Ready for progressive carbon taxes? Carbon footprint definition, support, and ethical motives

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Abstract

This paper shows for the first time the support for progressive carbon taxes and individual caps. It demonstrates how this support is linked with an aversion to intratemporal carbon footprint inequality and is thus likely to increase. To that end, it uses a survey representative of the French population.

A near majority supports progressive carbon taxes with uniform revenue redistribution. This support is much higher than for linear carbon

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taxes with a progressive revenue redistribution. This is true for all carbon tax bases that could be immediately implementable, — on gas, flights, and fuels. A near majority also favors individual flight caps. Given sufficient progress in carbon accounting, respondents wish to include emissions associated with wealth, financial, and to a lesser extent, labor income in the definition of an individual carbon tax base. Using this footprint definition, we show that a near majority also supports a progressive carbon tax on top of a more progressive income tax, as well as individual carbon caps.
A tax reform model reveals how support for progressive carbon taxes and individual caps is influenced by ecologearian social welfare preferences. These preferences, –introduced in this paper–, express aversion to intra-temporal footprint inequality. Our survey shows that respondents are ecologearian. Consistent with ecologearian preferences, information on footprint inequality increases support for progressive carbon taxes. Since this information comes from recently available statistics and media campaigns, this suggests a growing support for progressive carbon taxes in the future.

JEL: D63, H21, H23, P18, Q58 **Keywords:** Redistribution preferences, Carbon tax, Nonlinear Optimal Taxation, Environmental ethics, Revealed social preferences

1 Introduction

"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." Aldo Leopold, A sand county almanac 1949

How can we address the unpopularity of carbon taxes? Since Pigou's (1920) seminal work, linear carbon taxes have been recognized as a first-best policy to mitigate greenhouse emissions. However, despite their economic efficacy, carbon taxes face widespread public resistance. This global opposition,[1] has spurred extensive research into carbon tax support which reveals low levels of public backing (see recent reviews by Klenert et al. 2018, Carattini et al., 2018; Fairbrother et al., 2019; Maestre-Andres et al., 2019). On the other hand, research has suggested that non-linear carbon taxes might represent second-best policy alternatives (Jacobs and de Mooij, 2015). Since optimality within the bounds of acceptable tax policies is essential (Bierbrauer, Peichl,

[1] as briefly outlined in Appendix A.2.1

and Boyer, 2021), this raises the following question: could second-best policies, such as non-linear carbon taxes or individual caps, garner more public support than a Pigouvian carbon tax? If so, what underlying reasons might drive this support?

Weinzierl (2014), Saez and Stantcheva (2016), and Fleurbaey and Maniquet (2018) revealed how ethical objectives other than utilitarianism can better explain actual and preferred income tax schedules. Indeed, the empirical social choice literature, dating back to Yaari and Bar-Hillel (1984), has demonstrated the limitations of utilitarianism as a proxy for people's ethical preferences. Research within this field has thus explored alternative ethical objectives, including so far: libertarianism, equality of opportunity, poverty alleviation, or Rawlsian principles amongst others (Fleurbaey and Maniquet 2011; Gaertner and Schokkaert 2012).

A recent statistical development involves the creation of intra-temporal carbon footprint distributions, as exemplified in the international review by Pottier (2022). These statistics have found application in international NGO campaigns aimed at bolstering support for environmental policies. Could these campaigns signify the emergence of novel ethical preferences, – an aversion to intra-temporal carbon footprint inequality? And might such preferences be associated with support for non-linear carbon taxes and individual carbon caps?

To explore these questions, we analyze a survey of 1,510 adults representative of the French population conducted in December 2022. This paper shows for the first time the support for non-linear carbon taxes and individual caps. It demonstrates the connection between this support and aversion to intratemporal carbon footprint inequality, suggesting a future surge in support.

This paper makes three main contributions.

First, it thoroughly demonstrates strong support for progressive carbon taxes. Specifically, it reveals significant backing for progressive carbon taxes imposed on immediately implementable tax bases, such as gas, flights, and potentially fuels. This support exceeds that for linear carbon taxes, even when revenues are redistributed to those most affected by the tax, across all carbon tax bases. Additionally, our findings reveal substantial support for individual flight caps. Next, we investigate specific implementation options that could influence support for a prospective progressive carbon tax. Our survey demonstrates that respondents favor government calculations of individual carbon footprints. They also emphasize the importance of data privacy guarantees. Furthermore, respondents express a preference for a more progressive income

tax schedule. Considering these preferences, along with their favored carbon footprint definition, respondents endorse a progressive carbon tax as well as individual footprint caps.

Second, this paper examines the preferred footprint definition to be used in an individual carbon tax. Respondents wish to account for emissions associated with wealth, financial, and, to a lesser extent, labor income in the carbon footprint used as a potential basis for an individual carbon tax. These preferences can significantly inform the choice of the carbon footprint definition used in national statistics or individual carbon footprint calculators. Initially, the term 'footprint' denoted the amount of resources required to sustain all social and economic activities of an entity, be it a city, a country, or an individual (Wackernagel and Rees 1996).[2] Until recently, estimates of household or individual carbon footprints solely relied on consumption-based accounting. However, recent studies have extended carbon footprint distributions to include labor and capital revenues (Pottier Le Treut 2023) as well as wealth (Rehm and Chancel 2022). This raises a crucial question: Should emissions linked to labor and capital revenues, or wealth, be integrated into an individual's footprint? If so, should they be aggregated on par with consumption-based emissions? This article attempts for the first time to provide an answer to these questions by eliciting people's preferences.

Third, we present how support for progressive carbon taxes and individual caps is influenced by ecologearian social welfare preferences. These preferences, introduced in this paper, reflect an aversion to intra-temporal footprint inequality. To formally define these preferences, we use generalized marginal social welfare weights from (Saez Stancheva 2016). Expanding upon the multiple income taxation model from (Mirrlees 1976, Spiritus et al. 2023) to include externalities, we demonstrate how ecologearian preferences increase the case for a progressive carbon tax reform. Respondents exhibit ecologearian, rather than utilitarian, preferences when placed in the role of a concerned or impartial observer à la Smith. Consistent with ecologearian preferences, information on intra-temporal footprint inequality, derived from recent statistics and media campaigns, bolsters support for progressive carbon taxes. In contrast, support for progressive gas taxes does not increase, when awareness of European gas scarcity following the Ukraine war, is raised.

Examining policy support for non-linear carbon taxes and individual carbon caps is important as these proposals are gaining momentum worldwide,

[2](Wackernagel and Rees 1996) introduced the ecological footprint concept, representing the total area required for such support. This concept was later expanded to other footprint types ((Vanham et al. 2019)), including the carbon footprint.

driven by policymakers[3] and academics (Chancel and Piketty 2015, Piketty 2019, Chancel 2021, Rehm and Chancel 2022). Another notable trend involves the rapid advancement of individual carbon footprint accounting, with user-friendly calculators flourishing[4] and some applications even utilizing individuals' banking transactions for greater granularity.[5] The convergence of these trends regarding non-linear carbon taxes—popularity, political and academic support, fairness, and theoretical arguments, along with new individual data—draws parallels to historical developments in taxation. Indeed, support, fairness, efficiency arguments, and improved administrative data led to the introduction of income taxes at the turn of the 20th century (Ardant 1971, Webber and Wildavsky 1986). Therefore, could a progressive carbon tax mark the next milestone in taxation history? If so, it is important to study the preferred implementation of such a future policy, including, for instance, considerations of confidentiality and the actors involved in individual footprint calculation. This will enable us to maximize its support from the start and guide public and private initiatives in line with these preferences.

Literature review

This paper contributes to several literature strands.

First, this paper extends the economic literature analyzing preferences concerning non-linear tax schedules for income and wealth. (Fisman et al. 2020, Stancheva 2021, Boyer et al. 2022) provide recent reviews of key papers in this literature. Our treatment draws on (Sides 2011, Cruces, Perez-Truglia and Tetaz 2013, Kuziemko et al. 2015) who find that displaying income or wealth distributions influences redistributive preferences. Using a sociological approach, (Spire 2018) extensively examines French perspectives on tax fairness.

Second, this paper adds to the burgeoning literature investigating carbon tax support by examining for the first time a non-linear carbon tax. These studies have established that carbon tax support is positively correlated with,– or caused by (Douenne and Fabre 2019)–, with perceptions of self-interest,

[3]The Netherlands levies a non-linear energy tax based on an individual's domestic consumption of electricity and gas. Amendments have also been proposed in the French Parliament to create an individual "green wealth tax". Norwegian and French lawmakers have been crafting bills to create individual flight limits.

[4]They can stem from the public sector at the national, –e.g: the EPA calculator in the US –, and even international level. The European commission and the UN are now sponsoring a footprint calculator for citizens in Europe and all over the world respectively

[5]Such as the calculators of the private firms Carbo and Greenly in France.

emission reduction efficiency, fairness, and trust in the government. (Sommer Mattauch and Pahle 2022) is most closely related to our study. They explore the link between fairness preferences and various forms of (linear) carbon tax revenue recycling.

Third, this paper builds upon a theoretical literature studying optimal tax and transfer schemes to correct externalities starting with the seminal work of (Pigou 1920) and (Sandmo 1975). It includes key contributions such as (Bovenberg and van der Ploeg 1994; Cremer, Gahvari, and Ladoux 1998, 2003; Jacobs and de Mooij 2015) who derive second-best taxes on externality-creating commodities in order to maximize social welfare.

Fourth, this paper bridges the gap between the literature examining preferences for the distribution of natural resources at the micro-level of a common pool resource (Ostrom et al. 1994; Ostrom et al., 2002) and at the international level of COP climate negotiations. Both of these bodies of literature allude to the presence of ecologearian preferences. We address this gap by inquiring about respondents' preferences for natural resource distribution at the national level. Consequently, we can assess national support for ecologearian justice principles debated in international climate negotiations (Pottier et al. 2017), such as per capita emission caps for countries.[6]

Lastly, this paper provides a novel setting to develop and test social justice theories based on resource allocation. Indeed, (Rawls 1971, 1982; Sen 1992 and Dworkin 2000),argued that social justice deals primarily with the distribution of resources and means of flourishing (including personal characteristics that may be registered as internal resources) rather than the distribution of subjective satisfaction. In parallel and drawing on these principles, the theory of fair allocation, pioneered by (Kolm 1968, 1972) and (Varian 1974) involves fairness principles about resource allocation rather than interpersonal comparisons of utility, while looking for ways of allocating resources that are efficient in the sense of Pareto (for a survey, we refer to (Thomson 2010) and (Fleurbaey Maniquet 2011).[7]

The paper is organized as follows. Section 2 describes the survey, data col-

[6]Comprehensive reviews of the international climate justice landscape are available in works like (Okereke 2010; Moellendorf 2012; Stern 2014a,b; Godard 2017).

[7]This paper could also shed a new light on the debate on green carbon tax reform double dividend, by considering social welfare objectives that reflect aversion to carbon footprint inequality. This literature explores whether an increase in pollution taxes, coupled with a reduction in distortionary labor taxes funded by the proceeds, can enhance both environmental and non-environmental welfare. This topic has been extensively reviewed by scholars such as (Goulder 1995, Bovenberg 1999, Sandmo 2000, Schöb 2003). More recent contributions can be found in (Chiroleu-Assouline and Fodha 2014; Williams et al. 2015).

lection, and final sample. Section 3 shows the support for non-linear carbon taxes and individual caps in comparison to linear carbon taxes. It studies carbon footprint tax bases that are immediately implementable or that could be implemented in the future given sufficient carbon accounting progress. This section also elicits respondents' preferred carbon footprint definition. Section 4 presents the model. It formally introduces ecologearian preferences and their link with support for non-linear carbon taxes and individual caps. Section 5 demonstrates that respondents have ecologearian rather than utilitarian preferences. It also showcases that information on carbon footprint inequality increases progressive carbon tax support. Section 6 concludes.

2 Survey design and data

2.1 Survey presentation

2.1.1 Survey outline

The survey structure and order are presented in Figure 1. Respondents have to answer all questions on a given questionnaire page in any order before they can go to the next page. However, once completed, they cannot go back to a previous page. The questionnaire parts relevant to this paper are given in the Appendix A.

2.1.2 Random treatment groups

We compare the impact of media campaigns raising awareness about carbon footprint inequality and of the 2022/2023 European gas scarcity on non-linear carbon tax support. Therefore, the respondents are randomly split into three groups: the control, greenhouse gas (GHG) distribution, and gas scarcity information treatment groups. The control and GHG distribution treatment groups are similar except for additional information given interactively to the latter group.

2.1.2.1 Greenhouse Gas (GHG) distribution treatment The GHG distribution group is given additional information regarding intratemporal GHG emission inequalities and the consequences of high GHG emissions (see A.4). This information is similar to campaigns initiated and conducted by Greenpeace and Oxfam in France (Oxfam 2015, Greenpeace 2020, Greenpeace, Oxfam 2022).

First, it consists of facts about the consequences of +2°C vs. +1.5°C global warming. Second, respondents are asked about the maximum average GHG emissions per capita required to stay within the +1.5°C limit. Once answered, the correct answer is interactively displayed. Finally, information is shown about French carbon footprint inequality, both in terms of consumption and wealth (Oxfam 2022, Burq Chancel 2021). To make this last information more salient, respondents are immediately asked whether they would be in favor of policies decreasing the carbon footprint inequality. This, even if it would neither decrease the total amount of GHG emitted globally nor change the French income and wealth distribution. The impact of such information is of interest as such information campaigns will likely become more widespread in the future given the increasing carbon footprint inequality data availability.

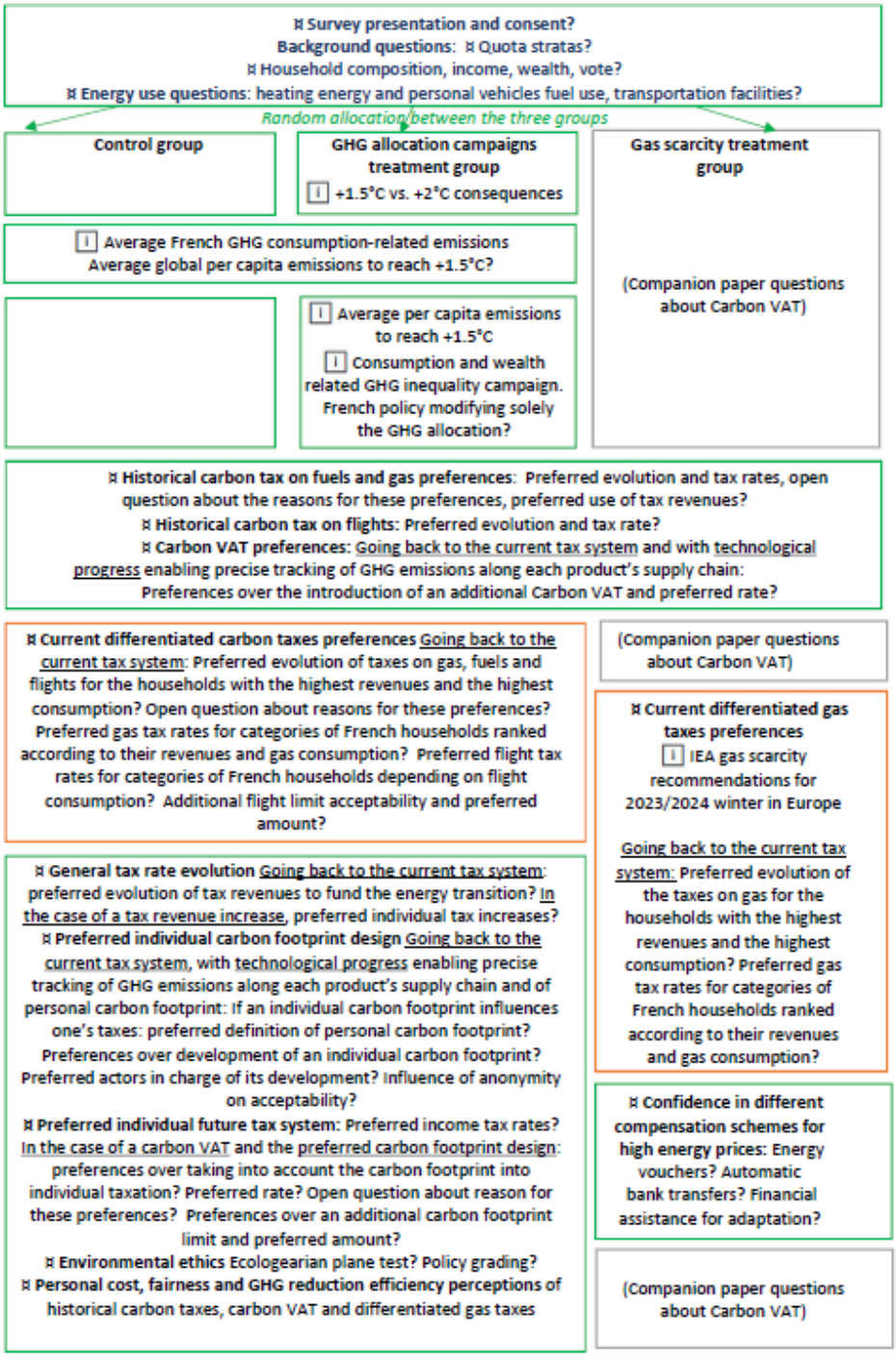


Figure 1: Survey outline

Notes ¤ This symbol indicates a new questionnaire page. Information stickers represent information given to respondents. The rest of the text with question marks at the end summarizes questions asked to respondents

2.1.2.2 Gas scarcity treatment group We study the impact of the expected 2022/2023 winter European gas scarcity on non-linear gas tax support. Thus, in this group, an International Energy Agency(IEA) recommendation to decrease European and French gas consumption by 13% during the 2022/2023 winter immediately precedes the non-linear gas questions common to all respondents (see (A.12)). The communication warns about the coming European gas scarcity in the winter of 2023/2024 triggered by the Ukraine war as a basis for this recommendation. It was issued shortly before the survey launch.

Other than that, many questions in the Gas scarcity group are identical to the two other groups. This includes questions about background, energy use, preferences for historical carbon taxes, and carbon VAT. There are also identical questions about non-linear gas taxes. Questions regarding perceptions of various compensation schemes for high energy prices are also asked for this group only (see A.13). The remaining answers for this group are analyzed in a companion paper and focus on carbon VAT (du Marais Guille L'Heudé 2023).

2.2 Data Collection, data quality and final sample

2.2.1 Data collection

The data come from a survey, conducted between December 2 and December 31, 2022 on French residents over 18 years of age. The survey was designed using the online platform Limesurvey. Participants were enrolled by the commercial survey company Bilendi-Respondi and received survey links via a dashboard and email.

2.2.2 Ensuring data quality

To improve data quality, two attention checks to detect and automatically exclude inattentive respondents were included. This is recommended in (Stantcheva 2022). The most stringent test is as follows. In the control and GHG distribution groups, respondents were given information about the yearly average GHG emitted by the production of all goods and services consumed by a French person towards the beginning of the survey. Respondents were then asked to provide the exact same information towards the end of the survey and right before questions about the preferred individual carbon footprint tax depending on GHG emissions. This enabled analyzing only the answers of respondents who were both attentive and aware of a French carbon footprint order of magnitude.

To improve data quality, 12 semi-directed interviews were also conducted in

addition to the test version of the survey on 10% of the sample. [8] Confidentiality concerns, mentioned in all semi-directed interviews, were thus uncovered. Therefore, corresponding questions were subsequently added to the survey.

Online Appendix C describes additional ex-ante and ex-post methods used in the survey to ensure quality responses.

2.2.3 Final sample characteristics

The final sample of 1510 respondents is close to representative of the French population along many dimensions. This is true by construction for the targeted dimensions of gender, region, age, urban area size and socio-professional category (see Table 7 in Appendix A.3) The final sample is also broadly representative on non-targeted dimensions such as energy use and household revenue by consumption unit (see Table 8 in AppendixA.3). Importantly, the sample is also representative along the voting patterns of the 2022 presidential election.

The median time for completion of the survey for the control and the GHG distribution treatment groups was 26.6 minutes. Online Appendix C shows the distribution of time spent on the survey.

3 Support for progressive carbon taxes and individual caps, implementable today or in the future

Unlike linear carbon taxes, respondents support progressive carbon taxes that could be immediately implementable or that could be levied in the future, given sufficient carbon accounting progress.

In this section, if not specified otherwise, results will be computed only for respondents in the control or greenhouse gas (GHG) distribution groups. Analyses focus on the median for policies that could be implemented now or in the future. Indeed, according to the median voter theorem the median rate would be chosen in case of a vote.

[8] Semi-directed interviews are recommended in the sociology survey literature (Parizot 2012 and Barbot 2012) to prepare the survey

3.1 The baseline: a low support for linear carbon taxes and Carbon VAT

A majority of respondents wish to decrease carbon taxes. This is true for fuels (56%), gas and heating oil (53%) and 61% are against the introduction of an additional carbon VAT (see Figure 2). The only exception is the tax on aviation fuels, as 55% wish to increase it. Consistently, the median of the preferred carbon taxes is negative on fuels (-0.1€/L), equal to 0 on gas and additional Carbon VAT but positive on aviation fuels (2€/flight hour) (see Table 1). Appendix A.2.1 motivates through recent political and social developments, the choice of asking respondents about decreasing carbon taxes. Indeed, the carbon tax acceptability literature mostly focuses on tax increase preferences.

Respondents' rejection of linear carbon taxes, – except for plane fuel taxes– , provides a useful benchmark for non-linear carbon tax acceptability. Indeed, the literature on carbon tax acceptability has focused on linear carbon taxes so far. For all these linear tax modifications, it is specified that all additional tax revenues stemming from a tax increase would be redistributed to the households most affected by these taxes. Indeed, this is one of the two most popular earmarking schemes according to the carbon tax acceptability literature. This low support is consistent with the literature and current political developments (see A.2.1). It shows that the low support for linear carbon taxes is more than ever a topical issue and calls for alternative policies.

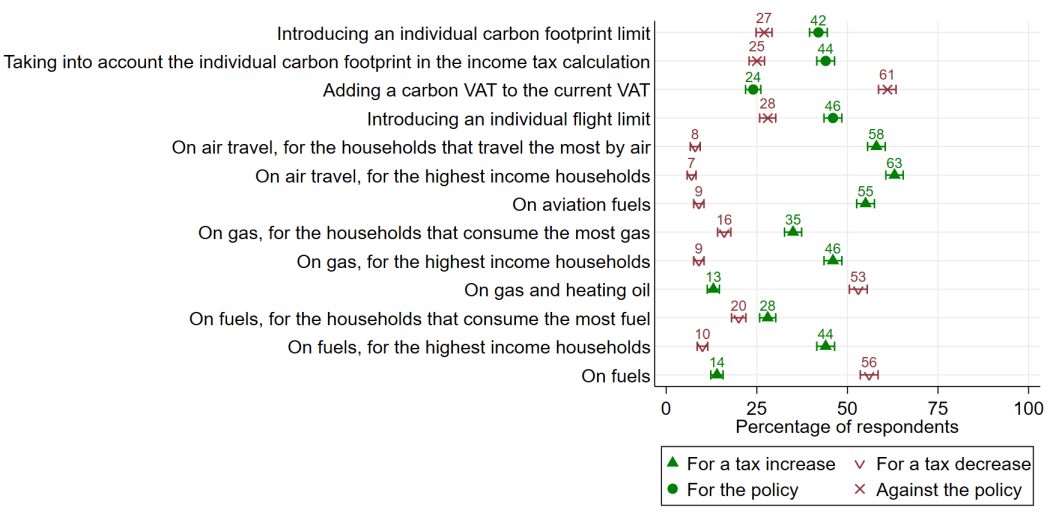


Figure 2: Preferred tax modifications or policy introductions

Notes Starting from the current tax system, questions about linear carbon tax modifications,–on gas, fuel, flights– were asked. Going back to the current tax system, respondents gave their opinion about an additional carbon VAT. Starting from the current situation again, questions about non-linear carbon tax modification –on gas, fuel and flights– were then given. Respondents were also asked about an individual flight limit in addition to their preferred non-linear flight tax rate. Finally, the support for an individual carbon footprint limit was tested in addition to the respondents' preferrednon-linear income/carbon tax system. For all linear taxes – on gas, fuel, flights or for a carbon VAT–, additional revenues would be redistributed to the most affected. For all non-linear carbon taxes implementable today – on gas, fuel and flights–, additional revenues would be uniformly redistributed. Given the respondents' preferred income tax rate, it is specified that thenon-linear carbon/income tax rate would not increase the overall individual tax level. Responses take into account the control and GHG distribution groups.

Table 1. PREFERRED LINEAR CARBON TAX CHANGES

	Median	*25th percentile*	*75th percentile*	**Mean**	*10% confidence interval*
On fuels (in €/L)	**-.1**	*-.5*	*0*	-.84	*.45*
On gas (in % of gas price)	**0**	*-15*	*0*	-6.7	*1.33*
On aviation fuel (in €/flight hour)	**2**	*0*	*10*	24.69	*4.96*
On Carbon VAT (in % of the price of goods and services on average)	**0**	*0*	*0*	.87	*.21*

3.2 Supporting immediately implementable progressive carbon taxes and individual caps

Respondents support progressive carbon taxes which we argue, could be implemented immediately. This support for progressive energy taxes is especially strong along the income rather than the energy consumption dimension. To disentangle linear from non-linear carbon tax preferences, on the next questionnaire page, s about current non-linear carbon taxes (A.8), it is first specified that respondents go back to the current situation, with the current French tax system, without taking into account their previous choices.

On which tax bases could a non-linear carbon tax be immediately implemented? The first condition to set up a non-linear taxation on a good, is that the good should be non-transferrable. The second condition is that the GHG emissions resulting from its consumption could be estimated. Finally, as the model showed, its carbon footprint of that good should be significant enough. Therefore, preferences for non-linear taxes on gas, fuel and flights for private use are studied. First, flights and gas consumption are both hardly transferable as of today. Second the carbon footprint of fuel, gas or plane is also relatively easy to estimate. [9] Finally, in 2019, fuel for personal vehicles is estimated to be on average, the largest source of GHG emissions stemming

[9]Indeed, most of the GHG emitted through their consumption are emitted directly where the consumption takes place. Therefore, it does not require tracking and conducting estimations on the whole value chain. One can however note the current uncertainty surrounding the climate consequences of flying associated with condensation formation which could go as far as doubling its previously estimated footprint (Kärcher 2018).

from a French person's consumption (21%) while gas and heating oil consumption is estimated to be its second-largest source (12%) (Malliet et al. 2019, Pottier et al. 2020). Flights are also estimated to be among the top sources of these GHG emissions, – they represent 4% of an individual's total emissions on average–, (SDES 2022).

Increasing energy taxes on the highest-energy consumption and especially highest-income households Increasing energy taxes on the highest-income households or on those who consume the most, is significantly more popular than their linear carbon tax counterparts. This is true for any of the immediately implementable non-linear carbon tax bases (fuel, gas or heating oil and aviation fuel) (see Figure 2 and questions A.8). Remarkably, it is specified that the additional non-linear tax revenues would be uniformly redistributed. In comparison, the additional linear tax revenues would be redistributed progressively, i.e to the households most affected by the tax increase.

Furthermore, increasing energy taxes on the highest-income households is more popular than on those with the highest consumption. This is true for each of these non-linear carbon tax bases. Thus, close to majority support increasing energy taxes on the highest-income households (44% for fuel, and 46 % for gas and heating oil). Support is even higher for aviation fuels (63%). In comparison, respondents in favor of increasing taxes on the households with the highest energy consumption are still far from the majority (28% for fuel, and 35 % for gas and heating oil). The only exception is aviation fuels which still enjoys a majority support (58%).

Supporting progressive gas and flight taxes along the consumption and especially income dimensions Respondents support strictly increasing gas taxes from one tax bracket to the next, both along the gas consumption and especially the revenue dimension (see Figure 3a). Indeed, the gas tax rate is significantly more progressive along the income than gas consumption dimension. The median tax preference increases[10] from 10% of the gas bill for the bottom 50% of households in terms of gas consumption, to a median of 22% for the top 10% of gas consumers. Similarly, the median tax preference goes from 10% of the gas bill for the 50% lowest income households, to a median of 30% for the 10% highest income households. This is consistent with a higher support for increasing taxes on the highest-income

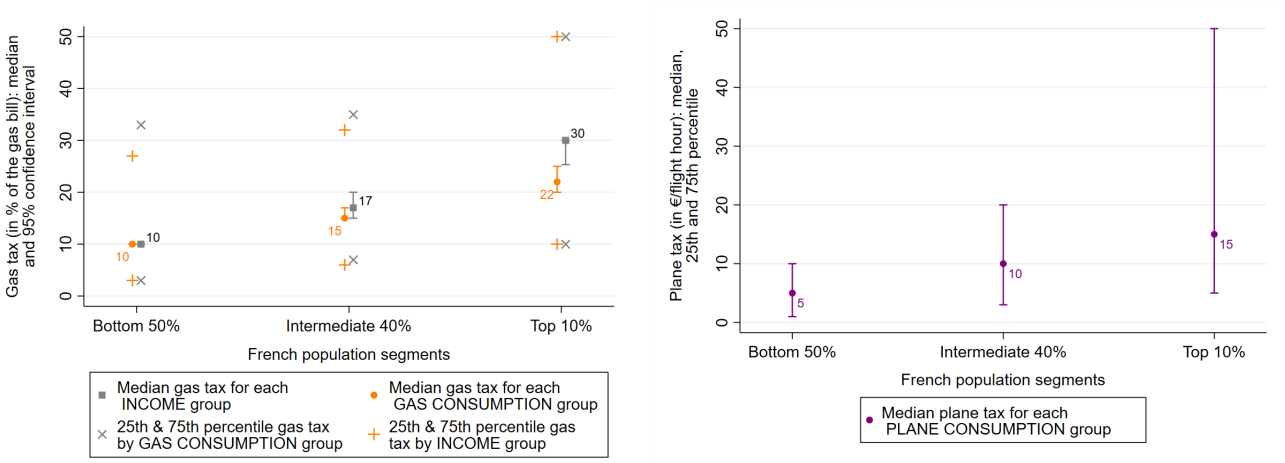
[10]We use 95% confidence intervals for medians using a binomial distribution as in (Mood and Graybill 1963)

households than on those with the highest gas consumption described in the former paragraph.

Respondents also support strictly increasing flight taxes along the flight consumption dimension. Indeed, Figure 3b shows that the median tax preference goes from €5 /equivalent flight hours for the bottom 50% of households in terms of equivalent flight hours , to a median of €15/equivalent flight hours for the top 10% of flight consumers. We use equivalent flight hours as it is specified that one hour of private jet flight amounts to 10 hours of flying with commercial airplane. Using equivalent flight hours is both coherent physically and enables to contribute to the worldwide ecologearian debate regarding private jets, as outlined in A.2.2.

Finally, the median of the preferred non-linear tax rate is remarkably higher than the median of the preferred linear tax rate for any consumption segments. This is true for both gas and flights. Indeed, even for the bottom 50% in terms of consumption or income, the median of the preferred non-linear tax rate is higher than its non-linear tax rate.

Individual flight hour caps Close to a majority (46%) is in favor of introducing an individual flight cap, in addition to the non-linear plane tax schedule they previously answered (see Figure 2 and question A.6). In comparison, only (28%) are against it. The rest is indifferent. This provides evidence that close to a majority of respondents have ecologearian satiated preferences and thus ecologearian preferences as defined in section 4.2. The median flight limit, — calculated over the respondents who are in favor of such a measure—, is 30 equivalent flight hours/year (see Table 2).



(a) Gas (b) Flight

Figure 3: Preferred immediately non-linear carbon tax schedules that could be immediately implemented

Notes (Mood and Graybill 1963) median standard errors. Respondents go back to the current situation (with the current French tax system), without taking into account their previous linear carbon tax preferences before expressing their non-linear carbon tax preferences. Additional tax revenues are uniformly redistributed.

Table 2. PREFERRED INDIVIDUAL FLIGHT CAP (IN EQUIVALENT FLIGHT HOURS)

Median	Mean	*25th percentile*	*75th percentile*
30	38.89	*10*	*50*

Notes. The results are expressed in equivalent flight hours. Indeed, the question specifies that one hour of flight using a private jet emits as much as a 10 hour flight with a commercial airline. The results were calculated only taking into account the respondents in favor of introducing an individual flight hour limit in addition to an individual non-linear plane tax.

3.3 Support for a future progressive income/carbon tax design

Respondents are shown to support a progressive income/carbon tax design, in a future where it would be technologically feasible. To do so, we first carefully elicit concretenon-linear income/carbon tax implementation preferences, – carbon footprint definition, confidentiality guarantee, and preferred income

tax–, through the survey design. [11] Indeed, semi-directed interviews showed that uncertainty regarding its concrete implementation influence the respondents' support of this novel policy. Furthermore, knowing people's preferences for anon-linear income/carbon tax gives the opportunity to design this policy according to these preferences from the start and thus maximize its support.

3.3.1 What carbon footprint definition?

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A majority supports (labor or financial) income-based and wealth carbon footprint accounting (see Figure 5). For each of these emissions, there is no majority against taking them into account in the carbon footprint. There is a clear majority (56%) for accounting partially or totally for the emissions linked with an individual's financial income, — e.g emissions from companies for which an individual receives dividends or income from saving products or emissions from housing for which the individual receives rent—. There is also a majority (52%) in favor of counting the emissions associated with a person's wealth, — e.g emissions from companies in which individuals has shares even if they do not pay dividends–. Meanwhile, 42% are for accounting partially or totally for the emissions of the company in which someone works. This is twice more than the 21% against it.

However, whether, it is for labor and financial revenue or wealth, more people are in favor of taking into account the emissions from these activities partially rather than totally. The ratio of people in favor of taking into account these emissions partially over people in favor of taking them fully into account is the highest for labor revenues. This could reflect a perception that people have less leverage over their work than about their financial revenues or wealth. This would confirm the carbon footprint responsibility principle.

On the other hand, a majority opposes accounting for emissions associated with essential consumption in the absence of alternatives. Indeed, 61% are against taking into account emissions from the production of services and goods specific for people with disabilities. 60% are against taking into account GHG emitted from commuting to work and running essential errands for people living in areas without access to public transportation. 55% are against accounting for emissions produced by the heating of people who don't have the financial means to renovate their homes.

[11] Respondents elicit their preferences regarding the concrete implementation of individual carbon footprint calculation on questionnaire page A.10 before giving their preferrednon-linear income/carbon tax preferences on page A.11.

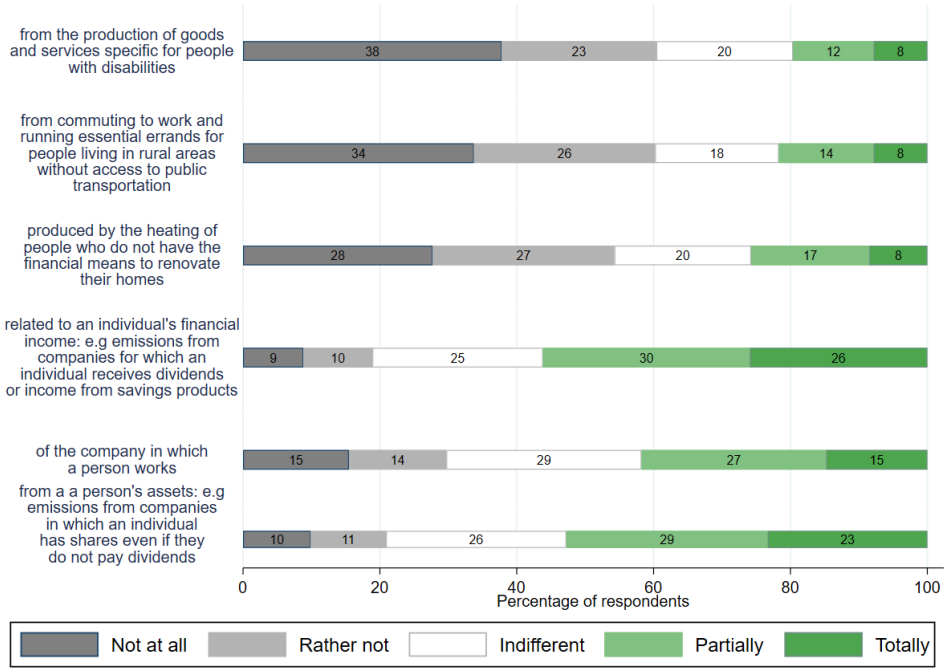


Figure 5: Preferred carbon footprint tax basis

Respondents answered: "Let's imagine that the government decides that the income tax depends in part on the individual carbon footprint. According to you, which emissions should be included in this carbon footprint? The emissions..."

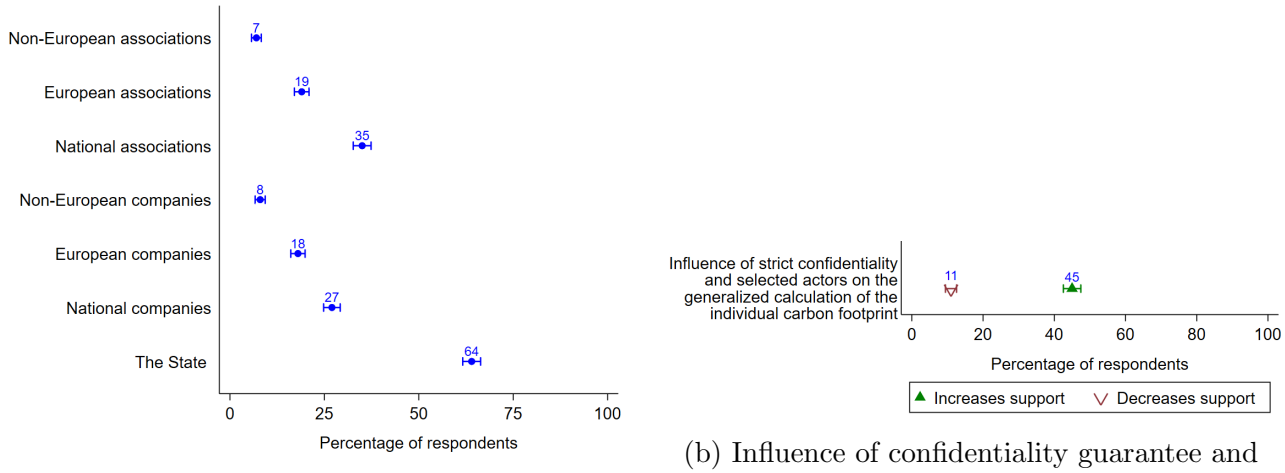
We propose a methodology in A.1 to construct an individual carbon footprint by aggregating the footprints stemming from different activities, – consumption, income etc.–, using stated preferences We construct an aggregate carbon footprint that could be used for a future individual carbon tax basis but also for voluntary footprint calculators. Indeed, people may voluntarily calculate and decrease their footprint, bearing in mind that it might be the basis of a future individual tax. Finally, we show that 50% are in favor of calculating, for each individual, the footprint they chose and gradually improving its precision.

3.3.2 Confidentiality guarantee and specific implementing actors influence the support for individual footprint calculation

Concern about the use of personal data and confidentiality arose in every preparatory semi-directed interview, when mentioning individual carbon taxation. Indeed, without deliberate precautions regarding confidentiality, the

actors in charge of computing the individual footprint could have access for the first time to detailed personal data about consumption, labor income, and financial assets all at once.

Therefore, respondents prefer by far entrusting the State (64%), then French associations (35%), followed by French companies (27%) with implementing and improving personal carbon footprint calculation. (see Figure 6a). Furthermore, for 45% of the respondents, ensuring that the framework calculating individual carbon footprint guarantees personal data privacy and is operated by the actors they previously chose increases their support for a generalized individual carbon footprint calculation (Figure 6b). This is noteworthy as the finest-grained individual carbon footprint calculators initiatives in France are currently privately led and provide heterogeneous data privacy guarantee.



(a) Preferred actors in charge of individual carbon footprint calculation

(b) Influence of confidentiality guarantee and selected actors on individual carbon footprint calculation support

Figure 6: Preferences regarding individual carbon footprint calculation

Notes Respondents answered question 61 for Figure 6a and question 62 for Figure 6b

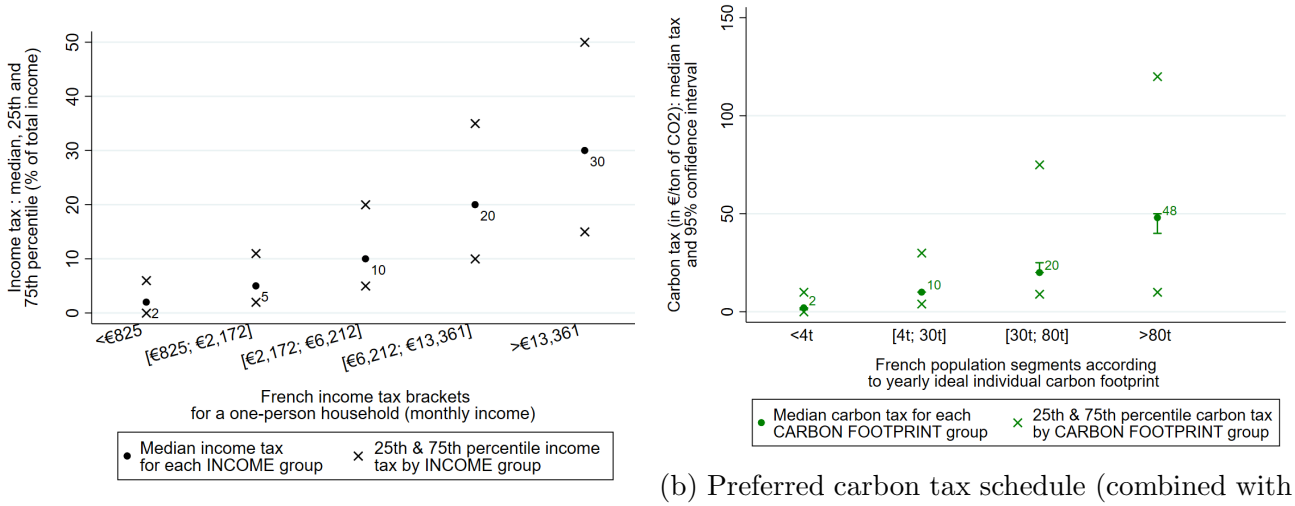
3.3.3 Controlling for more progressive income tax preferences

Testing the support for increasing the carbon tax along the footprint distribution requires disentangling preferences for a more progressive income tax. Indeed, respondents may accurately perceive income to be positively correlated with individual carbon footprint. If the actual income tax is less progressive than their preferences, they may then use the individual carbon tax as an

income tax proxy. Therefore, on the next questionnaire page (A.11), respondents first determine their preferred income tax before choosing their preferred individual carbon tax schedule. It is again specified that this part of the survey goes back to the current situation, with the current French tax system, without taking into account the respondents' previous tax choices.

Supporting a more progressive income tax schedule The median preferred income tax schedule is indeed more progressive than the effective income tax schedule in France (Figure 8a). Indeed, the median income tax as a percentage of the revenue goes from 2 % for the first income tax bracket to 30% for the top income bracket. By comparison, the effective tax rate went from around 7% to about 20% in 2018 (Bozio et al. 2018). Income tax brackets are expressed in average monthly revenue for a single adult with no children or disability. Preferences for income tax are expressed as average tax paid over income instead of marginal tax rates. Indeed, (Rees-Jones and Taubinsky 2019) amongst others, found evidence of widespread reliance on "ironing" heuristic, which linearizes the tax schedule using one's average tax rate. [12]

[12]Expressing preferences over average income tax rates, also enables a consistent framework with the previous non-linear energy taxes. It also facilitates a comparison with the current effective tax rates.



(a) Preferred income tax

(b) Preferred carbon tax schedule (combined with the previously selected income tax)

Figure 8: Preferred future individual income/carbon tax schedule

Notes (Mood and Graybill 1963) median standard errors. Respondents are first asked about their preferred income tax schedule (Figure 8a, then about having the income tax rate depend in part on the individual carbon footprint without increasing individual taxes overall. The respondents who are not against this latter proposal, are then asked about their preferred individual carbon tax schedule (Figure 8b

3.3.4 Support for a progressive individual carbon tax and footprint cap

Support for anon-linear income/carbon tax Close to a majority (44%) is in favor of having the income tax rate depend in part on the individual carbon footprint without increasing individual taxes overall. In comparison, only 25% are against it. The rest is indifferent. It is specified in the question 65 that their definition of an individual carbon footprint is used and calculated by their preferred actor (outlined in 3.3.1). It is also mentioned that thanks to technological progress, the government has put in place a Carbon VAT that depends on greenhouse gases emitted throughout the production of each good and service. This enables disentangling preferences for an individual carbon taxation from the Carbon VAT Pigouvian motive and from the improvement in carbon accounting along the value chain that would accompany a carbon VAT. Finally, they are told that the income tax is the one they chose in the previous question.

Support for a progressive individual carbon tax schedule Respon-

dents are in favor of strictly increasing[13] individual carbon taxes from one emission bracket to the next (see Figure 8b). Indeed, the median tax goes from €2/tCO2 for the lowest emission group to €47.5/tCO2 for the highest emission group. This carbon tax schedule is asked to respondents that are not against having the income tax rate depend in part on the individual carbon footprint. It is asked immediately asked after this sorting question.

Support for individual carbon footprint caps 42% support introducing an individual carbon footprint limit in addition to the individual income and carbon taxes that they just chose, while only 27% are against it (See Figure 2 and question 68). The rest is indifferent. This provides again evidence of respondents having ecologearian satiated preferences as defined in section 4.2. It is of the same order of magnitude as the support for introducing individual plane limits. The yearly median carbon footprint limit is 8 tons of CO2 per capita (Table 3).

Table 3. PREFERRED INDIVIDUAL CARBON FOOTPRINT CAP (IN CO2 TON)

Median	Mean	*25th percentile*	*75th percentile*
8	40.61	*5*	*10*

Notes. The carbon footprint definition used here is the one that the respondent chose previously in 3.3.1 and used for questions about anon-linear taxation. The results only take into account the fraction of respondents who were for introducing an individual carbon footprint limit in addition to individual income and carbon taxes.

4 Model : Ecologearian objectives and non-linear income/carbon tax reform

To express social welfare preference alternatives to utilitarian ones, this section uses generalized marginal social welfare weights, similar to (Saez Stantcheva 2016). We use these weights to introduce ecologearian preferences. These preferences are shown to increase the case for progressive income/carbon tax reform.

The economy consists of a unit mass of taxpayers who differ in a k-dimensional vector of characteristics denoted $\boldsymbol{\theta} \equiv (\theta_1, ..., \theta_k)$. We refer to the complete vector of characteristics of a taxpayer as her type. Types are

[13] using (Mood and Graybill 1963) median standard errors

drawn from the type space, which is denoted $\Theta \subset \mathbb{R}^k$ and is assumed to be closed and convex. Types are distributed over the type space according to a twice continuously differentiable probability density function $f(\boldsymbol{\theta})$, and the corresponding cumulative distribution function $F(\boldsymbol{\theta})$ over Θ.

A consumer chooses consumption of a good γ representative of goods and services that are both non-transferable and whose environmental footprint we can estimate precisely. An amount γ of this good has a carbon footprint which we note γ as well. A consumer also chooses the amount of consumption m of all remaining goods and services whose footprint is not easily estimated. We assign to the amount of good m a (roughly estimated) overall environmental footprint equal to m. A consumer chooses her labor income, z. She is faced with price p for good γ. p is normalized without loss of generality such that the price of m is equal to one. We define $\gamma^+ = \gamma + m$, as the total amount of pollution stemming from the consumer's consumption. An individual derives a private utility from consumption m and γ while incurring disutility from earning labor income $z \geq 0$:

$$U^p(m, \gamma, z, \boldsymbol{\theta}) \equiv m + \psi(\gamma, z, \boldsymbol{\theta})$$

ψ and U^p are thrice continuously differentiable. $U^p_m > 0$, $U^p_\gamma > 0$, $U^p_z < 0$, and $U^p_{\theta_k} > 0, \forall \theta_k \in \Theta$. ψ is convex in (γ, z).

$T(\boldsymbol{y})$ is the tax set by the government as a function of variables in the set $\boldsymbol{y} = \gamma, z. This includes the case where \mathrm{T}(\boldsymbol{y}) = \mathrm{T}(\gamma, z)$ is a non-linear function of two tax bases: an income tax basis z and the carbon footprint tax basis γ. We define the perturbed tax schedule in the direction $W(\boldsymbol{y})$ by magnitude t, – where t is close to 0 –, as: $\boldsymbol{y} \to T(\boldsymbol{y}) - tW(\boldsymbol{y})$. $T(\boldsymbol{y})$ follows the regularity assumptions from (Spiritus et al. 2023).

Therefore, a taxpayer of type $\boldsymbol{\theta}$ solves:

$$V^p(\boldsymbol{\theta}, t) \equiv max_{\gamma,z} U^p(z - T(\boldsymbol{y}) + tW(\boldsymbol{y}) - \gamma, \gamma, z; \boldsymbol{\theta}) \tag{1}$$

V^p is the maximum of the private utility. Because of the regularity assumptions regarding $T(y)$ and U^p, and the implicit function theorem, we can define the continuously differentiable functions $m(\boldsymbol{\theta}, t), \gamma(\boldsymbol{\theta}, t)$, and $z(\boldsymbol{\theta}, t)$ which solve (1). We define $\Omega \equiv \iint_{\boldsymbol{\Theta}} \gamma^+(\boldsymbol{\theta}, t) dF(\boldsymbol{\theta})$ the sum of all individual carbon emissions. We define the indirect utility of a taxpayer of type $\boldsymbol{\theta}$, as viewed by the planner, as:

$$V(\boldsymbol{\theta}, t) \equiv V^p(\boldsymbol{\theta}, t) - P(\Omega(t))$$

where P is strictly convex and continuously differentiable.

The government revenue is defined by : $R(t) \equiv \iint_{\boldsymbol{\Theta}} (T(\boldsymbol{y}(\boldsymbol{\theta}, \boldsymbol{t})) - tW(\boldsymbol{y}(\boldsymbol{\theta}, \boldsymbol{t})))dF(\boldsymbol{\theta})$ and the government welfarist objective is defined by :

$$O(t) \equiv \iint_{\boldsymbol{\Theta}} \Phi(V(\boldsymbol{y}(\boldsymbol{\theta}, \boldsymbol{t})))dF(\boldsymbol{\theta})$$

where Φ is a strictly increasing and strictly concave function.

Let there be a budget constant reform consisting in two perturbations $\mathscr{W}$ and $\mathcal{W}$ so that $\boldsymbol{y} \to T(\boldsymbol{y}) - t\mathscr{W}(\boldsymbol{y}) - t\mathcal{W}(\boldsymbol{y})$, this reform is desirable if :

$$\frac{\partial O^{\mathscr{W}+\mathcal{W}}}{\partial t} = \iint_{\boldsymbol{\Theta}} \Phi'(V) \frac{\partial V(\boldsymbol{y}(\boldsymbol{\theta}, t)}{\partial t} dF(\boldsymbol{\theta}) \geq 0 \tag{2}$$

As showed in (Spiritus et al. 2023), the effects of the perturbation $tW(\boldsymbol{y})$ can be decomposed into the effects of two types of prototypical tax reforms:

- a lump-sum perturbation which decreases the tax liability by a uniform amount. It is characterized by $tW(\boldsymbol{y}) = \rho$ so that $W(\boldsymbol{y}) = 1$

- compensated perturbations of the bth marginal tax rate τ_b evaluated at the solution of their maximization program $y_b(T)$. It is characterized by $tW(\boldsymbol{y}) = \tau_b(Y_b - y_b(\boldsymbol{\theta}))$, where Y_b denotes the variable in general. In this case, $W(\boldsymbol{y}) = (Y_b - y_b)$.

The change for taxpayer θ of any solution to the maximization program $x \in \boldsymbol{x} = \{m, c, z\}$ to an infinitesimal change t to the tax schedule can thus be decomposed as:

$$\frac{\partial x(\boldsymbol{\theta}, t)}{\partial t} = \frac{\partial x(\boldsymbol{\theta}, t)}{\partial \rho} W(\boldsymbol{y}) + \sum_{b: y_b \in \boldsymbol{y}} \frac{\partial x(\boldsymbol{\theta}, t)}{\partial \tau_b} W_{y_b}(\boldsymbol{y})$$

where $\partial x/\partial \rho$ and $\partial x/\partial \tau_b$ are the responses to, respectively, a lump-sum perturbation and to the compensated perturbation of the bth marginal tax rate τ_b.

4.1 Generalized Marginal Social Welfare Weight

For any individual of type $\boldsymbol{\theta}$, we define of a *generalized social marginal welfare weight* $g(\boldsymbol{\theta})$. We use the definition from (Saez Stantcheva 2016) of a money metric that measures how much society values a marginal lump sum monetary transfer to this individual

Definition 1 (Generalized Marginal social welfare weight) *The generalized marginal social welfare weight of an agent of type* $\boldsymbol{\theta}$ *is* $g(\boldsymbol{\theta}) = g(\boldsymbol{\theta}, x(\boldsymbol{\theta})) \geq$

0, *where g is a function of the agent's type and of the solution to her maximization problem* $x(\boldsymbol{\theta})$. $g(\boldsymbol{\theta})$ *is defined as* $g(\boldsymbol{\theta}) \equiv \hat{g(\boldsymbol{\theta})} / \iint_{\Theta} \hat{g(\boldsymbol{\theta})} dF(\boldsymbol{\theta})$, *where* $\hat{g(\boldsymbol{\theta})}$ *is an unnormalized generalized marginal social marginal welfare weight.*

As in (Saez Stantcheva 2016) the generalized marginal social are independent of the type of monetary transfer. The unnormalized weights $\hat{g(\boldsymbol{\theta})}$ have no constraints other than non-negativity and can therefore be easily estimated through a survey. By defining the weights $g(\boldsymbol{\theta})$ as the product of the empirically estimated weight $\hat{g(\boldsymbol{\theta})}$ and a constant, we get private marginal social welfare weights whose relative weights still depend solely on expressed preferences. Furthermore, this construction of $g(\boldsymbol{\theta})$ ensures the following equality:

Proposition 1 (Welfarist objective and generalized weights) *Let there be perturbed tax schedule* $\boldsymbol{y} \to T(\boldsymbol{y}) + tW(\boldsymbol{y})$. *For each type* $\boldsymbol{\theta}$, *we can define positive Pareto weights* $\pi(\boldsymbol{\theta})$, *so that the derivative of the government's objective function* $O(t)$ *equals:*

$$\iint_{\boldsymbol{\Theta}} \pi(\boldsymbol{\theta}) \Phi'(V) \frac{\partial V(\boldsymbol{y}(\boldsymbol{\theta}), t)}{\partial t} dF(\boldsymbol{\theta}) = \iint_{\boldsymbol{\Theta}} g(\boldsymbol{\theta}) W(\boldsymbol{y}(\boldsymbol{\theta})) dF(\boldsymbol{\theta}) - \frac{\partial P}{\partial t} \tag{3}$$

The proof is in Appendix B.1. In the case of strictly positive pareto weights and generalized marginal social welfare weights, a desirable budget constant tax reform is equivalent to the equation 3 being positive. It theweights are only positive, a desirable budget constant tax reform only implies that the equation 3 is positive.

4.2 Ecologearian generalized marginal social welfare weights

Ecologearian generalized marginal social welfare weights are introduced here. In the case of ecologearian weights, the social welfare decreases with a society's intratemporal carbon footprint inequality. This is because, ecologearian generalized marginal welfare weights decreases with an agent's footprint.

Ecologearian satiated marginal social welfare weights are also introduced here. This means that over a certain individual carbon footprint, these equal zero.

Definition 2 (Ecologearian preferences) *The generalized marginal social welfare weight of an individual of type* $\boldsymbol{\theta}$, $g(\boldsymbol{\theta})$*:*
- ***Utilitarian****:* $g(\boldsymbol{\theta}) = g(z(\boldsymbol{\theta})) > 0$, *g is strictly decreasing in* $z(\boldsymbol{\theta})$
- ***Ecologearian****:* $g(\boldsymbol{\theta}) = g(z(\boldsymbol{\theta}), \gamma(\boldsymbol{\theta})) > 0$, *g is strictly decreasing in* $z(\boldsymbol{\theta})$

and in $\gamma(\boldsymbol{\theta})$
• ***Strictly ecologearian****:* $g(\boldsymbol{\theta}) = g(\gamma(\boldsymbol{\theta})) > 0$*,* g *is strictly decreasing in* $\gamma(\boldsymbol{\theta})$
• ***Ecologearian satiated:*** $g(\boldsymbol{\theta}) = g(\gamma(\boldsymbol{\theta})) \geq 0$*,* $\exists \gamma^* > 0, \forall \gamma \geq \gamma^*, g(\gamma(\boldsymbol{\theta})) = 0$ *.* g *is strictly decreasing in* $\gamma(\boldsymbol{\theta})$*.*

Because of the quasilinearity of the private utility, each of these generalized marginal social welfare weights is also proportional to the partial derivative of the private utility with respect to the numéraire m ($V_m^p = 1$).

4.3 Ecologearian redistribution priority

Ecologearian redistribution priority is the difference for marginal social welfare of raising a homogenous lump sum tax on the top φ fraction of the γ distribution and the top φ fraction of the income distribution z. The following section will show how a positive ecologearian redistribution increases a progressive carbon tax reform desirability.

Definition 3 (Ecologearian redistribution priority) *Let* z^{φ} *be an income level and* γ^{φ} *a carbon footprint level so that* $\iint_{z(\boldsymbol{\theta})>z^{\varphi}} dF(\boldsymbol{\theta}) = \iint_{\gamma(\boldsymbol{\theta})>\gamma^{\varphi}} dF(\boldsymbol{\theta}) = \varphi$*. we define the ecologearian redistribution priority (relative to utilitarian redistribution) for the top* φ *as :*

$$E_{\varphi} = \iint_{z(\boldsymbol{\theta})>z^{\varphi}} g(x(\boldsymbol{\theta}), \boldsymbol{\theta}) dF(\boldsymbol{\theta}) - \iint_{\gamma(\boldsymbol{\theta})>\gamma^{\varphi}} g(x(\boldsymbol{\theta}), \boldsymbol{\theta}) dF(\boldsymbol{\theta}) \tag{4}$$

LEMMA: *In the case where* $\gamma(\boldsymbol{\theta})$ *is not a strictly increasing function of* $z(\boldsymbol{\theta})$ *and for any top fraction* $0 < \varphi < 100$ *of the population, :*
• *If the generalized marginal welfare weights are utilitarian, the ecologearian redistribution priority* E_{φ} *is strictly negative.*
• *If the generalized marginal welfare weights are strictly ecologearian, the ecologearian redistribution priority* E_{φ} *is strictly positive.*

4.4 Ecologearian preferences and progressive carbon tax desirability

This proposition gives conditions for a progressive carbon tax reform desirability. We show that it depends on the social welfare objectives and the carbon footprint definition.

Proposition 2 *Let there be a tax schedule* $\mathscr{T}(z)+\mathcal{T}(\gamma)$ *and a budget constant tax reform* $y \to \mathscr{T}(z) - t\mathscr{W}(z) + \mathcal{T}(\gamma) + t\mathcal{W}(\gamma) + l(t)$ *Consisting in:*

- a reform $\mathcal{W}(\gamma)$ which increases the marginal tax rate $\mathcal{W}_\gamma$ so that $\mathcal{W}_\gamma = -\kappa(\gamma)$[14] for individuals of type $\boldsymbol{\theta}$ in the small band where $\gamma^\varphi \leq \gamma(\boldsymbol{\theta}) \leq \gamma^\varphi + \epsilon$
- a reform $\mathscr{W}(z)$ which increases the marginal tax rate $\mathscr{W}_z$ so that $\mathscr{W}_z = \kappa(z)$ for individuals of type $\boldsymbol{\theta}$ in the small band where $z^\varphi \leq z(\boldsymbol{\theta}) \leq z^\varphi + \epsilon$
- a lump sum transfer $l(t)$ of the resulting net government revenue surplus to all individuals.

$\forall y \in \{\gamma, z\}$, $T(y) \in \{\mathcal{T}(\gamma), \mathscr{T}(z)\}$ and $W(y) \in \{\mathcal{W}(\gamma), \mathscr{W}(z)\}$, we note τ_y the compensated tax rate perturbation associated with $W_y(y)$ and $y^+ = \gamma + z$.

$\frac{\partial P^{W(y)}}{\tau_y}$ is the sum of the behavioral pollution $\frac{\partial \gamma^+(\boldsymbol{\theta})}{\partial \tau_y}$ for individuals $\boldsymbol{\theta}$, with $y^\varphi \leq y(\boldsymbol{\theta}) < y^\varphi + \epsilon$, multiplied by P'. $\frac{\partial R^{W(y)}}{\tau_y}$ is the sum of the behavioral tax revenue $\frac{\partial y^+(\boldsymbol{\theta})}{\partial \tau_y}$ from individuals $\boldsymbol{\theta}$, with $y^\varphi \leq y(\boldsymbol{\theta}) < y^\varphi + \epsilon$, multiplied by $T_y(\boldsymbol{\theta})$.

The reform is desirable if :

$$\underbrace{E_\varphi}_{\substack{\textit{Ecologearian}\\ \textit{redistribution}\\ \textit{priority}}} + \underbrace{\frac{\partial P^{\mathcal{W}(\gamma)}}{\tau_\gamma} - \frac{\partial P^{\mathscr{W}(z)}}{\tau_z} + (1 - P')(-\frac{\partial R^{\mathcal{W}(\gamma)}}{\tau_\gamma} + \frac{\partial R^{\mathscr{W}(z)}}{\tau_z})}_{\textit{Emission reduction efficiency}} \geq 0$$

The proof is in Appendix B.2. The tax reform desirability is the sum of two terms: the ecologearian redistribution priority E_φ, and an emission reduction efficiency term. When people have utilitarian preferences, ecologearian redistribution priority, E_φ should be strictly negative and therefore decrease such a tax reform desirability. However, when people have strictly ecologearian preferences, E_φ is positive and thus increases, as the case for the progressive income/carbon tax reform.
The emission reduction efficiency depends on the tax basis chosen for the individual carbon tax. Increasing a marginal carbon tax whose basis accounts for a small portion of individual GHG emissions,– such as plane flights or gas–, could decrease pollution associated with this tax basis, but increase the pollution associated with the numéraire m, -whose footprint is roughly estimated–, when redistributing lump sump the net budget revenue.

[14] $\kappa(\gamma) = 6(\gamma - \gamma^\varphi)(\gamma^\varphi + 1 - \gamma)$ is compatible with the regularity conditions regarding $T(y)$ from (Jacquet Lehmann 2021 or Spiritus et al. 2023)

5 Evidence of ecologearian preferences and of their impact on non-linear carbon tax support

In this section, we show that respondents exhibit ecologearian preferences, and consistent with our model, an ecologearian redistribution preference that is not strictly negative. Our model showed how ecologearian preferences strengthen the case for a progressive carbon tax reform. Coherent with our model, information on carbon footprint inequality increases non-linear carbon tax support. [15]

5.1 Ecologearian, not utilitarian ethical preferences

Most respondents are ecologearian, not utilitarian, according to our model definition This is true both when they answer as concerned or impartial observers. We also showed how ecologearian objectives increase a progressive income/carbon tax reform desirability and are linked to supporting individual carbon caps.

Using the definition of the ecologearian and utilitarian social welfare objectives defined in 4.2, respondents with ecologearian preferences support decreasing a society's carbon footprint inequality, even if it does not change the income distribution and total GHG emissions. By comparison, utilitarian respondents are indifferent to such a measure. -.

The empirical social choice literature recommends eliciting social welfare preferences both in the position of a concerned observer and in the case of an impartial observer by using concrete allocation choices rather than general philosophical questions (Gaertner Schokkaert 2012). The preferences expressed as a concerned observer,– when the respondent is affected by the choice in reality–, are directly politically relevant. Meanwhile, empirical social choice literature argues that impartial observers are best suited to elicit people's true ethical preferences. [16]

[15] Other factors associated with non-linear carbon tax support, – trust in the redistribution schemes, self-interest, efficiency and fairness perceptions among others–, are analyzed in the companion paper (du Marais 2023)

[16] (Roemer 2002) and (Sen 2009) favor the impartial observer over the veil of ignorance setting. They argue that an impartial observer's preferences are distinct from her risk aversion. This contrasts with the veil of ignorance setting where the respondents are told the probability associated with being affected by the choice at hand in each situation.

Ecologearian preferences as concerned observers When answering as concerned observers, 54 % are ecologearian, while only 28% of respondents are utilitarian (see Figure 10). To test this, respondents assigned to the GHG distribution treatment group read information about the French carbon footprint distribution associated with consumption and wealth (in page A.4). Immediately after, they are asked whether they would be in favor of a reform that would decrease the French carbon footprint inequality if it were not decreasing the total amount of CO2 emissions emitted globally and did not change the French income or wealth distribution. Ecologearian should be supporting such a reform, while utilitarians should be indifferent. In this concrete setting, it can be assumed that respondents are expressing their preferences as concerned observers.

Ecologearian preferences as an impartial observer à la Smith In the position of an impartial observer à la Smith, 57% are ecologearian, while only 37% of respondents are utilitarian (Figure 10). To determine this, respondents are faced with the following question (A.14):

"A and B are two people with ***the same income*** *and* ***working equally****. Each year, the production of goods and services consumed by* ***A emits 10 tons of CO2****. Each year, the production of goods and services consumed by* ***B emits 50 tons of CO2****. As part of an exchange between France and Canada, the county of A and B offers a trip to Canada. The trip will emit* ***2 tons of CO2****. In your opinion, who should be offered the trip? A; B; I am indifferent between A and B."* (The answer options are randomized)

Ecologearians choose A, while utilitarians are indifferent. The probability of having one's county organizing such a program and of discriminating between the participants based on their carbon footprint is very low so the respondent could be considered to be in the position of an impartial observer à la Smith.

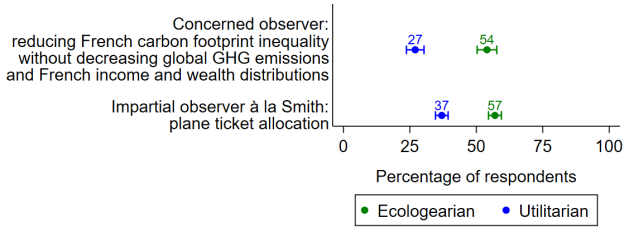


Figure 10: Ecologearian vs. Utilitarian preferences

5.2 Estimating ecologearian redistribution priority

We show that the priority for ecologearian redistribution for the top $\phi = 10\%$ is not strictly negative. This is consistent with respondents' preferences not being utilitarian according to our model (see 4.3). Furthermore, since the ecologearian redistribution preference is greater than in the case of utilitarian preferences, this increases the progressive income/carbon tax reform desirability described in 4.4.

To estimate the priority for ecologearian redistribution for the top $\phi = 10\%$, we draw on (Saez Stantcheva 2016) and their estimation of generalized marginal social welfare weights. Respondents are thus asked to rank different policies according to their preferences. They grade them from 0 to 10. 10 is the maximum desirability for a policy. The average grade for each policy, is shown in Figure 11.

- The average grade for increasing taxes by €100/month on the 10% of the French with the highest income defines $\iint_{z(\boldsymbol{\theta})>z^{\varphi}} g(x(\boldsymbol{\theta}),\boldsymbol{\theta})dF(\boldsymbol{\theta})$. It is equal to 6.4.
- The average grade for increasing taxes by €100/month on the 10% of the French with the greatest carbon footprint defines $\iint_{\gamma(\boldsymbol{\theta})>\gamma^{\varphi}} g(x(\boldsymbol{\theta}),\boldsymbol{\theta})dF(\boldsymbol{\theta})$. It is not significantly lower (6).

Therefore the ecologearian redistribution priority E_{φ} is not significantly different from 0.[17]

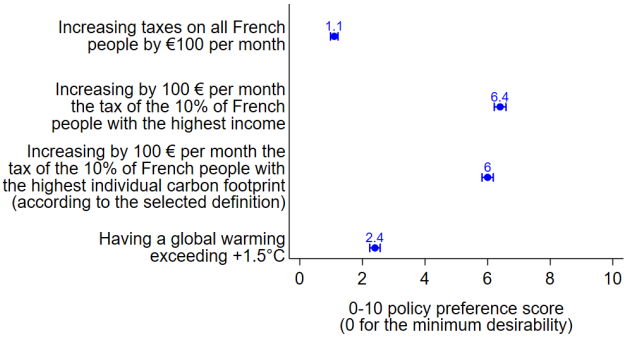


Figure 11: According to your preferences, give a score between 0 and 10 for each change (0 for a change you do not want at all and 10 for the maximum)

[17] In the survey, the model parameters are estimated for the current French tax system. However, Section 3.3 showed that respondents prefer higher taxes for the top income brackets. Therefore, the ecologearian redistribution priority $E_{10\%}$ would probably be higher if it was evaluated for an income tax system more progressive and thus closer to French preferences.

5.3 Information about carbon footprint inequality increases non-linear carbon tax support

Information campaigns raising awareness about carbon footprint inequality ,– described in 2.1.2.1 –, increases non-linear carbon tax support. Interestingly, in comparison, warning about European 2023/2024 gas scarcity, – described in 2.1.2.2–, does not increase non-linear gas tax support. As GHG distribution information campaigns are becoming more frequent (2.1.2.1), the support for non-linear carbon taxes could thus increase in the future.

GHG distribution information increases the support for non-linear carbon taxes, especially for a futurenon-linear carbon tax Displaying GHG distribution information significantly increases the support for increasing fuel or plane taxes on both the highest income households and on those who consume it the most (see Tables 4 and 5). This information also significantly increases the support for increasing gas taxes on the highest-income households. For all these taxes, the increase in support is at least 6% . The GHG distribution treatment also increases the support for introducing non-linear carbon/income tax system in addition to an existing carbon VAT and the respondent's preferred income tax (see Table 6). GHG information has most impact on support for introducing a futurenon-linear carbon/income tax system. The increase in support is as high as 14%. In contrast, the GHG distribution information does not significantly increase support for a plane or carbon footprint individual limit.

Gas scarcity treatment In comparison, warning about European gas scarcity treatment does not increase support for increasing gas taxes either on the highest-income households or on those who consume the most gas (see see Table 4).

Table 4. SUPPORT FOR IMMEDIATELY IMPLEMENTABLE NON-LINEAR CARBON TAXES

	For an increase in					
	Fuel taxes			Gas taxes		
	for everyone	for the highest income households	for the households that consume the most	for everyone	for the highest income households	for the households that consume the most
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Treatment effect without any controls						
GHG Distribution	0.03	0.11***	0.07***	0.03	0.08***	0.00
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Gas scarcity				0.04*	0.02	0.04
				(0.02)	(0.03)	(0.03)
Panel B: Treatment effects with controls						
GHG Distribution	0.04*	0.11***	0.08***	0.03	0.08***	0.01
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Gas scarcity				0.04*	0.02	0.05
				(0.02)	(0.03)	(0.03)
Panel C: Descriptive statistics						
Control mean	0.12	0.40	0.25	0.12	0.43	0.35
Observations	1510	1111	1111	1510	1510	1510

Table 5. SUPPORT FOR IMMEDIATELY IMPLEMENTABLE NON-LINEAR CARBON TAXES AND INDIVIDUAL CAPS

	For an increase in			**For the introduction of**
	Aviation fuel			
	for everyone	for the highest income households	for the households that consume the most	An individual flight hour limit
	(7)	(8)	(9)	(10)
Panel A: Treatment effect without any controls				
GHG Distribution	0.07**	0.06**	0.08***	0.02
	(0.03)	(0.03)	(0.03)	(0.03)
Panel B: Treatment effects with controls				
GHG Distribution	0.07**	0.06**	0.08***	0.02
	(0.03)	(0.03)	(0.03)	(0.03)
Panel C: Descriptive statistics				
Control mean	0.52	0.60	0.55	0.45
Observations	1111		1111	1111
1111				

Notes. Panel B includes socio-demographic controls gender, age, size of urban area, and socio-professional category to correct potential treatment imbalances. * p< .1, ** p< .05, *** p< .01

Table 6. PREFERENCES FOR FUTURE CARBON TAXES AND INDIVIDUAL LIMITS

	For the introduction of		
	a carbon VAT	an individual carbon/income tax	an individual carbon footprint limit
	(1)	(2)	(3)
Panel A: Treatment effect without any controls			
GHG Distribution	0.07***	0.14***	0.03
	(0.03)	(0.03)	(0.03)
Panel B: Treatment effects with controls			
GHG Distribution	0.07***	0.14***	0.03
	(0.03)	(0.03)	(0.03)
Panel C: Descriptive statistics			
Control mean	0.21	0.38	0.41
Observations	1111	1111	1111

Notes. Panel B includes socio-demographic controls gender, age, size of urban area, and socio-professional category to correct potential treatment imbalances. * p< .1, ** p< .05, *** p< .01

6 Conclusion

This paper presents evidence of support for progressive carbon taxes and individual caps, shedding light on their association with aversion to carbon footprint inequality.

The study reveals support for progressive carbon taxes, including those immediately implementable on gas, flights, or fuels, as well as those that could be implemented in the future pending advancements in carbon accounting. Support for directly implementable progressive carbon taxes with uniform revenue redistribution significantly surpasses that for linear carbon taxes, even when revenue recycling makes the latter progressive. In the event of a future implementation of a progressive carbon tax, respondents express a preference for a tax basis that accounts for individual wealth, financial, and to a lesser extent labor-related carbon footprints.

Furthermore, this paper introduces the concept of ecologearian preferences, which are defined in the article. These preferences reflect an aversion to intratemporal carbon footprint inequality. Respondents align more closely with ecologearian preferences than utilitarian ones. Consistent with our model and

ecologearian preferences, information regarding carbon footprint inequality,– drawn from recent academic research and environmental NGO campaigns –, amplifies support for progressive carbon taxes. Interestingly, the support for progressive gas taxes remains unaffected when raising awareness about European gas scarcity, following the Ukraine war.

This article demonstrates the popularity and thus the potential of progressive carbon taxes and individual caps as novel climate mitigation policies. The survey methodology presented here could be applied in different countries to comprehensively assess support for progressive carbon taxes. Indeed, preferences for redistribution in France are relatively high compared to other countries.

Moreover, a companion paper reveals that according to respondents, a progressive carbon tax could reshape the ethical discourse and enhance environmental awareness and preferences. Therefore, exploring the impact of constraining policies aimed at reducing carbon footprint inequality to boost environmental preferences, as opposed to relying solely on nudges or information, presents another interesting avenue for future research.

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A Appendix

A.1 Constructing individual footprints using stated preferences and support for generalizing the chosen footprint calculation

We propose the following methodology to construct the aggregated individual carbon footprint γ^{Tax}. This will be the individual carbon tax basis constructed from the answers to the survey presented in the former paragraph. If a majority is against taking into account the footprint of a given activity, it will not be taken into account. Every other footprint will be multiplied by its weight. The aggregated individual carbon footprint γ^{Tax} will equal the sum of the products of each remaining footprint multiplied by their weight. The weight of one footprint will be the sum of the share of people who are in favor of fully taking into account this footprint multiplied by 1 and of the share of the people in favor of partially accounting for this footprint multiplied by 0.5.

We note the carbon footprint of an individual associated with respectively her consumption γ^C, her labor revenues γ^L and capital revenues γ^K, and her wealth γ^W. We also define the carbon footprints of the essential expenses over which an individual has little control given the question statement. The disability-related expenses are noted γ^D, the transport expenses γ^T and the heating expenses γ^H. Given the survey's questions and answers as well as the proposed methodology, the preferred aggregated individual carbon footprint

γ^{Tax} on which to levy an individual tax would be:

$$\gamma^{Tax} = \gamma^{C} - \gamma^{D} - \gamma^{T} - \gamma^{L} + 0.38\gamma^{W} + 0.41\gamma^{K} + 0.29\gamma^{L}$$

The answers to the survey have demonstrated the responsibility principle for carbon footprint accounting. According to it, respondents are against taking into account GHG emissions for which people have little control over. However, regarding the carbon footprint associated with labor income, the survey does not differentiate between people with different education, geographical areas, or local unemployment levels. Yet, each of these factors influences the capacity that an individual has to switch to a less emitting job. To reflect this responsibility principle, the labor income weight could be multiplied by a scalar e_L to reflect the degree of responsibility over the labor income footprint that an individual has depending on these objective factors. γ^{Tax} could therefore be written:

$$\gamma^{Tax} = \gamma^{C} - \gamma^{D} - \gamma^{T} - \gamma^{L} + 0.38\gamma^{W} + 0.41\gamma^{K} + 0.29e_L\gamma^{L}$$

Personal carbon footprint calculators are more and more widespread. They are designed to help people voluntarily reduce their footprint. The methodology described above to define an individual carbon footprint for a future individual tax from stated preferences could be easily extended to define an aggregated footprint for these calculators. Indeed, individual wealth and income carbon footprints are becoming more available and so far no methodology has been designed to take them into account and compare them with consumption footprints. Furthermore, it would be interesting to voluntarily decrease one footprint bearing in mind the possibility that it could be the basis of a future individual tax.

Unlike this survey statement, some French people have the financial means to isolate their home to decrease their heating bill or have an alternative to individual cars for running essential errands. Furthermore, some personal footprint calculators (e.g Atelier 2 tonnes in France) explicitly distinguish between individual and political levers, – such as modification to the public transportation network–, to decrease one's footprint once it is calculated. Therefore, the personal carbon footprint used for calculators should take into account the footprint associated with the consumption of goods and services that are presented as unavoidable in this survey. Other than that the individual carbon footprint used for an online calculator $\gamma^{Calculator}$ could be the same as the one for an individual tax γ^{Tax}:

$$\gamma^{Calculator} = \gamma^{C} + 0.38\gamma^{W} + 0.41\gamma^{K} + e_L 0.29\gamma^{L}$$

Support for generalizing the carbon footprint calculation. When asked about it, 50% of the respondents are in favor of calculating an individual carbon footprint for each person and gradually improving it to make it more and more accurate (see Figure 12). This is much more than the 26% that are against it. This could therefore justify generalizing the calculation of the carbon footprint definitions defined in this subsection.

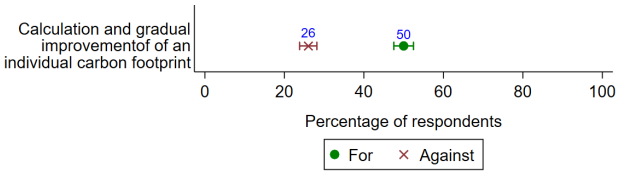


Figure 12: What do you think about calculating an individual carbon footprint for each person and gradually improving it to make it more and more accurate?

A.2 Survey design methodology

A.2.1 Why ask about decreasing linear carbon taxes?

Most of the literature on carbon tax preferences, – that is on individual fuels and gas use – focuses on asking for additional carbon tax preferences on individual fuels and gas use. However, several factors call for investigating negative carbon tax preferences on these tax bases as well. First, surveys show that carbon tax acceptability has been low both worldwide (Carattini et al. 2018, Fairbrother et al. 2019, Maestre-Andres et al. 2019] and in the French context (Douenne Fabre 2020, ADEME 2022, Conseil des Prélèvements Obligatoires 2022). Second, this survey was conducted in a context of two consecutive energy price hikes, especially in Europe (in 2018 and 2022), and of resulting demonstrations against carbon taxes and/or high energy prices for individual fuel and gas such as the Yellow Vests in France at the end 2018 or the Don't Pay energy campaign in the UK in late 2022. Third, this prompted governments to slow down carbon tax programs: Germany postponed its carbon tax introduction in 2022, France set up a "tariff shield" decreasing taxes on individual fuel and gas while the second French party called for going as far as decreasing the VAT on such product in the 2022 French elections. Finally, France, as many Southern European countries (OECD 2021) already display very high fuel and gas taxes for individuals. Thus, before the tariff shield, the carbon tax on fuel for individuals amounted to €313/tCO2 in 2020 (CGDD 2020).

Respondents are first asked about whether they would be in favor of increasing or decreasing "historical carbon taxes", on fuel and gas in A.5, or plane in A.6. If they are for a modification, they are then asked about the modification amount. In a subsequent page, they are asked in A.7 whether they are for or against the introduction of an additional Carbon VAT. If they are for it, they are then asked about the average price increase they would be ready to pay. To compute the average or median additional carbon VAT preferences, all respondents who are not in favor of such a policy are assigned a value of 0. In all these cases, it is specified that all additional tax revenues would be redistributed to the households most affected by these taxes.

A.2.2 Using equivalent flight hours

The metric for flight consumption is in equivalent hours of flights.

We use a flight hour metric. It is better correlated with GHG emissions than the total distance or price of a flight. Indeed, transferring may be associated with cheaper plane tickets and does not add distance to a flight. However, transferring emits significantly more GHG than a direct flight. Furthermore, semi-directed interviews showed that respondents understand and estimate flight hours better.

Furthermore, using equivalent flight hours enables to contribute to the worldwide ecologearian debate regarding curbing private jet emissions. Indeed, an important debate arose regarding private jet emissions in France and worldwide – e.g illustrated by the following of the ElonJet or L'avion de Bernard Twitter accounts tracking billionaire's jet emissions – . This debate seems a good indicator of newly expressed ecologearian preferences. Therefore, in order be able to contribute to this debate, the question about non-linear tax preferences or individual limit for flight hours adds that a private jet emits 10 times more GHG than a commercial airline.

A.3 Final Sample characteristics

Table 7. SAMPLE CHARACTERISTICS: QUOTA STRATAS

	French population	Sample characteristics
Female	.52	.52
Region		
Auvergne-Rhône-Alpes	.12	.11
Bourgogne-Franche-Comté	.04	.04
Bretagne	.05	.05
Centre-Val-de-Loire	.04	.04
Grand Est	.08	.08
Hauts-de-France	.09	.09
Île-de-France	.19	.2
Normandie	.05	.05
Nouvelle-Aquitaine	.09	.09
Occitanie	.09	.09
Pays de la Loire	.06	.06
Provence-Alpes-Côte d'Azur	.08	.08
Age		
18-24 years old	.12	.1
25-34 years old	.17	.14
35-49 years old	.27	.27
50-64 years old	.23	.25
Over 65 years old	.21	.24
Size of urban area		
Rural (<2k)	.21	.26
2k-19,999	.18	.22
20k-99,999	.14	.16
$\geq 99k$ outside of Paris area	.30	.22
Paris area	.16	.14
Profession		
Farmer operator	.01	.01
Craftsman, merchant, company manager	.03	.04
Executive, liberal profession, higher intellectual profession	.08	.11
Employee	.17	.2
Worker	.15	.09
Intermediate profession	.13	.14
Retired	.32	.29
Other inactive	.11	.13
Sample size		1510

Table 8. SAMPLE CHARACTERISTICS: OTHER INDIVIDUAL AND HOUSEHOLD CHARACTERISTICS

	French population	Sample characteristics
2022 French presidential election (First round)		
Right-wing	.33	.35
Far-right	.32	.32
Left-wing	.32	.33
Household consumption units		
Mean	1.61	1.57
Monthly household net revenu/c.u		
Median	1840	1750
Energy source (share)		
Gas	0.42	.36
Fuel	0.12	.07
Accomodation surface (m2)		
Mean	97	96
p25	69	65
Median	90	88
p75	120	120
Distance travelled by car (km/year)		
Mean	13,735	17217
p25	4,000	6000
Median	10,899	12000
p75	20,000	21500

Sources. Ministère de l'Intérieur and author's calculations; Budget des Familles 2011.

Online Appendix

A Questionnaire links and full questionnaire description

In the following text, each heading delimits a survey page. If not specified otherwise, the page is the same for all groups. Respondents have to answer all questions on a given questionnaire page in any order before they can go to the next page. However, once completed, they cannot go back to a previous page. In the text below, headings and text within square brackets are not shown to the respondent and answer options are separated by semicolons.

A.0.1 Consent form

1. [See Figure 13 (First attention check)]

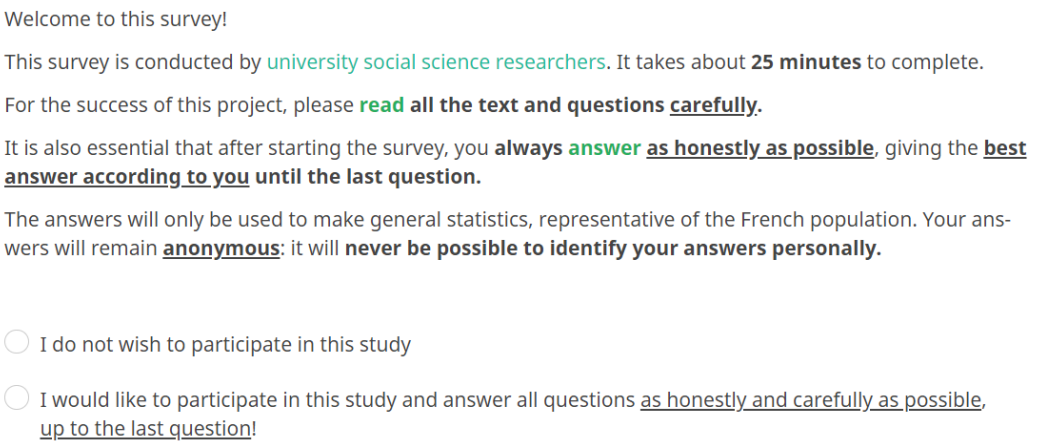


Figure 13

2. [If the respondent answered "I would like to participate in this study..." to question 1] **Thank you very much, enjoy this survey!**

   [First attention check: inattentive respondents are excluded at the end of this survey page]

A.1 Questions for quota stratas

3. What is your gender (in the sense of civil status)?

   Female; Male

4. What is your age?

5. In which region do you live?

   Grand Est; Nouvelle Aquitaine; Auvergne Rhônes Alpes; Bourgogne Franche Comté; Bretagne; Centre Val de Loire; Île de France; Occitanie; Normandie; Pays de la Loire; Provence Alpes Côte d'Azur; Hauts de France

6. In which type of agglomeration do you live?

   Parisian agglomeration; Urban area with more than 100,000 inhabitants outside the Paris area; Urban area with 20,000 to 99,999 inhabitants; Urban area with 2,000 to 19,999 inhabitants; Rural area (less than 2,000 inhabitants)

7. What is your current professional situation?

   Farmer; Craftsman, merchant, company manager; Executive, liberal profession, higher intellectual profession; Employee; Worker; Intermediate profession; Retired; Other inactive: housewife or man, looking for a job or not actively looking for a job

8. What is your highest diploma?

   No diploma, Brevet des collèges or BEPC; BEP or CAP [French professional education]; Baccalaureate; More than Baccalaureate

A.2 Sensitive questions: household composition, income, wealth and political preferences

9. The household includes **yourself** and all the people who usually share the same dwelling and have a common budget. In your household, how many people are...

   Over 14 years old

   Less than 14 years old

10. We remind you that your data is anonymous. Your answers are only used to make statistics representative of the French population.

    This year, what was the average **NET MONTHLY** income of your **whole household**?

    All the income (salaries, pensions, benefits, etc.) of the household are taken into account minus the taxes and social contributions paid.

    Less than €500; €500 to €1 000; €1 000 to €1 500 €1 500 to €2 000; €2 000 to €3 000; €3 000 to €4 000; €4 000 to €5 000; €5 000 to €6 000; €6 000 to €8 000; €8 000 to €10 000; €10 000 to €12 000; More than €12,000

11. (We remind you that **it is not possible to personally identify your answers** and that the data **collected is used only to make general statistics, represen** of the French population)

    How much do you estimate your household's **NET wealth** (in euros)? This includes all your possessions (housing, car, savings, etc.) net of debt.

    For example, if you own a house worth €250,000, your only asset, and you have €100,000 left to pay on your mortgage, your net wealth is €150,000.

    Less than €10,000; Between €10,000 and €60,000 ; Between €60,000 and €180,000; Between 180 000€ and 350 000€; Between 350 000€ and 550 000€; More than 550 000€

12. Who did you vote for in the first round of the last presidential election?

    Nathalie ARTHAUD; Nicolas DUPONT-AIGNAN; Anne HIDALGO; Yannick JADOT; Jean LASSALLE; Marine LE PEN; Emmanuel MACRON; Jean-Luc MÉLENCHON; Valérie PÉCRESSE; Philippe POUTOU; Fabien ROUSSEL; Éric ZEMMOUR; I did not vote; I voted blank or null; Does not wish to answer

A.3 Energy use: heating and transportation

13. What is the surface area of your home (in m^2)

14. What is the heating system of your home?

    Individual heating; Collective heating

15. What is the main source of heating energy for your home? Please select ...

    Electricity; City gas; Butane, propane and gas in tank; Fuel, oil, petrol; Wood, solar, geothermal, aerothermal (heat pump)

16. How many motorized vehicles (two-wheeler or car) does your household have **that consume fuel**?

    None; One; Two; Three or more

    If answered "Three or more" to 16.

17. What type of fuel do you use for your primary vehicle? If you have a hybrid car, please indicate the fuel used.

    Unleaded 95; Diesel; E85; Liquefied Petroleum Gas; Unleaded 95-E10; Unleaded 98

18. What is the average consumption of the main vehicle, in Liters per 100 km?

19. How many kilometers were driven with your main vehicle in the last 12 months?

20. What type of fuel do you use for your second vehicle? If you have a hybrid car, please indicate the fuel used.

    Unleaded 95; Diesel; E85; Liquefied Petroleum Gas; Unleaded 95-E10; Unleaded 98

21. What is the average fuel consumption of this second vehicle (in liters per 100 km)

22. How many kilometers were driven with your second vehicle in the last 12 months?

23. What is the average consumption of your other motorized vehicles? (in Litres per100 km)

24. How many kilometers were driven in total with your other motorized vehicles in the last 12 months?

If answered "Two" to 16.

25. What type of fuel do you use for your primary vehicle? If you have a hybrid car, please indicate the fuel used.

    Unleaded 95; Diesel; E85; Liquefied Petroleum Gas; Unleaded 95-E10; Unleaded 98

26. What is the average consumption of the main vehicle, in Liters per 100 km?

27. How many kilometers were driven with your main vehicle in the last 12 months?

28. What type of fuel do you use for your second vehicle? If you have a hybrid car, please indicate the fuel used.

    Unleaded 95; Diesel; E85; Liquefied Petroleum Gas; Unleaded 95-E10; Unleaded 98

29. What is the average fuel consumption of this second vehicle (in liters per 100 km)

30. How many kilometers were driven with your second vehicle in the last 12 months?

If answered "One" to 16.

31. What type of fuel do you use for your vehicle? If you have a hybrid car, please indicate the fuel used.

    Unleaded 95; Diesel; E85; Liquefied Petroleum Gas; Unleaded 95-E10; Unleaded 98

32. What is the average consumption of your vehicle, in Liters per 100 km?

33. How many kilometers were driven with your vehicle in the last 12 months?

34. Not using the car for your essential trips (e.g. home to work, essential shopping, taking the children to school, etc.) is...

    Totally possible; Somewhat possible; Difficult; Totally impossible

A.4 GHG distribution information and questions (For control and GHG distribution treatment groups only)

A.3.0.3 paragraph [Meanwhile, respondents assigned to the Gas scarcity treatment group answer questions about Carbon VAT]

35. [If the respondent is in the GHG allocation treatment group] [See Figure 14]

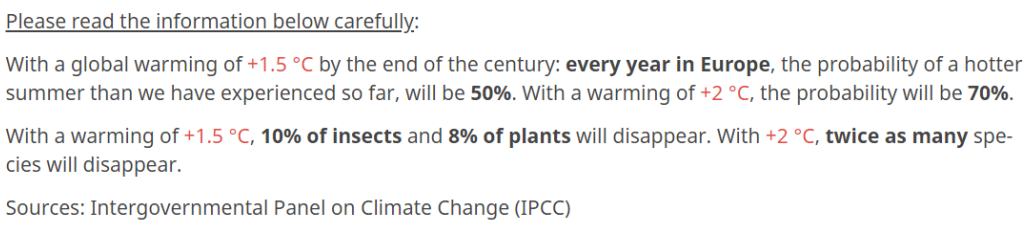


Figure 14

36. [See Figure 15]

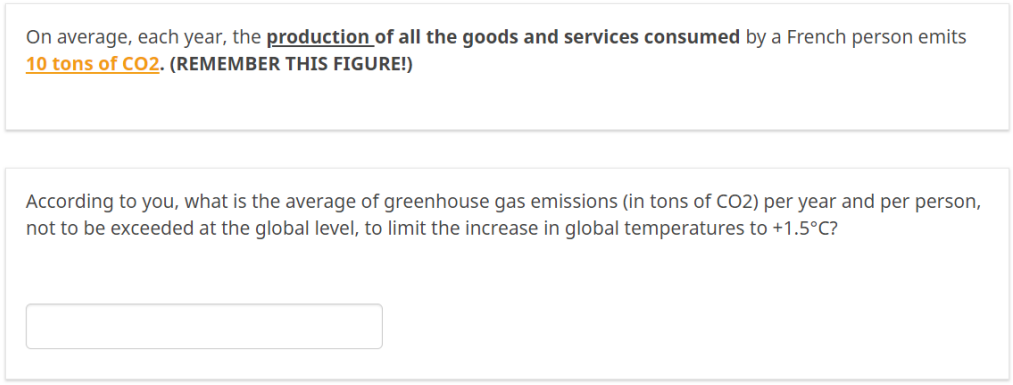


Figure 15

37. [If in the GHG distribution treatment group and once the respondent has answered the previous question]
The maximum amount of carbon is **2 tons of carbon** per year on average per person.

38. [If in the GHG distribution treatment group] [See Figure 16]

Read the information below carefully:

In France, the consumption, of the **1%** of individuals with the highest income emits **13 times** more Greenhouse Gases than the consumption of the **poorest 50%**.

It is estimated that the financial wealth of **63 French billionaires** emits **as much** Greenhouse Gases as that of **50%** of the French population.

What do you think of a reform that would **decrease the differences in carbon footprint between French people**, if it did not decrease the total amount of CO2 emissions emitted globally and did not change the distribution of income and wealth of French people?

I am...

For it | Rather for it | Indifferent | Rather against it | Against it

Figure 16

A.5 Historical carbon tax preferences

39. [See Figure 17]

Because of the tariff shield, today the state subsidizes gas and no longer taxes it.

What do you think about taxes on **fuels**, **natural gas and heating oil**?

If you choose to increase taxes, all of the additional tax revenue would be redistributed to the households most affected by these taxes.

I am...

	For an increase	Rather for an increase	For no change	Rather for a decrease	For a decrease
In **fuel** taxes					
In taxes on **gas and heating oil**					

Figure 17

40. [If the respondent did not select "For no change" to 39 regarding fuel taxes] By which amount, in € per Litre of fuel?

    (1 cent of euro is written 0,01€ and 10 cents is written 0,10 €)

41. [If the respondent did not select "For no change" to 39 regarding gas and heating oil] By how many percent, for natural gas?

42. For which reasons?

43. **If the government decided** to increase taxes on fuel, gas and heating oil, what would you like to do with the additional tax revenue?

    (Drag and drop all items from the list on the left to the list on the right in the order of your choice, from your first choice to your last)

    - Redistribute these tax revenues to low and middle income groups;

    - Finance measures in favor of the energy transition;

    - Redistribute all this tax revenue, by redistributing the same amount to each French person;

    - Redistribute this tax revenue to the people most affected by the increase in these taxes

    [The answer options are randomized]

A.6 Historical carbon tax preferences on flights

44. [See Figure 18]

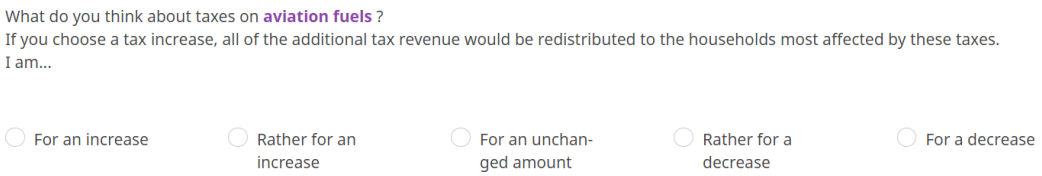


Figure 18

45. [If the respondent did not select "For an unchanged amount" to 44] How much, approximately, in € per flight hour?

A.7 Carbon VAT

46. In this part of the survey, we start from the **current situation, with the current French tax system** (without taking into account your previous choices)

    Let's imagine that for **each** product or service you buy, technological progress allows to indicate on the product all the **Greenhouse Gases** emitted **throughout its production**.

We could then calculate a **Carbon VAT** that would depend on the **Greenhouse Gases** emitted **throughout the production** for each good and service. As a reminder, the current VAT is a tax that depends on the price of products.

If it does not change the total amount of taxes paid by each French person, what do you think about replacing part of the current VAT by a **Carbon VAT**?

I am...

For it; Rather for it; Indifferent; Rather against it; Against it

47. For what reasons?

48. **If the government decides to add** a Carbon VAT, in addition to the current VAT, what would be your position?

    If you choose to add a carbon VAT, all of this additional tax revenue would be redistributed to the households most affected by these taxes.

    I am...

    For it; Rather for it; Indifferent; Somewhat against it; Against it

49. The **current VAT** is 20% of the **price** of goods and services **excluding tax**. In your opinion, how many **additional percentages on the price of goods and services excluding tax** should this Carbon VAT cost approximately?

    For example, if you answer 0.1% , the **Carbon VAT** would add an average of 0.1% tax to the price of goods and services before tax.

A.8 Preferred non-linear carbon tax rate (For control and GHG distribution treatment groups only)

[In the meantime, the Gas rationing group answers questions regarding carbon VAT]

50. [See Figure 19]

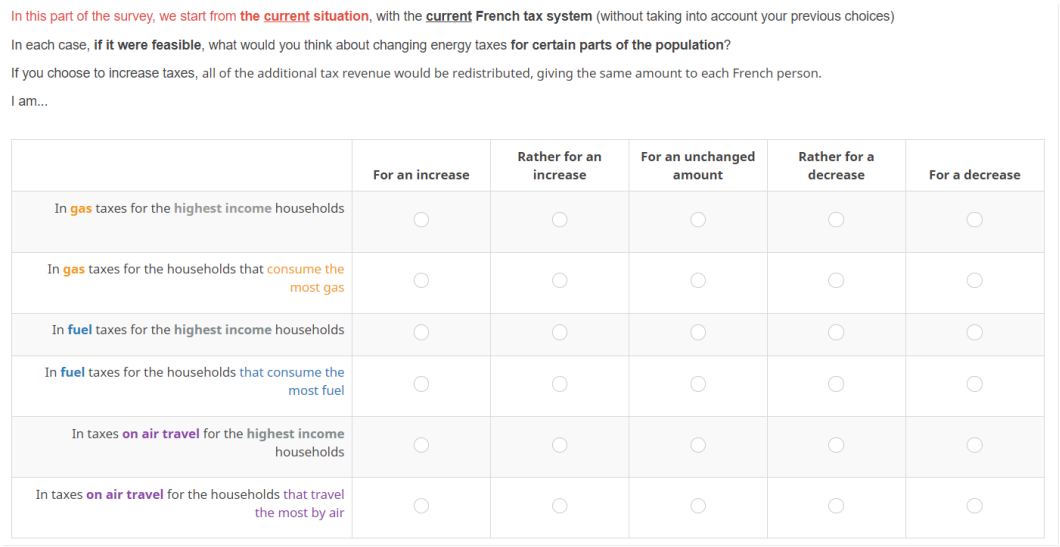


Figure 19

51. For which reasons?

52. [See Figure 20]

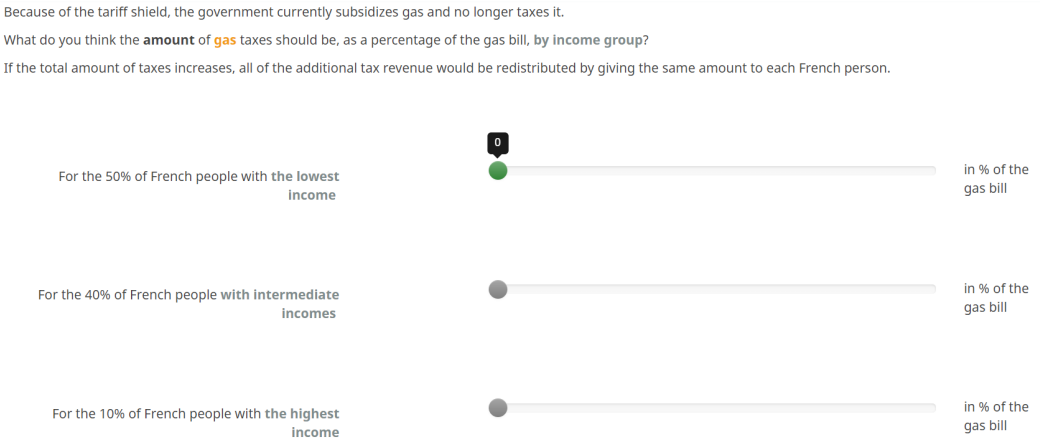


Figure 20

53. [See Figure 21]

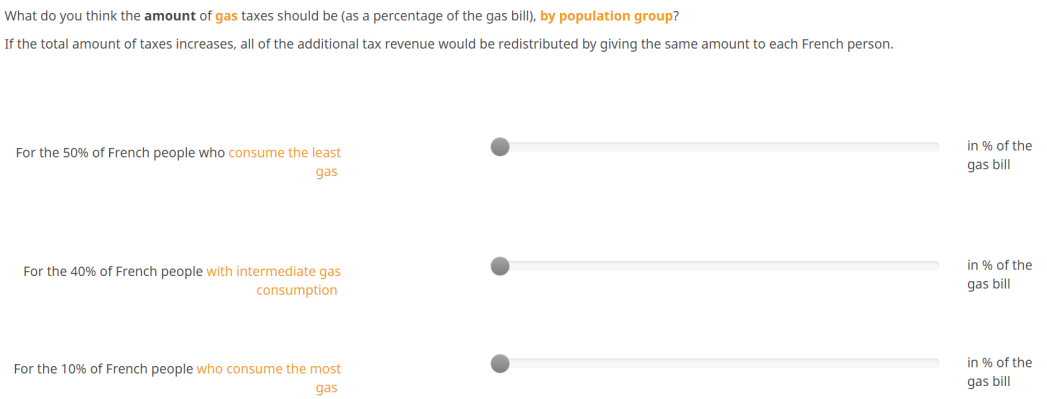


Figure 21

54. [See Figure 22]

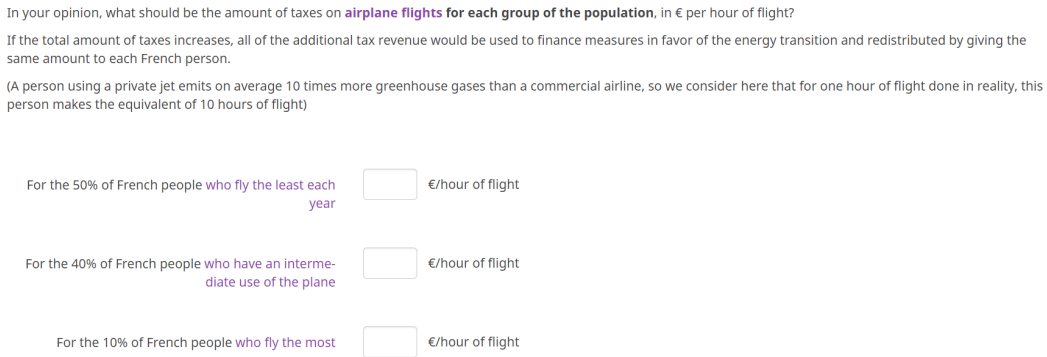


Figure 22

55. In addition to the taxes you have just chosen on airplane fuels, what do you think about introducing a **limit of flight hours** for non-business flights, which should not be exceeded? (If you are in favor of it, we will ask you the level of the limit)

    A person using a private jet emits on average 10 times more greenhouse gases than a commercial airplane, so we consider here that for one hour of flight done in reality, this person makes the equivalent of 10 hours of flight.

    I am...

    For it; Somewhat for it; Indifferent; Rather against it; Against it

56. [If the respondent answered "For it" or "Somewhat for it" to 55] According to you, what should be this individual limit not to be exceeded, in hours of air travel per year?

A.9 Preferred evolution of the tax system to fund the energy transition (For control and GHG distribution treatment groups only)

57. In this part of the survey, we start from the **current situation**, **with the current French tax system** (without taking into account your previous choices)

    What do you think about increasing taxes to finance measures for the energy transition?

    I am...

    For it; Rather for it; Indifferent; Somewhat against it; Against it

58. **Let's imagine that the government decides** to increase taxes to finance measures for the energy transition. Which taxes should be raised, if all options are feasible?

    (Drag and drop all items from the left list to the right list in the order of your choice, from your first choice to your last choice)

    - Increase the **income tax** on the **highest income households**;

    - Create a carbon VAT;

    - Increase taxes on gas for **the highest income households**;

    - Increase taxes on gas and fuel;

    - Increase the VAT

    [The answer options are shown in a random order]

A.10 Personal carbon footprint definition (For control and GHG distribution treatment groups only)

59. [See Figure 23]

In this part of the survey, we start from **the current situation**, **with the current French tax system** (without taking into account your previous choices)

In this part of the survey, we also imagine that the progress of carbon accounting allows to calculate **precisely** all the greenhouse gas emissions emitted during the production of each good and service as well as the complete **carbon footprint** of each person.

Let's imagine that **the government decides** that the income tax rate depends in part on the **individual carbon footprint**. According to you, which emissions should be included in this individual carbon footprint?

	These emissions should not be taken into account at all	These emissions should rather not be taken into account	I am indifferent	These emissions should be partially taken into account	All of these emissions should be taken into account
Emissions from the production of goods and services specific for people with disabilities	○	○	○	○	○
Emissions from commuting to work and running essential errands for people living in rural areas without access to public transportation	○	○	○	○	○
Emissions produced by the heating of people who do not have the financial means to renovate their homes	○	○	○	○	○
Emissions related to an individual's financial income: for example, emissions from companies for which an individual receives dividends or income from savings products, or emissions from housing for which the individual receives rent	○	○	○	○	○
The emissions of the company in which a person works	○	○	○	○	○
Emissions from a person's assets (e.g. emissions from companies in which an individual has shares even if they do not pay dividends)	○	○	○	○	○

Figure 23

60. What do you think about calculating an individual carbon footprint for each person and gradually improving it to make it more and more accurate? I...

    Strongly agree; Somewhat agree; Am indifferent; Somewhat disagree; Strongly disagree

61. If such an individual carbon footprint is calculated, in your opinion **which actors** should be in charge of its implementation, calculation and improvement? (Several answers possible)

    The State; French companies; European companies; Non-European companies; French associations; European associations; Non-European associations [The answer options are shown in a random order]

62. Current techniques (statistical anonymization, open source softwares) allow to **accurately calculate** an individual carbon footprint **without the actor in charge of the calculation having access to all the activities of a person** used for the calculation of the carbon footprint and **by guaranteeing the confidentiality of the data**.

If the **actors you have chosen** are in charge of setting up the carbon footprint calculation AND the **confidentiality of your data is thus guaranteed**, how does this influence your position towards the calculation of the individual carbon footprint for each person?

I would be much more in favor of calculating it for everyone; I would be a little more in favor of calculating it for everyone; It would not change my position; I would be a little less favorable to its calculation for each person; I would be much less in favor of its calculation for everyone

A.11 Ideal futurenon-linear tax system (For control and GHG distribution treatment groups only)

63. According to you, on average each year, how many tons of CO2 are emitted by the production **of all goods and services consumed** by a French person?

    [Second attention check: inattentive respondents are excluded at the end of this survey page]

64. [See Figure 24]

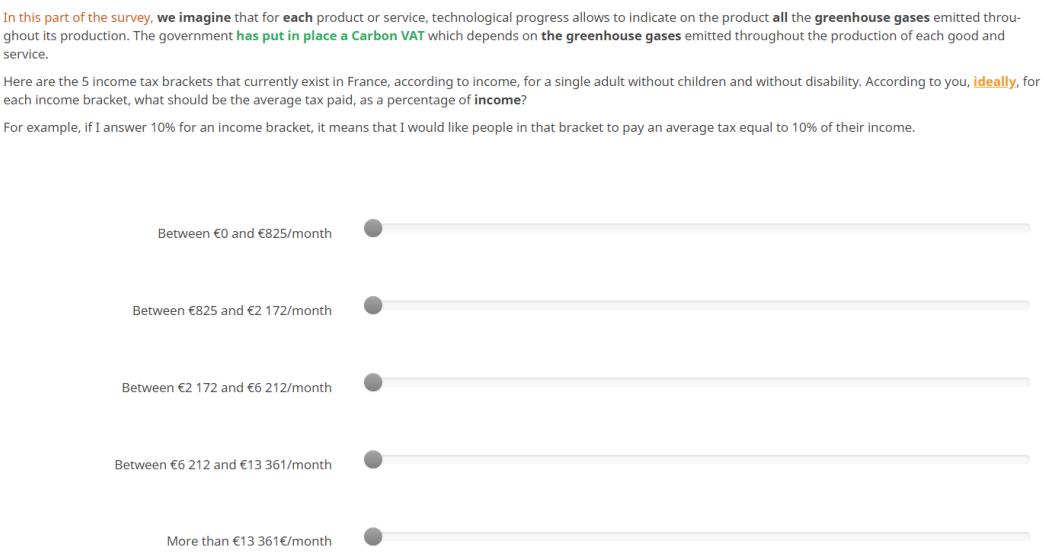


Figure 24

65. The **individual carbon footprint** is defined and calculated taking into account your choices on the previous page. There is a **carbon VAT**. The **income tax** is the one you chose as well.

    However, thanks to technological progress, the **income tax rate** could **depend in part on the individual carbon footprint**. This without necessarily increasing individual taxes. What do you think of it? I am...

    For it; Rather for it; Indifferent; Somewhat against it; Against it

66. For which reasons?

67. [If the respondent did not choose "Somewhat against it" or "Against it" to 65] [See Figure 25]

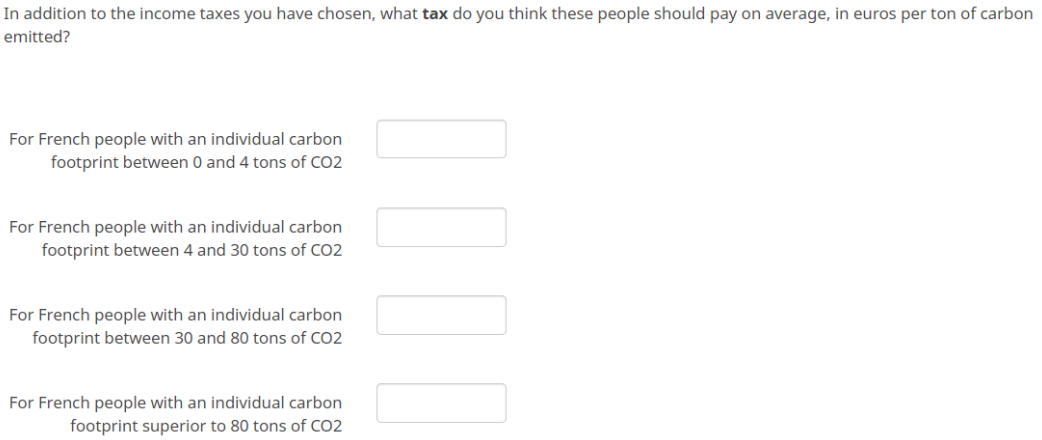


Figure 25

68. In addition to the taxation you have chosen on this page, what do you think about introducing an **individual carbon footprint limit that should not be exceeded** ? (If you are in favor of it, we will ask you the level of the limit)

    I...

    Strongly agree; Somewhat agree; Am indifferent; Somewhat disagree; Strongly disagree

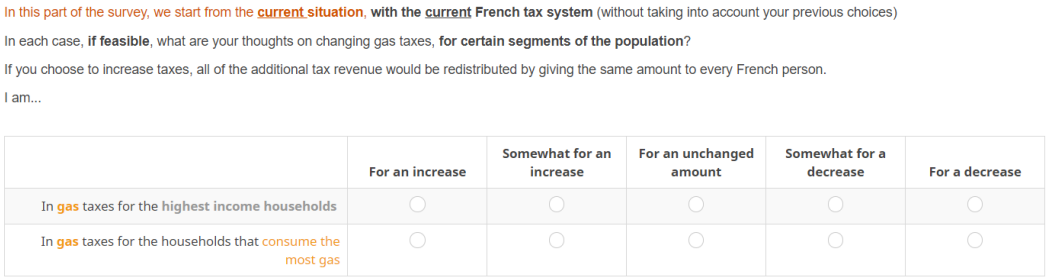
69. [If the respondent chose "Strongly agree" or "Somewhat agree" to 68] What should be the individual carbon footprint limit not to exceed each year, in tons of CO2?

A.12 Non-linear gas tax preferences (For Gas scarcity treatment groups only)

70. Read carefully the information below:

    In a new report, the **International Energy Agency** calls on **France and Europe** to take immediate action to avoid **any gas shortages for the winter of 2023/2024.** In order to have sufficient gas reserves for the winter of 2023/2024, it estimates that gas consumption must **decrease by 13% this winter**.

    [See Figure 26]


In this part of the survey, we start from the **current situation**, **with the current French tax system** (without taking into account your previous choices)

In each case, **if feasible**, what are your thoughts on changing gas taxes, **for certain segments of the population**?

If you choose to increase taxes, all of the additional tax revenue would be redistributed by giving the same amount to every French person.

I am...

	For an increase	Somewhat for an increase	For an unchanged amount	Somewhat for a decrease	For a decrease
In gas taxes for the highest income households	○	○	○	○	○
In gas taxes for the households that consume the most gas	○	○	○	○	○

Figure 26

71. [The question is the same as 52]

72. [The question is the same as 53]

A.13 Confidence in energy price compensation means ((For Gas scarcity treatment groups only)

[See Figure 27]

To compensate for rising energy prices, money can be distributed in different forms. In your opinion, what is the probability of receiving the full amount of money to which a person is entitled?

	Very uncertain	Somewhat uncertain	I don't know	Rather high	Very high
Through the Energy voucher	○	○	○	○	○
Through an automatic monthly bank transfer	○	○	○	○	○
Through assistance to adapt to rising energy prices: for example, financial assistance for insulation when the price of heating rises and financial assistance to change vehicles when the price of fuel increases	○	○	○	○	○

Figure 27

A.14 Environmental ethical preferences (For control and GHG distribution treatment groups only)

73. A and B are two people with **the same income** and **working equally**. Each year, the production of goods and services consumed by **A emits 10 tons of CO2**. Each year, the production of goods and services consumed by **B emits 50 tons of CO2**. As part of an exchange between France and Canada, the county of A and B offers a trip to Canada. The trip will emit **2 tons of CO2**. In your opinion, who should be offered the trip?

    A; B; I am indifferent between A and B [The answer options are randomized]

74. In this page of the survey, we start **from the current situation, with the current French tax system** (without taking into account your previous choices)

    According to your preferences, give a **score** between 0 and 10 for each change (0 for a change you do not want at all and 10 for the maximum)

    - Increasing taxes on all French people by €100 per month;

    - Increasing by 100 € per month the tax of the 10% of French people with the highest income;

    - Increasing by 100 € per month the tax of the 10% of French people with the highest individual carbon footprint (we use the definition you chose above);

    - Having a global warming exceeding +1.5°C

A.15 Personal impact, fairness and efficiency views of the different carbon taxes (For control and GHG distribution treatment groups only)

75. [See Figure 28]

What do you think would be the effect of each policy below on your **household's purchasing power**? It would...

	decrease by more than 30%	decrease by 20 to 30%	decrease by 10 to 20%	decrease by 0 to 10%	remain stable	increase by 0 to 10%	increase by 10 to 20%	increase by 20 to 30%	increase by more than 30%
Increase taxes **on fuel** by 10 cents at the pump	○	○	○	○	○	○	○	○	○
Introduce a tax **on gas** for individuals, increasing prices by 5%	○	○	○	○	○	○	○	○	○
Increase taxes on **airplane fuel** by €10 per flight hour	○	○	○	○	○	○	○	○	○
Introduce a **carbon VAT** on each good and service of 10 € for each ton of CO2 emitted during its production	○	○	○	○	○	○	○	○	○
Introduce a tax on **gas** for individuals, increasing prices by 10% for **the richest 30% of households**	○	○	○	○	○	○	○	○	○
Introduce a tax on **gas** for individuals, increasing prices by 10% for the **30% of households that consume the most gas**	○	○	○	○	○	○	○	○	○

Figure 28

76. [See Figure 29]

How do you rate each policy below? It is...

	Totally fair	Somewhat fair	Neutral	Somewhat unfair	Totally unfair
Increase taxes **on fuel** by 10 cents at the pump	○	○	○	○	○
Introduce a tax **on gas** for individuals, increasing prices by 5%	○	○	○	○	○
Increase taxes on **airplane fuel** by €10 per flight hour	○	○	○	○	○
Introduce a **carbon VAT** on each good and service of 10 € for each ton of CO2 emitted during its production	○	○	○	○	○
Introduce a tax on **gas** for individuals, increasing prices by 10% for **the richest 30% of households**	○	○	○	○	○
Introduce a tax on **gas** for individuals, increasing prices by 10% for the **30% of households that consume the most gas**	○	○	○	○	○

Figure 29

77. [See Figure 30]

What do you think would be the effect of each of the following policies on **greenhouse gas emissions in France**? They would...

	decrease by more than 30%	decrease by 20 to 30%	decrease by 10 to 20%	decrease by 0 to 10%	remain stable	increase by 0 to 10%	increase by 10 to 20%	increase by 20 to 30%	increase by more than 30%
Increase taxes **on fuel** by 10 cents at the pump	○	○	○	○	○	○	○	○	○
Introduce a tax **on gas** for individuals, increasing prices by 5%	○	○	○	○	○	○	○	○	○
Increase taxes on **airplane fuel** by €10 per flight hour	○	○	○	○	○	○	○	○	○
Introduce a **carbon VAT** on each good and service of 10 € for each ton of CO2 emitted during its production	○	○	○	○	○	○	○	○	○
Introduce a tax on **gas** for individuals, increasing prices by 10% for **the richest 30% of households**	○	○	○	○	○	○	○	○	○
Introduce a tax on **gas** for individuals, increasing prices by 10% for the **30% of households that consume the most gas**	○	○	○	○	○	○	○	○	○

Figure 30

B Proof

B.1 Welfarist objective and generalized weights

By definition of the maximum utility V, we have the following equivalence:

$$A = \iint_{\boldsymbol{\Theta}} \pi(\boldsymbol{\theta})\Phi'(V)\frac{\partial V(\boldsymbol{y}(\boldsymbol{\theta}),t)}{\partial t}dF(\boldsymbol{\theta}) = \iint_{\boldsymbol{\Theta}} \pi(\boldsymbol{\theta})\Phi'(V)[\frac{\partial V^p(\boldsymbol{y}(\boldsymbol{\theta}),t)}{\partial t} - \frac{\partial P}{\partial t}]dF(\boldsymbol{\theta})$$

Using the envelope theorem and the quasilinearity of the private utility: $\frac{\partial V(\boldsymbol{y}(\boldsymbol{\theta}),t)}{\partial t} = V^p_m W(\boldsymbol{y}(\boldsymbol{\theta})) = W(\boldsymbol{y}(\boldsymbol{\theta}))$. For all type $\boldsymbol{\theta}$, we define $\pi(\boldsymbol{\theta})$ so that $\pi(\boldsymbol{\theta})\Phi'(V) = g(\boldsymbol{\theta})$. By construction of $g(\boldsymbol{\theta})$, the integral of $g(\boldsymbol{\theta})$ over the type space equals 1. The result follows.

B.2 Desirability conditions for a progressive carbon tax reform

$\forall y \in \{\gamma, z\}$, $T(y) \in \{\mathcal{T}(\gamma), \mathscr{T}(z)\}$ and $W(y) \in \{\mathcal{W}(\gamma), \mathscr{W}(z)\}$, we note τ_y the compensated tax rate perturbation associated with $W_y(y)$ and $y^+ = \gamma + z$: Because of Equation (3), the derivative of the government's objective function can be written using generalized marginal welfare weights as :

$$\iint_{\boldsymbol{\Theta}} g(\boldsymbol{\theta})W(\boldsymbol{y}(\boldsymbol{\theta}))dF(\boldsymbol{\theta}) - \frac{\partial P}{\partial t} = \iint_{y^\varphi \leq y(\boldsymbol{\theta}) < y^\varphi + \epsilon} g(\boldsymbol{\theta})W(\boldsymbol{y}(\boldsymbol{\theta}))dF(\boldsymbol{\theta}) - \frac{\partial P}{\partial t}$$

we use Equation 4 to decompose $\frac{\partial x(\boldsymbol{\theta}),t}{\partial t}$ so that:

$$\frac{\partial R}{\partial t} = \iint_{y^{\varphi} \leq y(\boldsymbol{\theta}) < y^{\varphi}+\epsilon} [-W(\boldsymbol{y}(\boldsymbol{\theta})) + \frac{\partial y^{+}(\boldsymbol{\theta})}{\partial \tau_y} T_y(\boldsymbol{y}(\boldsymbol{\theta}))] dF(\boldsymbol{\theta})$$

(Because of the private utility's quasilinearity, we have: $\frac{\partial y^{+}(\boldsymbol{\theta})}{\partial \rho} = \frac{\partial(\gamma+z)}{\partial t} = 0$)

$$\frac{\partial P}{\partial t} = P' \iint_{y^{\varphi} \leq y(\boldsymbol{\theta}) < y^{\varphi}+\epsilon} [\frac{\partial \gamma^{+}(\boldsymbol{\theta})}{\partial \rho} W(\boldsymbol{y}(\boldsymbol{\theta})) + \frac{\partial \gamma^{+}(\boldsymbol{\theta})}{\partial \tau_y} W_y(\boldsymbol{y}(\boldsymbol{\theta}))] dF(\boldsymbol{\theta})$$

(Because of the private utility's quasilinearity, we have: $\frac{\partial \gamma(\boldsymbol{\theta})}{\partial \rho} = \frac{\partial m}{\partial t} = 1.$)

Because of the definition of φ we have the same cumulated density over $y^{\varphi}, \forall y \in \{z, \gamma\}$. Therefore, the lump sum impact of the two marginal reforms $W(y)$ on the government's objective function the lump sum pollution perturbation $\partial \gamma^{+}(\boldsymbol{\theta}) \partial \rho$ compensate each other. Similarly, the lump sum impact of the two marginal reforms $W(y)$ on the government's revenue compensate each other.

Therefore, the marginal impact of the two marginal reforms $W(y)$ on the government's objective function is equal to:

$$E_{\varphi} W(y^{\varphi} + \epsilon) + \frac{\partial P^{\mathcal{W}(\gamma)}}{\tau_{\gamma}} W(y^{\varphi} + \epsilon) - \frac{\partial P^{\mathscr{W}(z)}}{\tau_z} W(y^{\varphi} + \epsilon)$$

and the marginal impact of the two marginal reforms $W(y)$ on the government's revenue is equal to:

$$\frac{\partial R^{\mathcal{W}+\mathscr{W}}}{\partial t} = (-\frac{\partial R^{\mathcal{W}(\gamma)}}{\tau_{\gamma}} + \frac{\partial R^{\mathscr{W}(z)}}{\tau_z}) W(y^{\varphi} + \epsilon)$$

We redistribute lump sum $\frac{\partial R^{\mathcal{W}+\mathscr{W}}}{\partial t}$ to all individuals. The effect on the objective function is thus:

$$(\iint_{\boldsymbol{\Theta}} g(\boldsymbol{\theta})) dF(\boldsymbol{\theta}) - P') \frac{\partial R^{\mathcal{W}+\mathscr{W}}}{\partial t}$$

$\iint_{\boldsymbol{\Theta}} g(\boldsymbol{\theta})) dF(\boldsymbol{\theta}) = 1$ by construction of g. We sum the effects of the two marginal reforms $W(y)$ and of the net budget revenue lump sum transfer on the government's objective function, and divide by $W(y^{\varphi} + \epsilon)$. The tax reform desirability follows.

C Ensuring high quality responses

Ex-ante precautions In addition to the measures already mentioned in the main article, several ex-ante measures are designed to ensure high-quality responses.
First, semi-directed interviews as well as a careful examination of environmental policy press coverage, helped select the most easily understandable wording for new topics such as non-linear carbon taxes or carbon VAT.
Second, the first page emphasizes the importance of providing honest and best possible answers for the success of this academic project conducted by "university social science researchers". Respondents were also assured of the confidentiality of their data at the same time.
Second, the first page provides the first attention check which also requires a commitment on the part of respondents. Indeed, all those who do not answer "I would like to participate in this study and answer all questions, as honestly and carefully as possible up to the last question!" are excluded from the survey.
Third, a maximum time limit of 3 hours to complete the survey was set. This ensured that respondents kept in memory the information given by the treatments and the question order.
Finally, questions are designed to minimize careless answers. For instance, percentages are constrained to 100% and whenever possible respondents use sliders initialized at zero for such questions. According to the semi-directed interviews, consistent colors and tables were also deemed helpful for increasing attention.

Ex-post quality analysis First, analyses are conducted without respondents who completed the survey in less than 1/3 of the median time. This does not affect the results. These respondents represent only 2 % of the final sample. The time spent by the respondent on the survey as a whole, as well as on individual questions was indeed recorded. The distribution of survey duration for the control and the GHG distribution treatment is depicted in **??**

Then, reweighting the survey, — so that the targeted quotas would be exactly equal to those provided by the survey company—, does not affect the results as well.

Figure 31: Distribution of time spent on the survey for the final sample of the control and GHG distribution groups

