate politics. From "common but differentiated responsibilities" to "loss and damage" to "green climate fund", the most contentious debates in climate change negotiation revolve around global inequality. The current silence in textbooks misses the chance to showcase the important findings from the economics literature, such as uneven damages [47], conflicts [48], and sea level rise [49].

A final step borrows from Robert Schiller's (2010) discussion on how to teach economics in response to the financial crisis. He envisions an economic education that recognizes more interdisciplinary perspectives including "[those] promoted by the other social sciences: psychology, sociology, political science, and anthropology [50]". Climate change is an even more interdisciplinary subject than financial crises, so the same reasoning applies. These curricular changes will better prepare students to meet climate change challenges in the years to come.

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