Title: Understanding the climate responsibility associated with elections

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Summary: Elections represent infrequent, high leverage opportunities for everyday individuals to contribute to climate change mitigation. In this Perspective, we present two ways of thinking about the climate impact of voting in elections. The first, "emissions responsibility", intuitively apportions emissions to voters according to popular principles in carbon accounting and can be calculated for elections where there is a clear difference between major candidates (as in the 2019 Canadian federal election). The second "expected emissions value" approach is more probabilistic and can be used to investigate the rationality of participating in an election for climate-motivated voters. Building on these ideas, we discuss the possibility that "political carbon offsets" (donations to pro-climate politicians) could constitute a more effective and more equitable alternative to traditional, voluntary carbon offsets.

Main text: Climate change, like voting in a democracy, is a collective action problem. Individuals may hesitate to expend resources and effort to reduce their carbon footprints knowing that the marginal impact on the global carbon budget is close to zero. Likewise, the probability of casting the deciding vote in an election is low; in one United States presidential election, the probability was estimated at one in sixty million.[1] Given the low likelihood of casting a decisive ballot, researchers have argued over the efficacy and even rationality of voting.[2] Yet elections certainly influence collective action on problems like environmental pollution and climate change; Green party strength is associated with lower air pollution on a national scale,[3] and US states that vote for greener candidates have lower growth in carbon dioxide emissions[4].

While we know the relative impact of individual actions involving air travel, personal vehicles and diet,[5] the impact of political actions like voting is difficult to assess. Fortunately, in the vast majority of situations, there is little conflict between choices that lead to measurable reductions (cycling, planting trees) and choices where the causal chain is murky and seemingly unquantifiable (attending a climate strike or canvassing for a pro-climate politician). But on occasion, circumstances require tradeoffs. A climate organization could gather pledges to not fly for one year or collect the requisite number of signatures needed to force a state-wide vote for a renewable energy standard. A philanthropist could opt to buy a parcel of land and protect it from logging, or they could finance an election campaign for a politician with strong climate credentials. These dilemmas can be meaningful in scale: voluntary carbon markets were estimated at a total value of $191.3 million in 2016,[6] and Amazon founder Jeff Bezos alone pledged $10 billion to "scientists, activists (and) NGOs" in the effort to fight climate change.[7] How should such funds and efforts be allocated to maximize impact on climate mitigation?

The desire to quantify certain climate outcomes is justified insofar as it enables informed decision making. It is because of Life Cycle Assessments that an informed consumer can judge that an electric vehicle will produce less emissions over its lifetime than a conventional vehicle. Similarly, it is because the carbon sequestered by trees can be quantified that companies are able to leverage climate guilt for the emissions of a flight into verifiable carbon offsets. But since we have not quantified political actions in the same way, they cannot be assessed on the same terms, and may not be prioritized accordingly. Understandably, there have been expert calls to more explicitly measure the relationship between climate activism and reductions in greenhouse gas emissions.[8] While the large number of factors at play may prevent us from assessing the impact of an action like attending a climate demonstration in terms of greenhouse gas emissions, the path from voting for a pro-climate candidate to the implementation of policy that achieves emissions reductions is more quantifiable.

In this perspective, we explore two ways of thinking about the climate impact of voting in elections and note the implications for individual decision-making and motivating climate action. First, drawing on carbon accounting literature, we introduce the concept of the "emissions responsibility" associated with voting and present methods of quantifying that responsibility using a case study of the 2019 Canadian federal election. Second, drawing on the political science literature, we describe a probabilistic method for calculating the "expected emissions value" of casting an additional vote and use this method to discuss the rationality of voting. We then bring these ideas together to consider the merits of "political carbon offsets": donating to pro-climate politicians as a way to reduce emissions. Finally, we address the limitations of these approaches and how they could be improved in the future.

Emissions responsibility of voting

We propose emissions responsibility as a simple carbon accounting approach for calculating the emissions associated with an individual's votes. It follows the logic of carbon calculators which aim to link local decisions to global greenhouse gas emissions.[9] For instance, emissions from government activities like health care or road building are sometimes divided equally amongst a population,[9] whereas emissions from multi-person travel are divided amongst passengers based on the fraction of space that passengers occupy in the vehicle or aircraft.[10, 11] The thinking behind carbon footprint calculations can be traced to Life Cycle Assessments whose methods have been codified by various professional groups and government agencies.[12, 13] While there is no standard way to apportion emissions responsibility for political decisions, the concept of dividing responsibility for group emissions amongst members of that group is common and uncontroversial.

Per capita emissions therefore offer an entryway to the discussion of emissions responsibility. We often approximate both a nation's and an individual's responsibility for emissions by looking at per capita emissions in that nation. While it is true that every individual in a nation requires additional energy and resources, we would not ascribe responsibility to infants for their emissions. There are also many individuals in a democracy with little to no say over their own emissions since their lifestyle choices (e.g., drive or take public transit) are constrained by the decisions made by others in the voting booth (e.g., the winning party's support for new public transit initiatives). In terms of responsibility for emissions in a democratic country, it is therefore more informative to examine emissions per voter. If we calculate emissions per voter instead of emissions per capita, each voter takes on roughly twice the responsibility (Figure 1), since the emissions which we previously attributed to adolescents or the disenfranchised are now assigned to those with political agency.

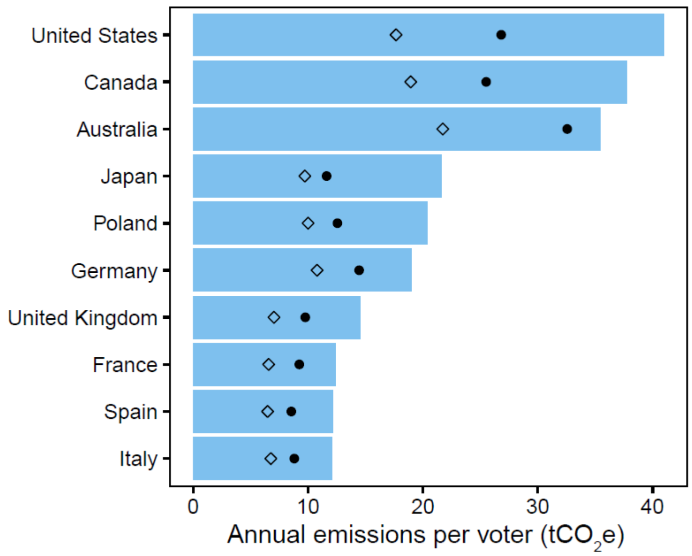

Figure 1 Emissions responsibility per voter. The ten most populous Annex I nations with Democracy Scores of six or greater shown above. Emissions responsibility per actual voter is represented by blue bars, emissions responsibility per registered voter is represented by black points and emissions per capita is represented by diamonds.

Quantifying emissions responsibility of a single vote

It seems reasonable that voters have higher responsibility for emissions than those who cannot vote, but climate policy may not always be "on the ballot". The 2019 Canadian federal election offers an instructive case study for quantifying emissions responsibility because there was a clear divide between the climate policies of the major political parties and because climate change was a top issue for voters [14]. Leading up to the election, four of the five major parties, including the ruling majority Liberal Party, presented platforms that would lead to modeled or stated reductions in greenhouse gas emissions. The Conservative Party of Canada, the largest opposition party, proposed removing existing policies, including the federal carbon tax, and enacting other policies that were widely criticized by climate experts. Because the Liberal Party was re-elected to the most seats in Parliament and was expected to at minimum maintain the climate policies which the second place Conservative Party promised to revoke, we can calculate the emissions potentially saved by this electoral outcome and suggest a few ways that responsibility for those saved emissions could be distributed among voters.

An analysis of the two front-running party platforms concluded that, by the year 2030, Canada would be emitting 100 $MtCO_2e$ per year less under a Liberal-led government, which represents roughly 14% of current emissions.[15] Assuming linear reductions, as projected by government modelling,[16] this would result in a cumulative sum of 612 $MtCO_2e$ by 2030 (Table S2). Since the next election could either overturn or enhance the relevant policies, we take only those projected emission reductions that would be achieved over 3.4 years (the average duration of an elected government in Canada between the last ten elections) and attribute them to this election (a total of 192 $MtCO_2e$).

A cautious or conservative approach to estimating emissions responsibility of voters is to equally apportion the emissions total to the 338 electoral districts that elect Members of Parliament, and then give equal responsibility to every registered voter in those districts. This results in a median value of 6.7 tCO_2e in reduced emissions per registered voter. This estimate is conservative because it assigns responsibility to individuals who were registered but did not vote and to individuals whose chosen candidate did not win in their district.

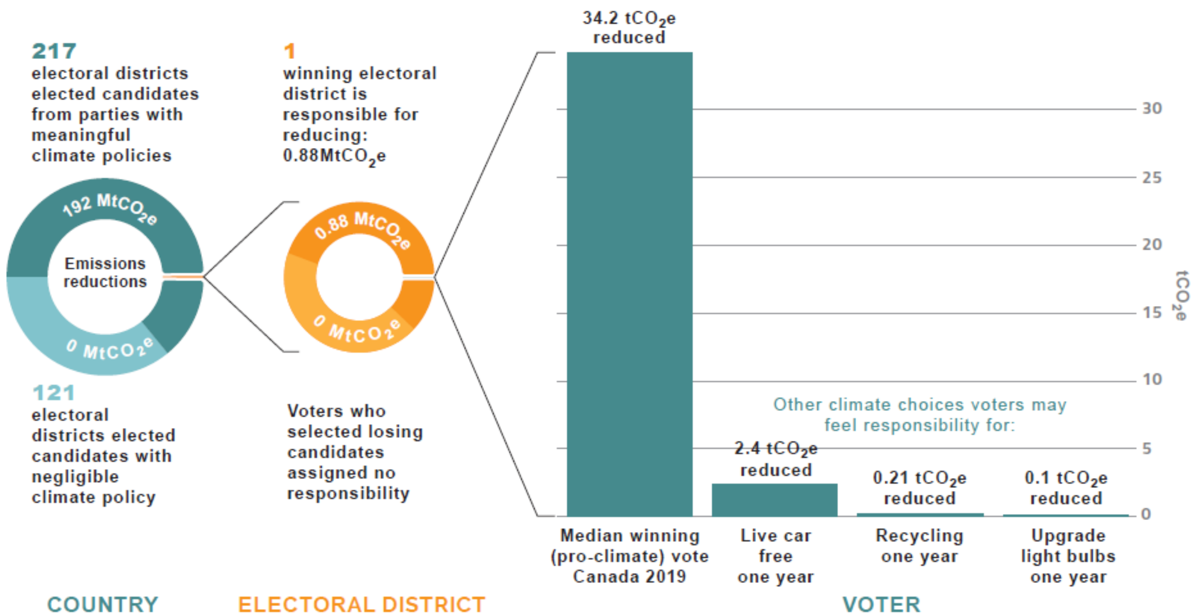

Figure 2 Distributing emissions responsibility in the 2019 Canadian federal election. Emissions allocated only to “winning voters”, see Table S1. Values for lifestyle choices taken from Wynes and Nicholas.[5]

Alternatively, we could apportion the projected emissions reductions from the election only to “winning electoral districts” – those electoral districts where either the Liberal Party or another party favoring progressive climate policies was successful. We then distribute emissions in each winning electoral district only to individuals who voted for the successful candidate (Figure 2). In this approach, the median winning voter is responsible for 34.2 tCO_2e reductions, while voters in the most influential electoral district are responsible for 228.7 tCO_2e of reductions (Table S3). These estimates may be more intuitive because they only attribute responsibility for policy decisions to voters who supported a party advocating those policies. A wide range of values will occur in any electoral system, like that of Canada or the United States, which has an uneven distribution of voters and or multiple parties splitting the vote.

There are various other ways one could apportion responsibility, though most would result in values somewhere between those we have presented. Regardless of which method we choose, for this particular election, the potential climate responsibility of voting is higher than most individual lifestyle decisions that the average person has the opportunity to make.[5]

The actual emissions impact of this or any other election cannot be known until years later, and changes in emissions may never be directly attributable to the election's outcome. For example, the elected party may alter or fail to enact their platform, the proposed policies may not have the estimated impact, or other factors may influence emissions and negate, inflate or obscure the impact of the policies. In this case, the emissions impact of the election may be larger than those suggested by the policy proposals announced during the campaign: in late 2020, the elected Liberal-led government released a more aggressive set of climate initiatives, including a linear increase in the carbon tax to CDN$170/ton in 2030, which may lead to twice the emissions reduction indicated in our analysis.[17] Nevertheless, elections in which the platforms of the leading candidates could result in very different climate outcomes have been common in recent years, including the national elections in the United Kingdom in 2019, Brazil in 2018, and the United States in 2016 and 2020. Note that in the case of the United States in 2020, we did not attempt an analysis due to differences in the political systems that create large uncertainties concerning the Biden administration's ability to pass climate legislation (these include the greater likelihood of court challenges and the antimajoritarian US legislative system).

The benefit of engaging in this type of thinking is that it provides an intuitive way for people to understand their share of climate responsibility during an election. Some people may believe that all eligible voters share equal responsibility for an outcome, and some may believe that only a subset of voters with a controlling influence over the result (winning voters) share responsibility. But if the emissions responsibility is comparable to that of high-impact lifestyle choices in both cases then we should regard the responsibility of voting to merit the same level of moral consideration.

Individuals may have a greater responsibility for the climate impact of their vote than for the climate impact of their consumer choices, but that does not necessarily indicate that their vote *causes* more emissions than their consumer behavior. The emissions responsibility approach is similar to that of a standard air travel carbon calculator. If an air traveler opts to stay home they would actually reduce emissions less than estimated by a carbon calculator, because the flight is likely to still proceed, and the effect of their absence on fuel use is small or negligible. Similarly, if a single voter opts to stay home, their missing vote is likely to have less of an emissions impacts than estimated by the emissions responsibility calculation. A more marginal approach would ask, "what is the emissions impact of this entire election, and what is the probability that my vote happens to be the one that causes one party to win?"

The next section examines how our thinking about elections changes if we approach the problem from this instrumentalist perspective. By synthesizing evidence from political science and carbon accounting, we describe a way to evaluate the causal value of a pro-climate voter's choice. We begin by applying this thinking to the question of the rationality of voting and then consider whether political donations are a viable alternative to carbon offset projects for certain pro-climate individuals.

Is it rational for a pro-climate citizen to vote?

There has been considerable debate as to why citizens spend time and energy casting votes that result in very little personal benefit. Voters may incur costs to cast a ballot because of a sense of civic duty,[18] because of pride and social norms[19, 20] or because of a desire for self-expression.[21] Setting these motives aside, scholars are undecided as to whether even self-interested citizens can rationally engage in the act of voting.[2]

Often a financial test is used to help evaluate whether the choice is rational.[22, 23] The idea makes use of the expected value calculation. In gambling if the expected value of a game is positive, then it is rational for a gambler to play because over a large number of attempts, the gambler can expect to gain money.[24] Lotteries are an interesting example of expected value in gambling because, though the odds of winning are astronomically low, the payoff is also quite substantial.[25] We can use the same math to evaluate whether participation in a lottery is advisable, finding that, except in rare cases, it is not.[26-29] Instead, the expected value of a lottery ticket is usually about half the cost of participating.[30] Elections are similar to lotteries in that the likelihood of one person's vote "making a difference" by serving as the deciding vote is also quite low but the consequences of an election can be considerable.

Based on this logic, scholars have argued that voting is a rational act for those voters who wish to increase social well-being instead of maximizing selfish gains.[22, 31-33] In larger elections where a voter is less likely to cast a pivotal vote, there is greater potential for social good that can compensate for these lowered odds.[34] The same relationship might be true for climate mitigation – the larger the number of voters, the larger the potential difference in terms of greenhouse gas emissions. Since it is possible to estimate both a range of probabilities for a pivotal election, and a range of potential outcomes for the difference in emissions attributable to an election, we can ask whether an ardent climate activist is rationally justified in voting.

Let us assume that there is a group of voters who are willing to vote altruistically, and whose sole aim in voting is to mitigate climate change. Such voters may engage in actions that have climate costs, such as driving to a voting booth, hoping that the costs will be paid off in the event that they cast a deciding vote which results in more ambitious climate legislation. We can adapt an expected value calculation to see whether it is a rational choice for a voter to drive to the polling station in order to cast such a vote. A basic model of this expected value calculation can be described by:

$$R = BP - C \tag{1}$$

where R represents the reward gained from voting, B represents the benefit gained by the preferred candidate winning, P represents the probability of casting a deciding vote and C represents the cost of voting.[35] For a climate voter seeking to maximize emissions reductions, R would represent the balance of emissions, where a positive value would justify the act of voting, B would represent the benefit in terms of the expected emissions reduced through the policies of the preferred candidate winning, P is the probability of casting a decisive vote, and C is the cost, in emissions, of casting a vote. Next, we consider ways to estimate P.

Estimating the likelihood of a pivotal election

Most actual estimates of P have focused on the United States, either at the national or the state level,[1, 36, 37] but methods for calculating this probability vary. If a forecast based on opinion polling data is available, one can use that data to estimate the likelihood that the election will be decided by a single vote. Assuming a forecast with low standard error for a very close election (where two candidates are expected to receive an equal share of the vote), an upper bound for P has been estimated at 20/n, where n is the number of voters[37]. Since most elections have much larger margins between candidates, we can expect most probabilities to be substantially lower.

In fact, researchers have looked at historical records to give an indication of how often pivotal votes occur. One analysis found that of 16,577 US elections, only one was decided by a single vote and in 40,036 US state elections, two elections were tied and seven were decided by only one vote[36]. These databases can be used to crudely approximate the probability of a pivotal vote by taking the empirical frequency, x/N , where x is the number of elections that the winner's vote tally exceeds the loser's by no more than a single vote, and N is the number of elections in the database. Because the number of pivotal elections is so rare, researchers can improve on these estimates by incorporating additional data such as the frequency of close but not pivotal elections, as in those within 10 or 100 votes[36]; for example, in the 2020 US election, one congressional race with almost 400,000 votes cast was decided by only six votes[38]. Using such methods, the probability of a pivotal election is estimated to be proportionate to the size of the electorate according to n^{-1} or more precisely, $n^{-0.9}$.[39] As might be expected, the larger the electorate, the less likelihood there is of a single individual casting a decisive vote. We assume the more conservative relationship of n^{-1} and use Equation 2 from Gelman, King and Boscardin[37] and Margolis[40] which allows us to take the size of the electorate (n) the forecast share of the vote (μ) and the standard deviation (τ) to approximate the probability of casting a decisive vote.

$$P = (\sqrt{2\pi}\tau n)^{-1} \exp\left(-\frac{(\mu - .5)^2}{2\tau^2}\right) \quad (2)$$

Figure 3 shows the likelihood of casting a decisive vote in a range of election scenarios for an electorate with size n=100,000.

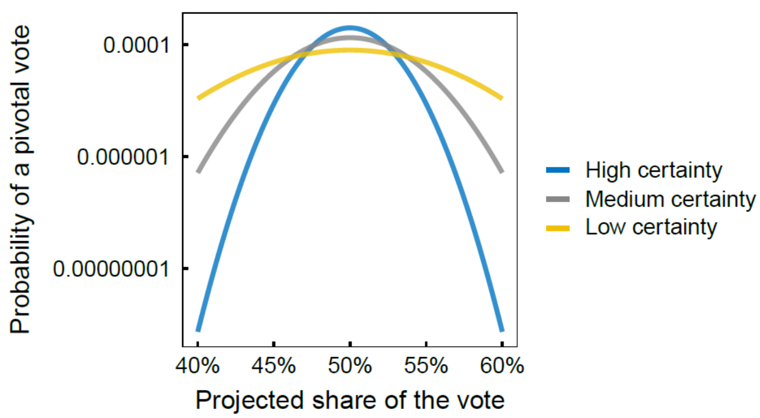

Figure 3 Probability of casting a pivotal vote for a generic election with n=100,000 voters. Blue line represents high level of forecast certainty (SD=0.02), grey is medium certainty (SD=0.03) and yellow is low certainty (SD=0.05).

In order for a voter to rationally cast a ballot in hopes of lowering net greenhouse gas emissions, the cost of casting a ballot (in terms of greenhouse gas emissions) must be lower than the probability of casting a decisive ballot multiplied by the expected emissions reduced by the preferred candidate winning. Setting the reward, R, to 0 and rearranging (1) we have:

$$C/((\sqrt{2\pi}\tau n)^{-1}\exp\left(-\frac{(\mu-.5)^2}{2\tau^2}\right)) \leq B \tag{3}$$

Even in a rural riding, it would be reasonable to expect a voter to be within 10 miles of a voting precinct.[41] Taking a few vehicles that exemplify a range of carbon intensities (a Tesla, a Honda Civic and a Ford F-150) and multiplying their fuel efficiencies by the range we find the cost in emissions (C) (Table S4).

We can then take an electorate size equal to n and solve for the amount of emissions (B_{min}) that would need to be reduced by the preferred candidate's victory and subsequent policies in order to make the act of voting rational for our climate voter. Doing so shows that the scale of the emissions required by various example electorates are achievable in most close elections (Figure 4). For instance, even in the case of a blowout election where the forecast share of votes is 60% for one candidate (roughly Joe Biden's share of the vote in New York State in 2020), the total B_{min} necessary to make voting rational in a highly polluting pickup truck is just 0.09%, 0.3% and 1.5% of one year of Cleveland's, Chicago's and France's respective emissions. To give an idea of the magnitude of change engendered by a typical climate policy, a single new national climate law can be expected to reduce emissions by 0.78% per unit of GDP, with that number growing after three years.[42] Since policies usually last for multiple years, there is a good chance that it is rational to vote in elections that are not blowouts provided that one candidate or party offers to implement meaningful climate policy while the other does not. However, for extreme cases, such as an election where one candidate is forecast to receive 80% of the vote with high certainty, the improbability of casting a decisive vote becomes so high that voting is no longer rational from an instrumentalist perspective. Note that B_{min} is less sensitive to distance travelled than to forecasted vote share since B_{min} scales linearly with emissions from the drive but increases exponentially as the forecasted share of the vote diverges from 50% (see sensitivity analysis Figures S1 to S3).

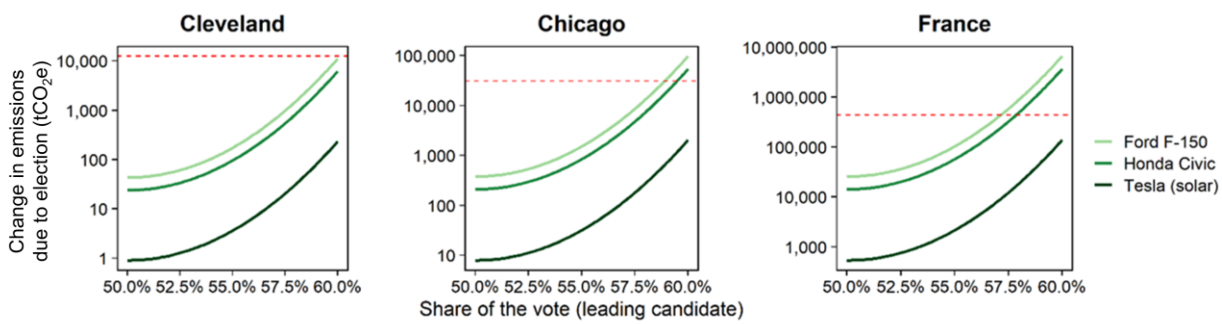

Figure 4 Emissions benefit of election (B_{min}) required to rationally justify voting versus forecasted share of the vote for the leading candidate. Analysis is based on a return trip of ten miles each way to the voting booth, and an election forecast with reasonable certainty (SD=0.03). Red dashed line shows 0.1% of annual emissions for each jurisdiction.

Nations with electoral systems that assign unequal voting power to different individuals may hold more elections where participation is not rational. For instance, the United States Electoral College devalues the voting power of individuals in states far from the national median partisanship.[1] This makes the likelihood of casting a pivotal vote for a Presidential candidate vanishingly small for many voters, and disproportionately likely for others (Table 1). However, in the case of US elections, participation may still be rationalized due to the opportunity to vote for candidates in other races or in ballot initiatives.

Table 1: Emissions reductions needed to justify voting in US States

State	P(casting decisive vote)	Necessary reductions from winning candidate ($MtCO_2e$)		
		Tesla	Civic	F-150
Wisconsin	1/7.1 million	1.4	38	68
Nevada	1/12 million	2.4	64	115
Illinois	1/250 million	50	1328	2398
California	1/7.5 billion	1500	39825	71925
Wyoming	1/58 billion	11600	307980	556220
Washington DC	1/150 trillion	30000000	796500000	1438500000

Note: US emissions in 2017 totaled 5742 $MtCO_2e$. Probabilities based on a forecast by the Economist taken 15 days prior to the election. Shows a range of states including most and least likely to cast a pivotal vote. Data for all states can be found in Table S5.

Not every election will offer a clear range of choices to our hypothetical climate voter. The leading candidates may have identical climate policies, or a set of policies whose emissions cannot be easily projected or even guessed. Still, as noted previously, there have been many recent elections where voters can choose between a candidate with rigorous climate policies and a candidate without. In such instances it is likely that even driving a high-emitting vehicle to cast a vote for a climate leader would be a rational decision.

The viability of political carbon offsets

For climate-concerned actors who are not constrained by a corporate directive to remain apolitical, there are strong arguments in favour of expending time and resources to change systems rather than focusing on discrete projects. For instance, a philanthropist could purchase a large plot of land and plant trees on it, or they could work to elect a pro-climate government who could plant the same number of trees, but also implement an electric vehicle incentive and a price on carbon. This reasoning, if applied to the average citizen, might imply that donating to a political campaign could lead to larger emissions reductions than purchasing carbon offsets. The question is whether campaign contributions influence election outcomes efficiently enough to outweigh purchasing offsets.

We can examine this question using both the emissions responsibility and the expected emissions value approaches to thinking about the climate impact of voting. First, we previously reported in the emissions responsibility case study that the reelection of the Liberal Party in Canada in 2019 is expected to result in savings of 192 $MtCO_2e$ compared to the next most likely alternative. Table 2 shows the cost of 192 Mt of emissions using carbon prices from a variety of different approaches, including the cost of offsets, a carbon tax, a cap and trade scheme and modelled estimates of the cost of the impacts of carbon emissions on society.

Table 2: Different measures of cost per tonne of CO_2

Approach	Cost per tonne (USD)	Cost of 192 $MtCO_2e$ (in billion USD)
Offsetters General Portfolio	14.26	2.74
Canada carbon tax	21.42	4.11
EU ETS	22.13	4.25
US social cost of carbon	42	8.06

The maximum spending limit on all political parties combined for the 2019 Canadian federal election was $175 million[43], about 1/15th of the cost of the carbon emissions outcome by the lowest measure (Table 2). While spending huge sums on an election does not guarantee a victory, there is strong evidence that candidates who spend more increase the likelihood of winning.[44, 45] This suggests that for elections where large quantities of emissions are at stake, as they were in Canada in 2019, and where campaign contributions are able to shift outcomes, political donations could be competitive with offsets in terms of efficacy.

But to answer this question using the expected emissions value of a vote approach, we would ideally want to know how much emissions can be saved through electing climate leaders and the relationship between campaign spending and increased likelihood of winning an election. At present, neither of these values can be determined with great precision. Still, to provide an initial exploration of the question we take the approach of using conservative measures and comparing these to the alternative of using carbon offsets.

A review of the "get out the vote" literature found that campaigns can increase voter participation at the cost of anywhere from $18-$137 per added vote.[46] But, from the perspective of a donor, some fraction of a donation will end up going to administration instead of advertising or get out the vote efforts. For generic campaign spending, the cost across four studies of adding one vote to a candidate's final vote margin for an incumbent was $15-$367 and $12-$110 for a challenger.[44, 47] We take $110 per vote as the maximum value from the campaign spending literature for challengers and convert into present day dollars ($175). The choice to use challenger spending is justified since some of the previous research on incumbent spending assumes that incumbents optimize vote share instead of probability of re-election,[44] which would lead to higher cost per vote for incumbents. The $175 estimate is also relatively close to the upper estimate from the get out the vote literature, which has the advantage of drawing on a broader range of elections (from local to national). It also assumes that the donation does not prompt additional fundraising or spending from the opposing candidate.

Next, as an example of how we could apply the expected emissions value calculation in the real world, we consider the Washington 1631 Ballot Initiative, where 3 million voters decided whether to enact a carbon tax in their state. Though ballot initiatives operate under circumstances where the effects of campaign financing are less understood than in typical elections,[48, 49] we assume that the cost of generating a vote is the same to take advantage of other useful features of the case study: voters knew the issue was centered on climate change and there is a strong causal link between the voters' choices and the implementation of a reasonably effective climate policy.

Applying Equation 2 to polling data preceding the election[50] we find the probability of casting a decisive vote was 2.7×10^{-6} (see Supplemental Experimental Procedures). We can then compare the \$175/vote cost of adding another vote to a generic campaign with the cost of carbon offsets using an expected value calculation (similar to Equation 1), which relates the emissions reductions associated with a single vote (R) to the total emissions benefit of a candidate or party winning (B) and the probability of casting a deciding vote (P). The expected reward from voting (R) must be at least 12.5 tCO_2e to be comparable to a carbon offset, since \$175 would purchase that much from the low-cost carbon offset (Table 2):

$$B = \frac{R}{P} = \frac{12.5}{0.0000027} = 4.6\ MtCO_2e$$

Substituting for the probability of a pivotal election and rearranging we find that the ballot initiative would need to result in reductions of 4.6 $MtCO_2e$ over the course of its implementation. To put this into perspective, Washington State emits 97.5 $MtCO_2e$ every year, so achieving 4.6 $MtCO_2e$ would require reducing statewide emissions by one percent for five years. Studies of carbon prices implemented in other jurisdictions have found reductions of 2%,[51] 3.8%[52] and 5-15%[53] annually, suggesting that such a reduction is feasible. If we assume the minimum reported effectiveness of the carbon price (2%) and that it is in place for only five years, the expected emissions value of a winning vote is 25 tCO_2e, and a donation to the winning campaign would have an expected efficiency of 7\$/tonne, less than half the price of the cheapest carbon offset (Table 2).

This outcome, though specific to the ballot initiative, is reasonably robust to changes in the forecast (see Figure S4 for a sensitivity analysis) and demonstrates the potential value of political donations in elections where a large quantity of emissions is at stake and the forecast is either close or the forecast uncertainty is high. In such cases, the only other influential variable is the size of the electorate. If the electorate is larger, then the chance of influencing the election with a donation is lower, but the impact of the election in terms of total emissions will likely be greater.

The Washington I-1631 ballot initiative was not successful and those who donated to that cause did not directly reduce emissions with their efforts. But the concept is probabilistic: a large amount of donations in a large amount of elections will reduce emissions (barring a "gambler's ruin" situation where there are too few pro-climate electoral victories to recoup costs in a limited number of election opportunities [28]). And while our estimates of efficacy are subject to large uncertainty, so too are carbon offsets; development projects do not always achieve the expected results[54] and forest carbon offsets may fail to generate real, verifiable emissions reductions for a host of reasons[55]. Since the goal of these donations is to impose policies that reduce emissions in one's own nation, "political carbon offsetting" also avoids the moral quandaries of paying less wealthy jurisdictions to make emissions cuts on behalf of polluting industries and individuals in developed nations.[56]

The additional benefits of electing climate leaders are substantial since changes wrought by government policy can extend beyond calculable emissions reductions. For example, the policies which stimulated market growth of photovoltaics were responsible for worldwide reductions in the cost of solar energy,[57] allowing for further growth of that market and more emissions reductions than what were achieved through the original policy. On the international level, when high-emitting countries achieve ambitious reductions it increases the willingness of other countries to contribute.[58] And targeting elections where agreed upon social tipping elements such as fossil fuel or renewable subsidies are at play increases the likelihood of achieving transformational change.[59]

Optimizing donations

Given these perspectives on the climate impact of voting and political action, how should everyday citizens or motivated philanthropists make effective political donations? All else being equal, investing in races in which the polling is close should be more advantageous since there is more chance of the donation swinging the election. Additionally, early research found incumbent spending to be less advantageous than challenger spending,[47, 60, 61] though later studies[44, 62] have convincingly questioned conventional wisdom on this point. Still, incumbents are more likely to use their finances to pay off debts or support other candidates[45], so challengers remain a more efficient investments from the viewpoint of donors.

Donors would also be wise to avoid the diminishing returns associated with giving to already well-funded campaigns. Evidence from senate elections[62], state house elections[63], judicial elections[64], and ballot initiatives[65], confirms the logic that initial spending which raises awareness adds more value than repeated contact with voters already exposed to campaign outreach. Based on the advantages of supporting underfunded challengers, donating to candidates attempting to supplant climate laggards in United States Democratic Primaries might be one way to scale up ambition for climate change in the short term.

Some of the criteria listed above for an efficient political donation are correlated, making it less likely that all conditions for an ideal donation can be satisfied. For instance, politicians increase spending in close elections,[66] so it may be difficult for a donor to identify close elections where spending is low. For small donors hoping to give effectively, identifying races that fit the multi-dimensional criteria suggested above could therefore be challenging. Instead best practice for political carbon offsetting might simply be achieved by giving to organizations who aim to elect climate-concerned legislators and relying on their expertise to allocate funding. This would also reduce the burden of evaluating which candidates are genuinely intending to reduce emissions. Donors can also add value to their efforts by openly discussing their campaign contributions, as this type of giving has been demonstrated to be contagious .[67] Finally, volunteering can be viewed as a substitute for donations, since the efforts of a volunteer at a get out the vote drive would be equivalent to a campaign paying for that same labor.

Conclusion

By drawing on the literature on carbon accounting and political science, this Perspective introduces new ways of conceptualizing the climate impact of voting. The case studies serve as illustrative examples and should not be seen as precise estimates of the climate impact of voting. The cost of generating a vote in a campaign will always vary based on the specifics of the campaign in question. In the future we may have a better understanding of how that value changes in different circumstances. The case studies nonetheless suggest that the responsibility that individuals have for emissions under elections can be comparable to the responsibility that they may incur for emissions in their everyday lives.

Each of the two proposed ways of conceptualizing the climate impacts of voting has its strengths and weaknesses. One potential critique of the emissions responsibility of voting as a form of personal carbon accounting is that it will result in double-counting. An individual might consider themselves to be responsible for saving a certain amount of emissions by voting in favour of a renewable energy standard, and then later credit themselves for using less home energy emissions now that their electricity has a lower carbon intensity. One could avoid the double counting issue by treating emissions responsibility for voting as an alternative metric, and not a complementary metric to carbon footprints from lifestyle change. For instance, individuals could be motivated to consider the active reductions they can engender in the world (“carbon handprint”) as opposed to their lifestyle emissions (carbon footprint).

We acknowledge that introducing a concept of emissions responsibility for voting could lead to a type of moral licensing where individuals would then feel emboldened to increase emissions elsewhere, but it is not the same thing as a carbon accounting error with verifiable consequences. On that note, there is reason to question the utility of introducing these ideas into the public. Individualizing group action may make certain behaviors appear less important and thereby actually decrease motivation. Conversely, since some members of the public do not consider voting to be an effective way to reduce emissions,[68] communicators could motivate voters with an emissions responsibility analysis that demonstrates what is "at stake". Future climate communication research should test the efficacy of emission responsibility analyses in application to voting behavior.

The more probabilistic approach to calculating the emissions associated with voting suggests that climate voters are rationally justified in participating in many elections, and also that those wanting to fight climate change with donations could give serious consideration to political efforts, instead of limiting themselves to traditional carbon offsets. Introducing this type of probabilistic thinking to those with the wealth to contribute to climate mitigation projects offers a way to justify investing in candidates with the leverage to achieve greater results than private investments can create on their own.

Experimental Procedures

Resource Availability

Lead contact

Further information and requests for resources should be directed to and will be fulfilled by the corresponding author, Seth Wynes (christopherseth.wynes@concordia.ca).

Materials availability

This study did not generate new unique materials

Data and code availability

The datasets and code underpinning this research are available in the Supplemental Information or in the Concordia University Dataverse: https://doi.org/10.5683/SP2/9B1IO3

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Author Contributions

S.W. conceived of the presented idea, performed calculations and drafted the manuscript. M.M. and S.D.D. contributed to the final manuscript. S.D.D. supervised the work.

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