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One Solution to Two Problems:

Solving Federal Debt and the Climate Problem through a Human-Oriented Carbon Tax

Abstract

Carbon taxes, or the taxation of greenhouse gas emissions, have been touted as a solution to rein in both climate change and the ballooning U.S. national debt. Carbon tax proposals also maintain many free market principles and have found support even among some fiscal conservatives. This paper examines the impact a carbon tax could have on climate change and the U.S. debt. It investigates the implementation details of a carbon tax and argues that such a tax should be levied upon a broad tax base. It investigates several criticisms of carbon taxes, such as tax interaction effects and tax leakage, as well as potential solutions. Finally, the paper analyzes one climate model's failure to fully value human lives, arguing for a human-life-oriented analysis of climate policies.

Introduction

Climate change is a key issue for the 21st century, as it could bring about water shortages, desertification, and sea level rise. According to the World Health Organization (WHO), half of the world's population will live in water-stressed areas as soon as 2025, partially due to climate change. When it comes to sea level rise, researchers concluded that even if Paris agreement standards were met, sea level would still rise from 0.7 to 1.2 meters within the next two centuries (*The Independent*, 2020). According to a study published in Nature (Mengel et al., 2018), this sea level rise will threaten the homes of some 100 million people, even if the strictest greenhouse gas emissions targets are met. Climate change is both a local and global problem, which, if left unaddressed, will bring unprecedented economic, social, and geopolitical problems. Therefore, formulation of a coherent policy to fight climate change is a necessity.

Another impending issue facing the United States is the ballooning national debt. The US Government Accountability Office states that at the end of fiscal year 2018, the total federal debt was $ 21.6 trillion. According to Xu et al. (2016), the US federal debt in 2007 was a manageable 65 percent of GDP. It increased to 102 percent by 2013, and if current policies remain implemented, the Congressional Budget Office (CBO) projects that the debt will grow by 300 percent by 2037. Consequently, 2011 was the first time the S&P downgraded the US government credit rating from the top grade of AAA to AA+. According to Xu et al. (2016), unless there is action that is taken to reduce or reverse the course of federal deficit, the United States could face more serious economic harm than the great recession of 2007-2009. Therefore, it is necessary that policy makers, economists, and politicians alike come up with policy decisions on ways to combat this impending crisis.

Carbon taxes are a policy tool that can possibly mitigate both problems. The following sections of the paper will discuss the principles of a carbon tax, its alleged theoretical benefits in fighting climate change and reducing federal debt, its advantages over other carbon policy tools, and arguments against its use. The paper will also discuss fundamental errors in the concept of present discounted value, the short-term validity of revenue stability promised by a carbon tax, and the impact such a tax will have on employment.

What is a Carbon Tax?

Many commonly-used goods and services rely on the burning of fossil fuels. This process inevitably often releases the carbon trapped by such fuels into the atmosphere, contributing to climate change. The resulting environmental effects are considered an externality of the initial good or service.

Consider an example. Suppose John would gain a benefit of $10 by mowing 1 sq. ft of his lawn using a lawn mower that runs on gasoline and emits fumes. However, for his neighbors, the fumes emitted might cost them health or money. For instance, John’s asthmatic neighbor Drew might have to visit a hospital due to asthma attacks precipitated by fumes from John’s gasoline mower. This might incur him a cost of $50 for the doctor’s visit, and $25 for a cab ride to the hospital. And although these costs were not accounted for in the transaction between John and the mower company, the society—here in the form of Drew—had to inevitably incur it. Such phenomena, where parties not involved in economic transactions are subjected to costs and/or benefits, are referred to as externalities. If the externality is associated with a cost and not a benefit, it is classified as a negative externality. If the externality is associated with a benefit to society, it is classified as a positive externality.

Carbon dioxide emissions are a negative externality. Parties involved in any economic transaction involving the burning of fossil fuels might not take into account the amount of carbon dioxide emitted. However, this carbon dioxide contributes negative consequences for society at large in the form of climate change. Therefore, for society, the value of the transaction that took place is less than the value placed upon it by the parties involved. Carbon taxes are an effective tool to account for this societal cost in the original private transaction.

A carbon tax is a carbon pricing scheme that is levied as a tax on the carbon content of a fuel that is burned. According to Ramseur et al. (2012), the primary motive of such a tax is to put a price on carbon pollution and therefore, limit or disincentivize market actors from participating in the carbon polluting activity. A carbon tax thus incentivizes suppliers to look for ways to provide goods and services by emitting less carbon and incentivizes demanders to look for supplements of carbon-intense goods and services. In contrast with a cap-and-trade policy or any other policy which sets non-negotiable restrictions on the quantity of permissible carbon pollution, a carbon tax lets the free market decide the optimal amount of carbon pollution. This optimal amount should be the equilibrium where the societal costs of pollution match the benefit of not polluting. In this way, a carbon tax is a theoretically efficient tool to combat climate change without hindering a free market.

While the name might suggest that such a tax is only applied to carbon-emitting goods and services, it can be applied to any service or a good that emits a greenhouse gas—be it methane, nitrous oxide, or ozone. This makes its tax base wider than it would be if it were applied only to carbon dioxide emitting activities.

Principles of a Carbon Tax

Many economic processes, goods and services rely on greenhouse gas emissions. These include fundamental processes like the import and extraction of fossil fuels, the rearing of livestock, and agriculture. According to a New York Times article (Conniff, 2018), agriculture (including cattle raising) is the third largest source of greenhouse gas emissions, after energy and industrial sectors, contributing around 14.5 percent of greenhouse gas emissions. Once these fundamental processes are carried out, intermediary processes generate electricity using coal and natural gas, create plastics and other petrochemical products at oil refineries, and slaughter livestock to create processed meat and ship it to distant markets. These intermediary processes also utilize and emit greenhouse gases in various amounts. Moving further down, the final step includes electricity and heating usage by households and commercial buildings, use of gasoline and other fuels for transportation, utilization of petrochemical industry products like plastics, and further utilization of electricity to produce more goods and services like automobiles and home appliances. Again, these all contribute to greenhouse gas emissions.

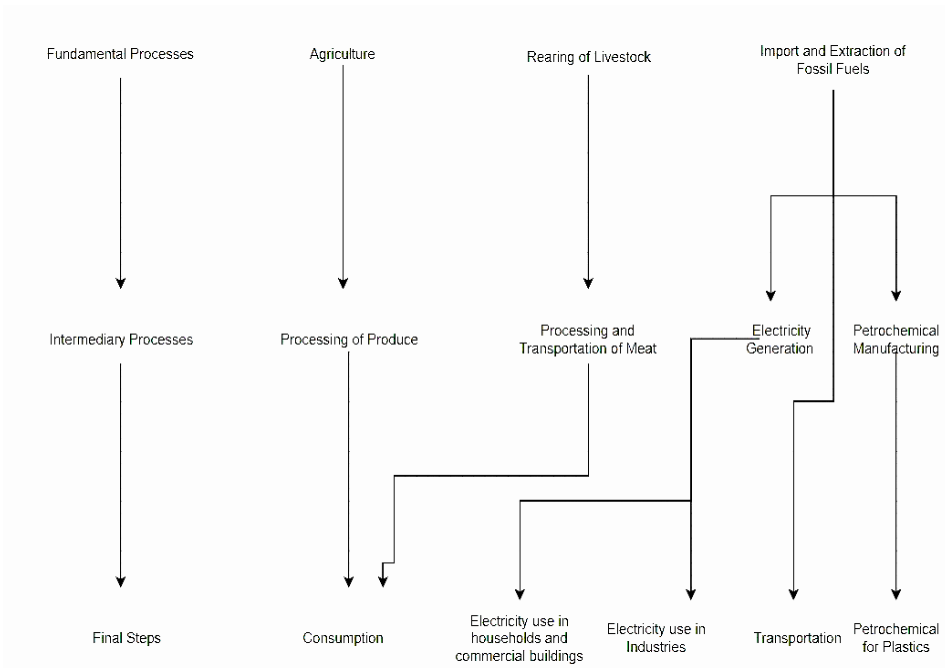

Figure 1: Flowchart depicting stages in an economy that emit greenhouse gases.

Carbon taxes could either be applied at any of these individual steps, or at multiple steps. Let us first compare the taxation of fundamental processes and intermediary processes. Fundamental processes include agriculture, rearing of livestock, and import and extraction of fossil fuels. Intermediary processes include electricity generation in power plants. We can further segment our analysis by the three major fossil fuels: coal, natural gas, and petroleum.

According to Ramseur et al. (2012), taxing fundamental processes for petroleum would tax over 360,000 petroleum wells, over 13,000 operators, and about 235 petroleum importers, cumulatively taxing 33% of total US greenhouse gas (GHG) emissions. On the other hand, taxing intermediary processes for petroleum would tax 115 petroleum refineries and 235 petroleum importers, covering about 32% of total US greenhouse gas emissions. Similarly, taxing fundamental processes for natural gas would tax 21% of total US GHG emissions; taxing intermediary processes for natural gas would cover 13% of total emissions.

The discrepancies between these two options are explained by US exports of fossil fuels. According to the US Energy Information Administration, in 2018 the US exported 7.60 million barrels of petroleum per day, 15 percent of its total coal production, and 3.61 trillion cubic feet of Natural Gas. The second option for all these three fossil fuels accounted for taxation not at the point of extraction, but at the point of generation of electricity. Consequently, fossil fuel exports remained untaxed, leading to the difference in total US GHG emissions.

Another argument for taxing intermediary processes rests on elasticity. Suppliers of fossil fuels—in our case, oil and gas wells, operators, and coal mines—have a single choice: to sell their raw products. Therefore, these fossil fuel suppliers are relatively inelastic, compared to power plants or consumers who have the mobility to choose fossil fuels with lower carbon content. In other words, levying taxes at the intermediary processes level rather than the fundamental processes level gives industries greater options to choose amongst various fuels. Therefore, these industries should be able to cut their emissions. As I explain later, this transition from taxing fundamental processes to taxing intermediary processes also benefits by levying taxes on a wider tax base.

A transition from taxing intermediary processes to taxing final processes can have a similar effect. Such a transition would tax consumers of electricity, gasoline, meat, dairy, processed food items and plastics, and producers of automobiles, home appliances, and technology. This would inherently mean both a widening of the tax base and greater availability of substitutes for carbon-intensive goods. Consumers using fossil-fuel-based electricity can opt for renewable electricity. People could choose electric cars over automobiles run on gasoline. Food items with big carbon footprints, such as beef, could be substituted for vegetarian or vegan substitutes with a reduced carbon footprint. In this way, imposing consumer-level taxes increases the tax base, incentivizes consumers to lower the carbon taxes they pay, and consequently reduces emissions. The next sections explore the balance between revenue generation and emissions reduction, compares a carbon tax to other carbon policy tools, and criticisms of a carbon tax.

Benefits of a Carbon Tax

Other countries have implemented some form of a carbon tax, many with positive results. For example, Sweden implemented a carbon tax in 1991, and its emissions decreased by 9% between 1990 and 2006. Carbon pricing made pollution expensive and induced the Swedish domestic heating industry to switch from fossil fuels to biomass derived from forests (Fouché, 2008). Britain currently has a carbon tax of $25 per metric ton of carbon dioxide. The tax covers around 23% of the country's total emissions and has successfully reduced emission levels to their lowest level since 1890. There, the carbon tax has prompted the country's electric utilities to switch from coal to natural gas, a relatively cleaner source of energy.

A carbon tax can also raise revenue for debt repayments. The following are several proposed plans, each with their own revenue estimates. Any one of these plans could be used to repay federal debts.

- Ramseur et al. (2012) cites a study from the Congressional Budget Office (CBO) which estimated that a tax rate of $20 per metric ton of carbon dioxide would generate approximately $88 billion in 2012, rising to $144 billion by 2020.
- In 2011, the CBO evaluated a cap-and-trade program similar to a carbon tax, in which carbon allowances would be traded in the market and sold at an auction. This pricing mechanism, applied from 2012 to 2021, would raise around $1.2 trillion in revenue.
- The 112th congress debated the Save Our Climate Act of 2011, which would have established a tax rate of $10 per short ton of carbon dioxide emissions. The tax rate would have increased annually by $10 until the total US carbon dioxide emissions were no more than 20% of 1990 carbon dioxide emission levels. The bill would have generated around $480 billion in revenue in ten years (Ramseur et al., 2012).
- In 2010 the Bipartisan Debt Reduction Task Force estimated that a tax of $23 per ton of CO2 starting in 2018, increasing 5.8% annually, would raise approximately $1.1 trillion in cumulative revenues through 2025 (Domenici et al., 2010).
- According to a December 2018 CBO report ("Options," 2018), a $25 per metric ton tax on carbon dioxide emissions beginning January 2019, would generate about $1.099 trillion from 2019 to 2028. This is nearly 5% of the $23 trillion federal debt held today.
- In 2013, the CBO projected a deficit of $9.1 trillion under a possible fiscal scenario for 2013 to 2023 (Ramseur et al., 2012). If a carbon tax of $20 per metric ton of carbon dioxide (with 5.6% annual increase) were applied under such a condition, the deficit,

from 2013 to 2023 would be reduced from $9.1 trillion to $7.9 trillion, or from 4.5% to 3.9% of the GDP. This would reduce the 10-year budget deficit by 13% overall.

Impose a Tax on Emissions of Greenhouse Gases

											Total	
Billions of Dollars	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2019–2023**	**2019–2028**
Change in Revenues	66.0	103.4	105.9	108.2	111.2	115.1	118.9	119.5	123.2	127.1	494.7	1,099.0

Sources: Staff of the Joint Committee on Taxation; Congressional Budget Office.

This option would take effect in January 2019.

Figure 2: CBO table showing estimated annual revenue from a carbon tax.

Some of these proposals nearly achieve the $1.2 trillion debt reduction goal that a bipartisan "super committee" set out to accomplish, over a period of ten years beginning in 2012/2011. However, none of these proposals came to pass. The actual debt today is much higher than the projections under these alternate fiscal scenarios

Table 1-3.
CBO's Baseline Projections of Federal Debt
Billions of Dollars

	Actual, 2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Debt Held by the Public at the Beginning of the Year	14,665	15,750	16,685	17,755	18,841	20,042	21,264	22,457	23,784	25,102	26,407	27,917
Changes in Debt Held by the Public												
Deficit	785	960	1,008	1,034	1,159	1,181	1,151	1,284	1,274	1,260	1,479	1,378
Other means of financing[a]	299	-25	63	52	42	41	41	43	44	44	32	27
Total	1,084	935	1,070	1,086	1,201	1,222	1,193	1,328	1,318	1,305	1,510	1,405
Debt Held by the Public at the End of the Year												
In billions of dollars	15,750	16,685	17,755	18,841	20,042	21,264	22,457	23,784	25,102	26,407	27,917	29,322
As a percentage of GDP	77.8	78.9	80.7	82.4	84.5	86.4	88.0	89.7	91.2	92.4	94.0	95.1

Figure 3: CBO 10- year budget projections, August 2019

Criticisms of a Carbon Tax

While carbon taxes are widely praised for their theoretical, and in many cases practical, benefits, they are still surrounded by criticisms. First, a carbon tax encourages distortion and therefore leads to a tax interaction effect. Second, avoidance of a carbon tax through leakage can undermine its emission reduction goals. Third, its regressive nature often raises concerns over equity. Fourth, it cannot be a long-term source of revenue due to decreasing carbon-intense economic activities. And fifth, its application can have negative consequences on employment provided by carbon-intensive industries. The following subsections address each of these criticisms.

Thpe Tax Interaction Effect

Taxes prevent markets from attaining efficient equilibrium outcomes. For example, high marginal income tax rates disincentivize individuals from working harder and making more money. High corporate taxes disincentivize companies from expanding their production processes. Higher property taxes disincentivize individuals from investing in property. In other words, taxes prevent markets from maximizing utility and thereby create deadweight losses. Such deadweight losses are referred to as distortions.

An effective method to minimize the distortionary impact of a tax on the economy is to widen the tax base. A tax with a wider tax base is like any other tax but is levied on a wider audience. As a result, a wider tax base can generate the same amount of tax revenue using a lower tax rate. Such a tax maximizes efficiency, minimizes distortions, and generates the same amount of revenue. One example is an income tax. Every employed person in the workforce accrues an income in some way or another. Consequently, income taxes happen to be amongst the taxes with the widest tax base. But this is not necessarily true for other types of taxes, and certainly not for a carbon tax. In fact, a carbon tax happens to be amongst the taxes with a narrower tax base.

Further complicating matters, most carbon tax proposals propose swapping a carbon tax with an existing tax, which may have a wider base. Policymakers often argue that imposing new taxes should not increase net tax revenue; this goal is termed revenue neutrality. While revenue neutrality is not a prerequisite, some policymakers will not approve a carbon tax in the absence of revenue neutrality. Enactment of a carbon tax therefore would imply a revenue-neutral swap with an existing form of a tax. This process is the tax interaction effect.

Any tax that could be swapped with a carbon tax usually has a wider tax base than a carbon tax. This means that for a carbon tax swap to be successful and revenue neutral, the new carbon tax would need a higher tax rate than the existing tax it is being swapped with. This higher tax rate amplifies and increases distortions in the economy rather than alleviating them.

Resulting distortions create deadweight losses, lower efficiency, and block transactions from reaching market equilibrium conditions.

This problem could be addressed by changing the point of taxation. Rather than taxing carbon-intensive goods and services at the point of extraction—the fundamental processes step discussed earlier—they should be taxed at the final stage. In other words, rather than taxing coal fields and oil wells, an effective carbon tax would tax household and commercial electricity usage, transportation fuel, plastics, industrial goods, and other consumer goods. This would effectively widen the tax base and therefore might lower the tax interaction effect. While this does increase the complexity of tax administration, we note that the original tax swap already reduced tax administration complexity. Therefore, the net effect on such complexity might just be zero.

Another powerful policy tool that could lower the tax interaction effect would be to levy a carbon tax not just on carbon-intensive goods, but also on goods and services that produce other forms of greenhouse gases. Many carbon tax policies have not considered levying a tax on other GHG emitting goods and services. Agricultural crops like rice and livestock such as beef, for instance, contribute significantly to methane and other GHG emissions. These could be subjected to a carbon tax, widening the carbon tax base and therefore lowering tax rates for a revenue-neutral swap. Since agricultural outputs are consumed by every person in an economy, such a carbon tax would significantly widen the tax base, lowering the tax rates. Such an initiative might also encourage the market to invest in cultivating food items that have a lower GHG footprint, thereby increasing employment. However, it might negatively impact the producers of meat and other polluting food items, thereby causing unemployment. The sections that follow discuss similar carbon tax tradeoffs.

Leakage and Arbitrage

Another widely discussed criticism of a carbon tax is leakage due to arbitrage. Carbon taxes often are not imposed uniformly: some jurisdictions might have a higher carbon tax than others, and others might not have a carbon tax at all. In situations like these, producers and consumers can avoid carbon taxes by moving their production or consumption processes to jurisdictions with lesser carbon oversight. This would obviously depend on their elasticity towards a carbon tax and would involve multiple cost-benefit analysis before such decisions are made. Multinational corporations and utility companies, for example, might find it cheaper to shift their production processes to neighboring jurisdictions with lesser carbon oversight. This way, they could avoid paying for carbon emissions, continue to pollute, and sell their goods and services at lower prices even in states with significant carbon oversight. This phenomenon, often referred to as arbitrage, is a problem that often occurs at global levels. In accounting, this is referred to as tax leakage, as it helps multinational companies save millions on their tax receipts.

Leakage seems to demand a coordinated global solution. One approach is for countries to agree on a global carbon tax standard, reinforced through sanctions. That way firms will have no safe haven to pollute free of charge and will be required to innovate and pollute less. Another effective strategy could be to levy carbon tariffs on imports, accounting for carbon pollution in the price of the final goods sold. This step would imply a change in point of taxation from the fundamental process stage to the final steps stage and would therefore also widen the tax base. However, such initiatives need large-scale global cooperation, which can be difficult to attain. Tariffs often create international trade tensions, and sanctions are often seen as last resorts. According to the Partnership for Market Readiness (2015), leakage can also be discouraged through research and development support, business support, and product or investment tax credits. As with other carbon tax problems, these policy solutions must undergo cost-benefit analysis before implementation.

Regressive Nature

A carbon tax is regressive in nature: in other words, it burdens the poor more than the rich (Ramseur et al., 2012). According to Grainger et al. (2009), since poor households spend a greater share of their income on energy than higher-income families, households in the lowest fifth of the income distribution could shoulder a carbon tax burden four times that of households in the top fifth of the income distribution. In their research paper, they show that the burden on the poorest households doubles when a tax on carbon is targeted narrowly at energy consumption (and not other energy uses) rather than broadly across all industries. The research also shows that regressive nature of a carbon tax depends upon the width of the tax base. They also show that the tax burden of the lowest fifth decreases from being 4 times as high as the highest fifth to being 3.25 times as high when the tax is levied on all greenhouse gases. Consequently, a possible strategy to reduce the regressive nature of a carbon tax would be to widen the tax base.

Declining Revenues

A carbon tax is a short-term revenue source. Put in place to disincentivize carbon emissions, carbon taxes gradually shift production from carbon-intensive to more carbon-free processes. However, carbon taxes rely chiefly on carbon emissions to generate revenue. If carbon tax rates remain constant, decreasing carbon emissions mean decreasing revenues.

This is the primary reason why several proposed carbon policies included annual increases in their tax rates. The CBO's 2011 carbon policy increased its proposed carbon tax at an annual rate of 5.6%. The Save our Climate Act of 2011 proposed a $10 annual carbon tax increase. And the Bipartisan Debt Reduction Task Force's 2018 carbon tax proposed an annual 5.8% increase in its tax rate.

To account for decreasing revenue, carbon taxes need to start with wider tax bases, tax all greenhouse gas emissions, and have annual rate increases of some kind to balance shrinking revenues. The primary tradeoff here requires policymakers to carefully calculate and agree on an emissions reduction rate whose climate mitigation benefits equal or outweigh the costs associated with a shrinking carbon tax revenue.

<u>Reduced Employment and Economic Growth</u>

A higher carbon tax on a narrow tax base would hurt some industries more than others and consequently force them to go through budget cuts, closure of operations, and large scale layoffs. This can decrease employment, lower production and hamper economic growth. It can also compromise horizontal equity by unfairly taxing a narrow band of carbon emitters, while forgiving other GHG emitters of the same income level. A possible mitigation strategy could involve widening the tax base and lowering tax rates. More policy analysis is needed to address this problem.

Carbon Tax Models: Discussion and Critiques

Several economists and policymakers have developed models of carbon tax plans designed to assess their costs and benefits. One such model is the Dynamic Integrated Climate Economy Model, created by Yale Economics Professor William Nordhaus. The model integrates climate science and economics, weighing costs and benefits associated with policy steps to slow global warming. The model uses an economic tool called the "present discounted value" to value future costs accrued by climate abatement and climate damages. For a given policy, it then predicts the difference between the present-valued reduction in climate damages, and the policy's abatement costs. The best policies should maximize this difference between climate relief and abatement costs.

	Difference from Base		Present-Value Climate Damages	Present-Value Abatement Costs
	Objective Function	Abatement Plus Damages		
Run	(Trillions of 2005 U.S. $)			
No controls				
250-year delay	0.00	0.00	22.55	0.04
50-year delay	2.34	2.14	18.85	1.60
Optimal	3.37	3.07	17.31	2.20
concentration limits				
Limit to 1.5 $\times CO_2$	−14.87	−14.60	9.95	27.24
Limit to 2 $\times CO_2$	2.88	2.67	15.97	3.95
Limit to 2.5 $\times CO_2$	3.37	3.08	17.31	2.20
Temperature limits				
Limit to 1.5°C	−14.73	−14.44	9.95	27.08
Limit to 2°C	−1.60	−1.80	13.09	11.30
Limit to 2.5°C	2.27	1.99	15.32	5.28
Limit to 3°C	3.24	3.02	16.67	2.90
Kyoto Protocol				
Kyoto with United States	0.71	0.63	21.38	0.58
Kyoto w/o United States	0.15	0.10	22.43	0.07
Strengthened	1.00	0.71	16.01	5.87
Stern Review				
discounting	−16.95	−14.18	9.02	27.74
Gore proposal	−21.66	−21.36	10.05	33.90
Low-cost backstop	17.19	17.19	4.92	0.48

Figure 4: Calculations from William Nordhaus's DICE model

Using this strategy, Nordhaus predicted that his optimal policy would incur \$2.2 trillion in abatement costs, \$17.31 trillion in climate damages, and \$3.07 trillion in resulting benefit (all amounts in 2005 USD), compared to the baseline condition of inaction. He similarly calculated benefits for proposals from politician Al Gore, from the influential "Stern Review" article on climate change, and the Kyoto protocol (both with and without the United States).

While the model used complex mathematical constructs, there are two points to critique. First, abatement costs usually imply revenues generated in the form of a carbon tax. These revenues, as suggested throughout this research paper, can be used to repay US federal debt payments and restore investor confidence in the US economy. Current unsustainable debt patterns can lead to an economic recession; revenues generated from a carbon tax have the potential to avert a federal debt default and a subsequent economic crisis. This two-way benefit provided by climate abatement costs (carbon taxes) can dramatically lower the net climate abatement costs. If this is taken into account, models with lower climate damages and higher abatement costs might be more effective in combating climate change, and more efficient in achieving economic equilibrium.

Second, the model relies too heavily on present discounted value measurements. Under present discounted value, assets and property in the wealthy western world have the highest price tags. This grossly underestimates the economic potential of developing nations, whose growth will be compromised by climate catastrophes. More importantly, it grossly underestimates the catastrophic aftermath of climate calamities – in social costs, economic costs, and the loss of human lives. Therefore, while the optimal model predicts the present discounted value of climate damages to be around $17.31 trillion, actual costs might be much higher.

Conclusion

In this paper, we first examined the impending threats of climate change and the US national debt. We then tried to find a common solution in the form of a carbon tax and explored various policy initiatives that address both crises. We analyzed the particular benefits of a carbon tax, compared to other carbon mitigation policies. We looked into common criticisms of a carbon tax and possible solutions. Finally, we discussed the danger of analyzing carbon taxes solely with incomplete economic instruments and failing to equally value human lives.

This research suggests that a carbon tax is one of the most effective policy instruments to combat climate change. A carbon can mitigate both climate damages and the dangers of debt default. By taxing a wider tax base, covering all greenhouse gases, and increasing the tax rate annually, it can overcome leakage, distortion, regressiveness, and declining revenues. And by equitably considering the human lives at stake, policymakers can find better policies to efficiently limit the losses due to climate change.

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