

Pre-Analysis Plan: Learning about negative externalities and support for a carbon tax

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1 Introduction

Climate change is one of the most pressing issues facing the world and its negative impacts have already started materializing¹. As carbon dioxide (CO₂) concentration in the atmosphere continues to increase, it is critical for policy makers to take action to reduce greenhouse gas emissions. However, despite the urgency, climate action has not been adequate and the issue has become one of the most polarized across the political spectrum in many countries, including Canada and the United States. Many strategies have been proposed to overcome this polarization and build support for climate mitigation policy. One such strategy, the results of which are so far mixed, consists in using messages that focus on co-benefits of policies that also address climate change (Feldman and Hart, 2018; Lauren Feldman, 2018; Mossler et al., 2017; Petrovic, Madrigano, and Zaval, 2014). This could for instance mean using messages that stress how reducing emissions helps fight air pollution rather than underlining the climate change benefit. Another strategy may be to make the economic benefits of climate change mitigation more salient. While polarization may not be easy to overcome with political messages or on ethical grounds, making it about pocketbook evaluations may reduce some of the opposition.

This is particularly relevant for a case like climate change, since at the basis of climate action is the understanding of the economic concept of negative externality: Economic actors do not directly bear the climate change-related costs associated with the emissions that they can dump free of charge into the atmosphere; consequently, they emit too much greenhouse gases. While political solutions are hard to implement, because of polarization and conflicts of interest among

¹See for example <https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html>

other reasons, the economic solution is actually quite trivial and it involves putting a higher price on things that cause harm, such as a pollution or carbon tax. This means that government intervention can actually lead to an increase in social welfare relative to the market equilibrium. Economists of all stripes overwhelmingly agree on this. According to multiple polls of economists, support for policies that would put a price on emissions of carbon dioxide and other greenhouse gases, in particular for a carbon tax, is nearly universal². While climate change is the ultimate case of a negative externality, examples of these market failures abound: from passive smoking, to traffic congestion, to air, water, or noise pollution.

Since the extreme polarization on climate change makes any communication on the issue potentially ineffective, one strategy would be to illustrate the concept of negative externality using an alternative framing, for example emphasizing pollution rather than climate change. While it is not clear whether people understand the difference between conventional air pollution (such as smog, including particulate matter, nitrogen oxides) and carbon pollution, air pollution carries a negative connotation and is much less polarized than climate change (Bickerstaff and Walker, 2001; Mossler et al., 2017). Air pollution is very frequently mentioned as a key cause of climate change in the climate change literature (Bostrom et al., 2012) and CO₂ is considered a pollutant under the Clean Air Act. For these reasons, this framing might help the climate change cause, both through increasing support for action against air pollution and potentially also increasing support for a carbon tax, once the welfare effects of a corrective tax in the presence of a negative externality become clear.

In this paper I intend to use a survey experiment where I manipulate information on the negative

²According to the Chicago Booth IGM Forum, which regularly surveys US and European economic experts, in 2021, support for pricing emissions was around 99% among economists (<https://www.igmchicago.org/surveys/pricing-emissions/>); 98% of economists in 2012 agreed that a US carbon tax of \$20 per ton would involve fewer net distortions to the US economy than raising marginal tax rates on labor income (<https://www.igmchicago.org/surveys/carbon-taxes-ii/>); in 2011 94% of economists agreed that a tax on the carbon content of fuels would be a less expensive way to reduce carbon-dioxide emissions than would a collection of policies such as “corporate average fuel economy” requirements for automobiles (<https://www.igmchicago.org/surveys/carbon-tax/>). Finally, a survey of the members of the American Economic Association from 2020 by Geide-Stevenson and La Parra Perez (2021) also finds that 86% of economists agree that climate change poses a major risk to the US economy and 88% agree that pollution taxes or marketable pollution permits are a more efficient approach to pollution control than emission standards.

externalities of pollution to then infer its effects on policy support for both an air pollution tax and a carbon tax, the latter being the one most often associated with climate action. The control group will not see any information treatments and will only be asked whether they support an air pollution tax and a carbon tax. The treatment group will see a short non-partisan cost-benefit exercise which will outline the welfare effects of a negative externality, before and after the introduction of a corrective tax.

My hypothesis is that those who learn about and understand the mechanisms of negative externalities in the context of pollution should then be more likely to not only support an air pollution tax, but also a carbon tax. The mechanisms that I anticipate would explain the latter effect are an increase in the salience of the economic dimension of climate change mitigation, and a change in the perceived costs and benefits of a corrective tax.

Finally, I am also interested in testing if there is a relationship between zero-sum thinking on the environment and support for corrective taxes, such as a carbon tax. Is it really that if the environment wins, the economy must lose? In reality, at least at the macro level, the implied premise of much of environmental policy is the idea that net social welfare is increased—the pie gets bigger—as we protect the environment to protect ourselves. The information treatment’s objective is to convey just that: that a corrective tax increases social welfare. First, using the control group, I intend to test whether there is a relationship between zero-sum thinking and support for corrective taxes, and I expect that people who see the world in zero-sum terms are less likely to support corrective taxes. Second, I intend to test whether the information treatment actually reduces zero-sum thinking on the environment, as people understand that a corrective tax can actually increase social welfare.

2 Background

Let’s consider the example of a market for smartphones³. Let’s look at Figure 1. The red line, the demand curve (D), shows the quantity demanded at each price. Demand curves are based on the benefits that individuals perceive while maximizing utility. In this case the marginal private benefits (MPB) are the same as the benefits to society as a whole (MSB). The blue line represents

³Example adapted from “The Economics of Pollution” by OpenStaxCollege, CC BY 4.0

the private supply curve (S_p), which shows the quantity of smartphones supplied by all the firms at each price if they are taking only their private costs into account and they are allowed to emit pollution at zero cost. This reflects marginal private costs (MPC). At time t , firms producing smartphones will supply the quantity of smartphones demanded at the market equilibrium, quantity $q=25,000$ at price $p=\$650$ per smartphone. However, to produce smartphones some pollution is created as a result of the metals, plastics, chemicals and energy used in manufacturing. There are hence external costs of pollution (e.g., injuries to health and environmental harms), in addition to the private costs of producing the smartphones (costs of labor and materials to make smartphones). In a market in which there are no restrictions against pollution, firms can emit pollutants into the air and water absolutely free. Let's assume that this additional pollution cost amounts to \$200 per smartphone. Now assume that the firms which produce smartphones must factor in these external costs of pollution, hence the firms have to consider not only the private costs of labor and materials needed to make a smartphone, but also the broader costs to society of injuries to health and other values caused by pollution. The green line, S_s , represents the social supply curve, which includes the private supply curve and the external cost of pollution. This line reflects the marginal social costs (MSC), which are equal to MPC plus marginal external costs (MEC). A corrective tax is introduced, so firms are required to pay \$200 for the pollution costs each time they produce a smartphone, production hence becomes more costly. With the new tax of \$200, the new equilibrium will be at $p=\$750$ and $q=15,000$. So taking into account the costs of pollution results in a higher price, lower quantity of production, and lower quantity of pollution. But does society overall benefit or lose by the introduction of this tax? Figure 1 illustrates the welfare effects of the tax.

One way to calculate social welfare is to consider producer and consumer surplus, the external cost of pollution (pollution damage here-on) and tax revenue. Producer surplus is the difference between the actual price of a good and the price the producer is willing to sell a good at (the area above the supply curve and below the equilibrium price). Effectively, this is the total benefit (total revenue) for producers, $f + g + k + h + i + j$, minus the total variable costs, $i + j$. Before the tax, at E_0 , this equals $f + g + h + k$. Consumer surplus is the difference between willingness to pay and price (the area under the demand curve and above a horizontal line at the equilibrium price). This is the total benefit to consumers, $a + b + c + d + f + g + k + h + i + j$, minus the costs of consumption, $f + g + k + h + i + j$, and it's equal to $a + b + c + d$ before the tax. Pollution damage is

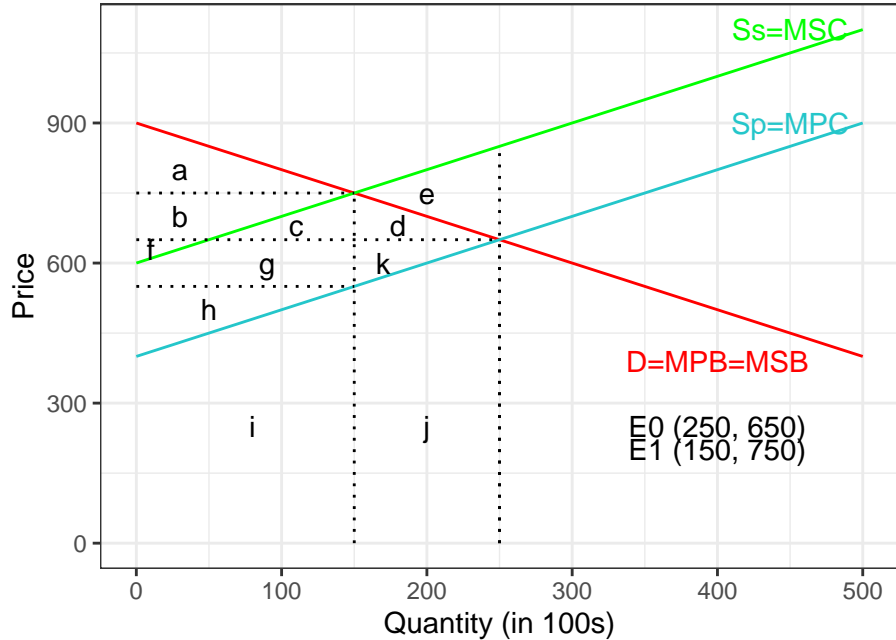


Figure 1: The Economics of a Pollution Tax

equal to the area: $c + d + e + h + g + k$. If we subtract pollution damage from the sum of producer and consumer surplus, we obtain social welfare which is equal to $a + b + f - e$. After the tax, producer surplus is equal to h (producer total benefits, $h + i$, minus producer costs, i) consumer surplus is equal to a (consumer total benefits, $a + b + c + f + g + h + i$ minus costs of consumption, $b + c + f + g + h + i$), tax revenue is $b + c + f + g$, and pollution damage is now $c + g + h$. If we subtract pollution damage from the sum of consumer and producer surplus and tax revenue, we obtain social welfare, which is equal to $a + b + f$ ⁴. This is larger than $a + b + f - e$, social welfare is thus higher with the corrective tax than without.

This means that e was a deadweight loss from being at the optimal market level of production. That is to say, the optimal market level of production was inefficient for society. By leaving the market unregulated and letting the interaction of producers and consumers set quantity and price, society as a whole is worse off than if quantity had been restricted by policy for example. This means that there is an opportunity for government intervention to make society better off.

⁴Tax revenue is considered a benefit for society because tax revenue can be used to provide services such as roads, police, public education, etc., it can be redistributed to citizens as a cash transfer or as a tax credit, or can be allocated to investment in green technology

3 Survey experiment design

I want to see if giving people a cost-benefit treatment, effectively an economic literacy treatment, could affect attitudes towards not only an air pollution tax, but also towards a carbon tax, by making the economic dimension of climate change more salient and by changing the perceived costs and benefits of a corrective tax. I anticipate two groups: A control group that sees no information vignettes and is only asked whether they support an air pollution tax and a carbon tax, and a treatment group that sees cost-benefit information on the welfare effects of corrective taxes.

3.1 Control group

The control group would see the following questions in this order.

- Please tell me on a scale from 0 to 10 how much you personally support the following policy. 0 means no support at all, 10 means complete support (I will randomize the order of the options).
 - Introducing a carbon tax.
 - Introducing an air pollution tax.

Since the question of interest revolves around support for a carbon tax, to get at the mechanisms behind support or opposition for it, I ask several questions. Following Feldman and Hart (2018), to get at the mechanisms behind policy support, I would take two steps. One is to measure cue processing, whether people intuitively accept or reject a policy based on their partisanship. This would be captured by measuring the time interval between seeing the question and selecting a response. Furthermore, I intend to measure the perceived benefits and costs of a carbon tax, by asking the following question:

- Think again about the proposed policy of introducing a carbon tax. When considering this policy, do you think the benefits outweigh the costs, or the costs outweigh the benefits? (1 = costs strongly outweigh the benefits, 10 = benefits strongly outweigh the costs).

Next, I want to measure the salience of different policy goals. Without information on its functioning, people might not understand that a corrective tax's main objective is to increase social

welfare (rather than to merely raise revenue). Hence, I will test whether people who see the aggregate information treatment are more likely to say that increasing social welfare is one of the most important goals of a carbon tax.

- Which of these goals of a carbon tax are most important to you ? (I randomize the order in which they see these and I put in bold – just here in the PAP – increasing social welfare).

- **Increasing social welfare**
- Reducing emissions
- Fighting climate change
- Improving public health
- Incentivizing use of renewables
- Incentivizing use of nuclear energy
- Enhancing national and global security
- Raising revenue
- Preserving ecosystems and species
- Conserving water resources and clean water

Then I would ask more specific questions on different policies involving a carbon tax and varying uses of tax revenue.

- Governments can use the revenues from carbon taxes in different ways. Please tell me on a scale from 0 to 10 how much you personally support the following policy. 0 means no support at all, 10 means complete support (the order of policies is randomized).
 - Introducing a carbon tax and using the money to reduce citizens' sales tax by an equal amount;
 - Introducing a carbon tax and using the money to provide equal cash transfers to all households;
 - Introducing a carbon tax and using the money to provide cash transfers to low-income households;

- Introducing a carbon tax and using the money to provide tax rebates for the most affected firms;
- Introducing a carbon tax and using the money to fund research into renewable energy sources;

Finally, to test the relationship between zero-sum thinking and support for a corrective tax (using the control group only), and to test whether the information treatment reduces zero-sum thinking I would ask this question to measure zero-sum thinking on the environment:

- Please tell me on a scale from 1 (strongly disagree) to 7 (strongly agree) how much you personally agree with the following statement:
 - If we take action to protect the environment, then economic growth must be sacrificed.

3.2 Treatment group

The treatment includes cost-benefit information on the welfare effects of corrective taxes. This treatment can be seen as a proxy for economic literacy since it is aimed at explaining the concept of negative externality in the context of pollution and the welfare effects of a corrective tax, making the economic dimension more salient and changing the perception of benefits and costs.

The treatment would consist of a pre-treatment vignette and then table 1. The pre-treatment vignette would look like this:

“Imagine a market for smartphones. In a normal year, the quantity and price of smartphones will be determined by people’s demand for smartphones and the amount that the phone manufacturers are willing to supply, which means that firms will make 25,000 smartphones and sell them at \$650 each.

However, the production of smartphones creates **pollution**, due to the plastics, metals, chemicals, and energy used in manufacturing. This pollution has adverse effects on the environment, climate, and health, thus creating **external costs to society** from the production of smartphones, in addition to the **private costs** that include costs of labor and materials to make smartphones. If we translate this pollution into a dollar

amount, we might say that each time a firm produces one smartphone they create \$200 of external costs.

However, in a market where manufacturers don't have to pay to pollute, they can create these external costs for free. But, if **a corrective tax (such as an air pollution tax or a carbon tax)** is introduced, the firms would be required to pay \$200 per smartphone, to account for these external costs of pollution. This tax thus would make production more costly. Due to this increased cost, the firms would produce fewer smartphones and would sell them at a higher price: 15,000 smartphones at \$750 each.

Taking into account the external costs of pollution through a tax raises the price of the smartphones, reduces the number of smartphones made, and also reduces pollution. Does society overall benefit or lose by the introduction of this tax? ”

Then I would ask a manipulation check question:

- According to the passage you just read, what kind of tax is introduced?
 - An income tax
 - A corrective tax
 - A payroll tax

Next, I would show the following text along with the table:

“Social welfare refers to the overall well-being of a society, which can be affected by various factors, including pollution or the introduction of a tax. One way to measure changes in social welfare is to compare the benefits and costs of a policy change, such as the introduction of a corrective tax, for different groups in society. Based on the scenario described in the prompt you just read about firms producing smartphones, the following table shows gains and losses after introducing a corrective tax (such as an air pollution tax or a carbon tax).

Table 1: Gains and losses in million \$, rounded. Losses are in red, gains in black

	Producers	Consumers	Pollution Reduction	Tax Revenue	Social Welfare
After Tax	-2	-2	+2	+ 3	= +1

In this case, relative to before the tax, producers lose \$2 million in total, and consumers lose \$2 million in total, since after the tax manufacturers have to pay more to produce smartphones and consumers have to pay more to purchase them. However, the introduction of a corrective tax leads to a reduction in pollution that brings a benefit of \$2 million to society. Furthermore, the tax revenue from the corrective tax of \$3 million constitutes an additional benefit, since this money can be, for example, redistributed to citizens as a cash transfer or as a tax credit, or can be used for investment in research and development for green technologies. By taking all these factors into account we can easily calculate that after the introduction of the corrective tax, social welfare increases by \$1 million.”

Then I'd ask a second manipulation check question:

- Is social welfare higher or lower after introducing the corrective tax?
 - Lower
 - Higher
 - Not Sure

Then I would ask the generic policy support questions, like in the control group.

- Please tell me on a scale from 0 to 10 how much you personally support the following policy. 0 means no support at all, 10 means complete support (I will randomize the order of the options).
 - Introducing a carbon tax.

- Introducing an air pollution tax.

Then, to focus on the mechanisms behind support for a carbon tax, I would again measure the time interval between seeing the question and selecting a response and ask the perceived benefits vs costs question:

- Think again about the proposed policy of introducing a carbon tax. When considering this policy, do you think the benefits outweigh the costs, or the costs outweigh the benefits? (1 = costs strongly outweigh the benefits, 10 = benefits strongly outweigh the costs).

Next, I want to measure the salience of different policy goals. Without information on its functioning, people might not understand that a corrective tax's main objective is to increase social welfare (rather than to merely raise revenue). Hence, I will test whether people who see the aggregate information treatment are more likely to say that increasing social welfare is one of the most important goals of a carbon tax.

- Which of these goals of a carbon tax are most important to you ? (I randomize the order in which they see these and I put in bold – just here in the PAP – increasing social welfare).

- **Increasing social welfare**
- Reducing emissions
- Fighting climate change
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Then I would ask more specific questions on different policies involving a carbon tax and varying uses of tax revenue.

- Governments can use the revenues from carbon taxes in different ways. Please tell me on a scale from 0 to 10 how much you personally support the following policy. 0 means no support at all, 10 means complete support (the order of policies is randomized).
 - Introducing a carbon tax and using the money to reduce citizens’ sales tax by an equal amount;
 - Introducing a carbon tax and using the money to provide equal cash transfers to all households;
 - Introducing a carbon tax and using the money to provide cash transfers to low-income households;
 - Introducing a carbon tax and using the money to provide tax rebates for the most affected firms;
 - Introducing a carbon tax and using the money to fund research into renewable energy sources;

Finally, to test the relationship between zero-sum thinking and support for a corrective tax (using the control group only), and to test whether the information treatment reduces zero-sum thinking I would ask this question to measure zero-sum thinking on the environment:

- Please tell me on a scale from 1 (strongly disagree) to 7 (strongly agree) how much you personally agree with the following statement:
 - If we take action to protect the environment, then economic growth must be sacrificed.

Since a carbon tax may be a polarizing cue, I also plan to measure partisanship, as I anticipate heterogeneous effects between Liberals and Conservatives. Framing may interact with partisan identity such that Conservatives may be less supportive of a carbon tax.

The survey will be administered to opt-in samples obtained from a commercial survey sample provider. The sample size will be 1,500 individuals in Canada, we will apply quotas for age, gender, and region. The target are all respondents aged 18+.

Finally, I will not exclude respondents based on manipulation check questions, but rather I will conduct analyses both without accounting for that, and accounting for it (interacting it with the treatment variable).

4 Hypotheses

To recap, since the extreme polarization on climate change makes any communication on the issue potentially ineffective, I will illustrate the concept of negative externality using an alternative framing, one that emphasizes pollution rather than climate change. It is unclear whether the majority of people can tell the difference between conventional air pollution and carbon pollution, but the former is less polarized (Bickerstaff and Walker, 2001; Mossler et al., 2017). For these reasons, this framing might help the climate change cause, both through increasing support for action against air pollution and also increasing support for a carbon tax, once the welfare effects of a corrective tax in the presence of a negative externality become clear. In particular I expect that:

H1 The information treatment on the negative externalities of pollution increases support for both an air pollution tax and a carbon tax, relative to the control group.

I then investigate the mechanisms that could explain an increase in support for a carbon tax after the information treatment.

H2 The information treatment on the negative externalities of pollution decreases cue-processing (measured by how quickly respondents select an answer on policy support), relative to the control group.

H3 The information treatment on the negative externalities of pollution increases beliefs that the benefits of a carbon tax exceed its costs, relative to the control group.

H4 The information treatment on the negative externalities of pollution increases the salience of the social welfare dimension, relative to the the control group.

H5 The information treatment on the negative externalities of pollution increases support for a carbon tax, regardless of how revenues are used, relative to the control group.

I expect these effects to be stronger among conservative respondents since their support may be lower to start with and they may be more sensitive to the economic/pocketbook framing of the information treatment.

Finally, I expect that:

H6 Respondents higher on zero-sum thinking on the environment are less supportive of corrective taxes (only test in control group).

H7 The information treatment on the negative externalities of pollution decreases zero-sum thinking on the environment, relative to the control group.

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