ERC Starting Grant 2025
Part B2[1]
(<u>not</u> evaluated in Step 1)

Section a. State-of-the-art and objectives

Standing halfway between the universal adoption of the Sustainable Development Goals (SDGs) in 2015 and their target date (2030), research shows that SDGs like the eradication of extreme poverty cannot be achieved without international transfers (Fabre 2024; Soergel et al. 2021). At international climate negotiations, Global South countries condition increased ambition on funding from the Global North. Many voices are therefore calling for the introduction of a global redistributive tax system, notably on CO_2 emissions. In September 2023, **the African Union adopted a declaration calling for a global carbon tax**, immediately supported by the president of the European Commission.[2] At the same time, the climate movement broadly supports the principle of a fossil fuel non-proliferation treaty that would include North-South transfers, in a spirit of climate justice.

As early as 1990, economists proposed the establishment of a *cap and share* **system: a global carbon market whose revenues would be allocated on an equal per capita basis** (Grubb 1990). High-income countries were quick to reject such a solution (Bertram 1992), which **would involve a transfer of around 1% of global GDP to lower-income countries**. This diplomatic rejection probably inhibited opinion surveys on the subject, as the first one was only published (in *Nature*) in 2019 (Carattini, Kallbekken, and Orlov 2019). Yet, despite this sort of taboo on the subject, **representative surveys indicate majority public support for such global redistribution policies, even in countries that would be net contributors**. In a working paper (Fabre, Douenne, and Mattauch 2023), I show, with the help of surveys on 56,000 respondents, that **support for a *cap and share* is** not only **very strong** in each of the 20 countries covered, but that **it is also sincere**. After ensuring that the policy is well understood (and in particular its negative impact on purchasing power in high-income countries), I show using randomized experiments that declared support is not subject to social desirability bias, and that a progressive candidate would gain voting intentions by adding *cap and share* to their program.

The hypothesis of this project is that a majority of the population (particularly in high-income countries) would accept a globally redistributive climate policy such as *cap and share* (involving massive international transfers compared with current transfers, but moderate transfers compared with redistributions occurring at national level). The project is divided into two parts. **The first part will test my hypothesis using new opinion surveys** of the public and elites **as well as semi-structured interviews**, in countries with a large carbon footprint per capita**.** In the light of previous results, I expect this hypothesis to be confirmed. **The second part will seek to draw the consequences of this new perspective towards a *cap and share*, established by an alliance of countries within a "climate coalition"**, by carrying out preparatory studies for its establishment. On the one hand, **I will simulate the economic effects of a *cap and share* using an integrated climate-economy-energy model**, with different scenarios for participation in the climate coalition. On the other hand, **I will study the dynamics linking carbon prices and oil (and gas) prices** for different scenarios of geopolitical alliances (climate coalition, cartel of oil-exporting countries).

The overarching objective of the project is to characterize the political feasibility, economic effects, and geopolitical implications of a *cap and share*, a global climate policy seeking both climate

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[1] Instructions for completing Part B2 can be found in the '*Information for Applicants to the Starting and Consolidator Grant 2025 Calls*'.
[2] Cf. the Nairobi declaration (African Union, 2023) and this Tweet from Ursula von der Leyen.

justice and universal support. Expected results include the magnitude and factors of public support, the gains and losses by income decile for each country, and the likely paths of oil price, carbon price, trade balances, and GDPs. With my results, I will elevate understanding of attitudes towards globally redistributive policies, sharpen economic projections of climate policies, and advance assessment of the power of oil exporters and the cost of securing energy supply during the decarbonization. I **will push the research frontier on three fronts by conducting semi-automatic interviews on a representative sample and by developing state-of-the-art models of both the climate-economy and the oil market**. The project's strength and originality lies in fully characterizing a policy with various disciplines and complementary methods.

Impacts and benefits of the project

The findings of Fabre et al. (2023) already attract a lot of interest, as shows their coverage in *Foreign Policy*[3] and the participation of climate negotiators from major countries (EU, China, India, Brazil, Germany…) to a roundtable I organized.[4] The impacts of the proposed project may be enormous. If the strong public support is confirmed and if I find viable a geopolitical scenario with a credible climate coalition and with sufficient North–South transfers to eradicate extreme poverty, my results could pave the way for a joint solution to climate change and global poverty. They have the **potential to reshape international climate negotiations** and political dynamics for the better.

For this reason, I will devote **particular efforts in popularizing the research results** and fostering a public debate. In particular, I will write a **book** in English for the general public, which should give ample opportunities to **intervene in the media**, and I will organize two **high-level workshops** with prominent scholars and climate negotiators. Upon publication of the book, I will submit a column to worldwide newspapers and popularize research results through online **infographics** and explainer **videos** (I am already experienced, with 5 columns in *Le Monde* and a YouTube channel).

I will leverage this opportunity to acquire the necessary leadership, supervision, and project management skills. I will develop my research group, by fitting at the center of an ambitious modelling effort in my own research institute. Through 14 research papers, I will make decisive contributions in four domains: the political economy of globally redistributive policies, the methodology of semi-structured interviews, integrated assessment modelling, and modelling of the oil market. This research together with the book and the planned workshops will bring international visibility to my career, and I will be recognized as a leading expert on international climate policy.
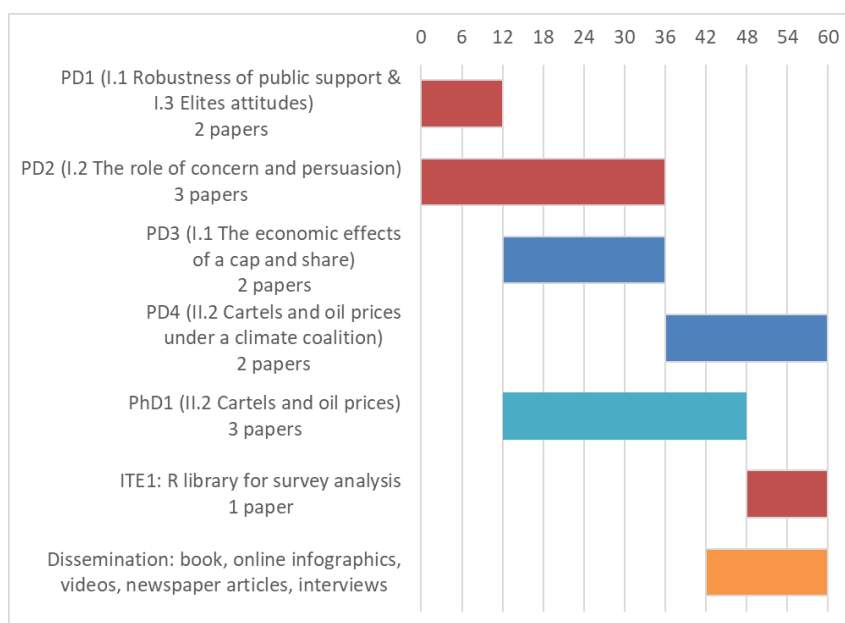

Figure 1 Gantt chart with personnel involvement and planned output (PD: Post-Doc, ITE: IT Engineer).

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[3] https://foreignpolicy.com/2023/09/14/foreign-aid-development-western-voters-governments/
[4] http://www.eaere-conferences.org/index.php?p=434

Section b. Methodology

Work Package I.   Acceptance of a *cap and share*

Duration: **36 months**; Personnel: **60 person.months (PD1**, **PD2**, **IT Engineer 1)**.

Although Fabre et al. (2023) find sincere public support for a *cap and share*, only a series of converging studies would confirm the depth of this support. I propose to carry out additional **surveys to test hypotheses that could temper the declared support**: warm glow, other antagonistic concerns, or concrete obstacles to the realization of a *cap and share*. Furthermore, I will also **interview a representative sample of the population face-to-face** to understand how people reason about this issue, and conduct a **survey on policymakers** to assess whether their attitudes are in line with the public at large.

Note that through the lens of *cap and share*, I will actually study broader attitudes towards global climate and redistributive policies, as *cap and share* embeds the key trade-off between the benefits and costs of such policies. Focusing on a specific policy brings concreteness and precision.

Task I.1 The robustness of public support

Main Contributions

The public support for internationally redistributive policies observed in previous surveys might have been overstated according to some hypotheses. **A first hypothesis is that** a large part of **the population supports** a policy of **global redistribution for as long as its implementation seems unlikely**, in order to ease their conscience. **If support were mainly due to such a psychological mechanism, called *warm glow*, it might dissipate when the prospect of the policy materializes (H1a) or if the policy can be replaced a less costly substitute with the same moral appeal (H1b).** Second, although previous surveys detailed the direct costs and opportunity costs of globally redistributive policies for the respondent and their fellow citizens, **the salience of global issues in the surveys may have created a context favorable to universalistic answers** (H2). Second, while previous surveys have tested truly global policies, the **support may be lower in the likely case where some countries do not participate** (H3). To assess the robustness of the strong support for a *cap and* share and other globally redistributive policies found in previous surveys, **I will conduct a new representative survey in the U.S., Japan, Russia, Saudi Arabia, and Europe**.

Relation to the literature

Noting that people engage in costly actions that benefit others, such as charity donations, Andreoni (1990) introduced the concept of *warm glow* in the realm of economics. This concept posits that people obtain a *warm glow* satisfaction by contributing to a public good irrespective of the impact of their contribution. As this form of altruism is impure, it can have perverse effects. For example, if people support a *cap and share* to appear generous and altruistic while not genuinely caring about extremely poor people or future generations vulnerable to climate change, they may change their mind once the policy becomes close to materializing. To measure warm glow, Nunes & Schokkaert (2003) assess the willingness to pay for two public goods separately vs. jointly. As the average willingness to pay jointly for the two public goods is equal to the maximum willingness to pay for each for them (rather than the sum), Nunes & Schokkaert (2003) identify warm glow (which can also be interpreted as satiation in public good provision). In other contexts, warm glow is not found. Comparing votes of workers either informed or not that their vote will be implemented, Bauer et al. (2021) reassuringly find that in both cases, workers express the same preference that their pension fund should invest in sustainable products.

Research in social psychology has shown that individuals often have ambivalent attitudes, linked to conflicting aspirations. Depending on the context, one facet of their identity is activated rather than another (Fielding & Hornsey, 2016; Kim et al., 2012). While previous surveys show that for most people, one facet of their identity is favorable to a globally redistributive climate policy (Fabre, Douenne, and Mattauch 2023), it remains unclear to what extent support for a *cap and share* is deeply entrenched or context-dependent.

Apart from the framing of the questionnaire, the content itself of the *cap and share* tested may have had a strong influence on the answers, and in particular its global aspect. In reality, there are few chances that countries such as Russia, Saudi Arabia or even the U.S. participate to a *cap and share* in the foreseeable future. Yet, attitudinal surveys on climate burden-sharing have consistently found that the larger the number of countries committing to an international climate policy, the stronger the support (Bechtel and Scheve 2013; Carlsson et al. 2013; Dabla-Norris et al. 2023; Gampfer, Bernauer, and Kachi 2014). Surely, a global *cap and share* is not the same policy as an international *cap and share* covering "only" 70% of global carbon emissions, as only the former has the capacity to stop global warming. But it is important to study the support for the latter, as prospects for a *cap and share* would vanish if there is no majority support in Europe for a non-global agreement.

Research plan

With a postdoc (*PD1,* over M1–M12, experienced in conducting surveys)**, I will run online representative surveys over 3,000 U.S. Americans, 2,000 Japanese, 1,000 Russians, 1,000 Saudis, and 5,000 Europeans (from France, Germany, Italy, Poland, Spain, Switzerland, and the UK).** The surveys will be translated and distributed through provision of services by a survey company. I will share the work with PD1 for the survey design, data analysis, and article writing.

To assess attitudes towards global redistribution in a neutral context and test H2, I plan to start the survey with a question on the preferred allocation of the revenues of a global tax. Refining Fabre et al. (2023), who only asked the share of revenues that should be allocated to low-income countries, the question will also **ask the respondents to allocate the budget accruing to their country among several categories: healthcare, education, energy transition, defense**, **development**, etc. Thereby, the framing will not emphasize development issues compared to national public goods.

Then, I **will split the sample into three random branches to test warm glow**. In the first branch, respondents will have to decide how much they would donate to a reforestation NGO, should they win the survey's lottery. In the second branch, respondents will be asked their support for a *cap and trade* without international transfers, where each country would rebate as equal cash transfers the revenues of a global carbon price collected on its territory. The third branch would serve as a control group. Then, I will ask all respondents whether they support a global *cap and share*. **Warm glow would be revealed if treated respondents support the *cap and share* less than the control group. Such result would indicate that the support (at least partially) derives from a moral satisfaction at having recently supported a just cause** (supporting H1b).

Next, I will verify that people consider the implementation of global redistribution policies unlikely, by asking **questions about the feasibility and obstacles to such policies**. I **will manipulate beliefs about the realism of such policies through a treatment** informing randomly drawn respondents that global redistribution policies are being discussed in international negotiations and could soon be implemented, since they are supported by most countries. Respondents will then be asked whether they support these policies: the Bridgetown Initiative to finance development, the Climate Change Loss and Damage Fund, and $100 billion per year for the Green Climate Fund. **Warm glow would be revealed if treated respondents support these policies less than the control group**, as this would indicate that respondents support global redistribution more when they have few chances to materialize (in line with H1a).

Building on Fabre et al. (2023)*,* who found that the median preferred share allocated to low-income countries is 30% in the U.S. and in Europe, the next question will **ask the support for an international tax on individual wealth with 30% funding low-income countries**. To test H3,

random variants of the question will **vary the set of countries that would implement the tax**: the whole world; all high-income countries; or several high-income countries. In this last case, I will give information on which countries would participate; for example, French people would read "several high-income countries (including Japan, Germany, Spain, the UK, but not the U.S.)" while Americans would read "including the EU but not Japan nor Canada".

Finally, I will complete the questionnaire with questions on global redistribution that have never been asked before. Similarly to the question on a non-global wealth tax, I will ask the **support for a non-global *cap and share***. I will ask the **preferred way to provide resources to low-income countries** (after detailing their pros and cons): direct transfers to the population, unconditional transfers to the governments, transfers to the governments conditioned on the respect of human rights and the rule of law, transfers to local governments, or to NGOs. I will also ask the **support for massive redistribution**, with additional taxes on individual income above €4,000 per month transferring 5% of high-income countries' GDP to low-income countries.

Addressing the limitations

While this survey addresses itself the limitations of previous surveys, it still suffers from one limitation: it mostly relies on closed questions. Through the use of qualitative methods, the following task will allow to more correctly interpret attitudes.

Guide "how to run a survey" and R library

After completing this new survey, **I will hire an IT engineer** (ITE1, M49–460, developer proficient in R) to turn scattered scripts **to easily cleanse survey data and generate graphs** (developed myself during my various survey projects) into a fully-fledge open-source **R library**. **I will write a paper on how to smoothly run a survey, offering** a streamlined process, tips, and **ready-to-use code**. This library will help researchers (including myself) running surveys more efficiently. I will maintain it over the long run (as I have the necessary developing skills in R).

Task I.2 The role of concern and persuasion

Main Contributions

In my surveys, I have made habit of including open-ended fields, reading them one by one and classifying them. These responses provide valuable insights into the way people think. But they suffer from a flaw: **many respondents don't fill in the open-ended fields**, or do so in a lapidary fashion. To uncover the mindset of these laconic respondents, **I hypothesize that the spoken word will prove more effective** than the written word. With the help of a postdoctoral researcher, I plan to conduct **two-part semi-structured interviews with 300 people**. The use of **videoconferencing** will allow conducting the interviews on a **representative sample** of the population, which is unusual in qualitative research. **In the first part, I will uncover the respondents' main political concerns and assess their attitude towards climate change, extreme poverty, and global redistribution. In the second part, the interviewer will discuss the pros and cons of a *cap and share*.** I will also conduct **in-depth interviews on 30 diverse people**.

On top of manually coding some characteristics of the interviewees (such as the tone or their attitude regarding *cap and share*), I **will automatically transcript the videos into text and classify the respondents' answers** using generative artificial intelligence (AI). The first part of this work will allow me to **reveal the correlations between respondents' concerns, political attitudes, their socio-demographic characteristics, and the way they speak. The second part will enable to estimate the proportion of respondents who can be influenced, their characteristics, and the most effective arguments**.

Relation to the literature

The first questions on respondents' concerns (in general and politically) relate to a large literature in political science. Despite early conflicting evidence (Niemi and Bartels 1985), **"issue salience"** – which designates **the priority attributed to a given issue – is** now widely acknowledged as **key in determining one's vote** (Dennison 2019; Edwards, Mitchell, and Welch 1995; Egan 2013; RePass 1971). For example, Dennison (2020) explains the rise of the far right in Europe with increased issue salience of immigration, while attitudes on immigration have remain stable or even improved in the last 15 years. Similarly, the support for global redistribution might be outshined by more prioritized concerns.

Despite a wealth of quantitative surveys on attitudes towards foreign aid (Bauhr et al., 2013; Gilens, 2001; Hudson & van Heerde, 2012; Kaufmann et al., 2019; Nair, 2018; Paxton & Knack, 2012), (multilateral) global redistribution has been seldom studied (Fabre, Douenne, and Mattauch 2023). Even on foreign aid, **qualitative methods have rarely been used**. Conducting 185 interviews of British people, Henson et al. (2010) finds that the general public perceives foreign aid as largely ineffective but ethically necessary. Interviewing 17 Icelanders, Ingham (2013) finds that development is confused with humanitarian aid.

After some pioneers conducted **sociological interviews through videoconferencing** (Deakin and Wakefield 2014), finding that most people prefer to be interviewed in video calls rather than phone calls (Mabragaña et al., 2013), this method **has exploded since** the **Covid** pandemic (Lobe et al., 2022). Provided that some safeguards are respected (such as offering phone call as a plan B to the interviewee), the experience of this new technology is overwhelmingly positive (Lobe et al., 2020).

With the recent advances of generative AI, researchers have also started to replace humans with machines in the time-consuming tasks of transcription and coding. Comparing different **transcription tools**, Wollin-Giering et al. (2024) find that the most accurate is *Whisper*, developed by OpenAI. Although Whisper is free, it requires a good graphic processor to run efficiently. **While transcription of a 3-minute speech takes more than 10 minutes by hand, it just takes 3 minute to manually correct the automatic transcription**. Concerning the classification of texts' topics, Gilardi et al. (2023) and Alizadeh et al. (2023) find that untrained ChatGPT-3.5 approaches the accuracy level of crowd-workers (at 65% vs. 70-73%). Moreover, Törnberg (2023) find that the more powerful model **ChatGPT-4 outperforms human classifiers.** Similarly, Heseltine & Clemm von Hohenberg (2024) find that ChatGPT-4 correctly classifies texts up to 95% of the time, and conclude that automatic coding is a cost-efficient and viable approach, especially when disagreements of multiple ChatGPT-4 runs are adjudicated by a human expert. Following a set of best practices established by Törnberg (2024), the use of ChatGPT-4 appears the most effective way to transcript and code my interviews. That being said, taking into account the warnings of several researchers (Kristensen-McLachlan et al., 2023; Pangakis et al., 2023; Weber & Reichardt, 2023), I **will replicate most of ChatGPT's coding manually to validate its use, employing live coding** (Parameswaran et al., 2020).

Chopra & Haaland (2023) go one step further: not only do they use an AI to summarize and classify the semi-structured interviews, they also replace the interviewer by ChatGPT and run the semi-structured interview by (written) chat. Although doing so allows scaling up the sample while dramatically reducing the cost of running interviews, it does not solve the problem that many people are unwilling to engage with open-ended questions (now asked in the form of a chat). As Chopra & Haaland (2023) admit that they screen out such respondents and that their sample is therefore not representative, I decided not to pursue this research design.

Research plan

For this project, **I will hire a post-doctoral scholar** (*PD2*, M1–M36, with perfect command of English and experienced in running semi-structured interviews). In my previous surveys, I recruited

a thousand anonymous volunteers for a videoconference interview, from the U.S., the UK, and France. I would like to use this sample of volunteers to get a representative (or at least diverse) sample of the population of these three countries. **I will run the interviews with French people while the post-doc will run the ones in English**. Although **the post-doc and myself will jointly conceive the final setup**, here is the setup I provisionally envision. The first part of the interview will be as close as possible as open-ended fields in a questionnaire (but I hypothesize that respondents will be more loquacious in front of the camera); while the second part will mimic a natural political discussion. **Except for in-depth ones, each interview will last 30 minutes**, complemented by a 5 min pre-session and a 5 min debriefing.

The first part of the interview will be conducted by a pre-recorded video (with only two versions: French and English), launched by the interviewer through screen-sharing. The respondent will be given a **predetermined amount of time to answer each question**, reminded with a timer, which will result in silence if they answer too briefly. This mode of interview guarantees that answers are not influenced by variations in the interviewer's intervention. **The questions asked will move from the general to the specific, starting with an enquiry into the respondent's current concerns in their life,** followed by their **political concerns and desires,** before moving on to the respondent's **thoughts on foreign policy, climate change, global poverty and**, finally**, global redistribution.** While I will adjust the questions, recording and timing in a pilot study, I think that the first two (broad) questions deserve 4 minutes each while the latter four (which are more specific) should be answered in 2 minutes each. In total (counting the time to ask the questions), **the first part** of the interview **will last 15 minutes**. It will be preceded by a pre-session of 5 minutes to make sure that the micro, audio, and internet connection work properly, introduce the setup, and make the respondent at their ease. During the first part of the interview, the interviewer will live-code the respondent's answers. **The content of answers will be coded** into broad categories: type(s) of **concerns** (e.g. health-related, sentimental, work-related, political), **political desires** (e.g. none, justice, security, public services, foreign affairs), **attitudes towards climate change, global poverty, and global redistribution** (e.g. undecided, support or oppose action). **The speech type will also be coded: its tone** (e.g. enthusiastic, angry, jaded, soft), **language style** (e.g. formal, colloquial, slang, grammar mistakes), and **prosody** (loudness, frequency of pauses, hesitation).

After the first part, a one-minute pre-recorded video will describe the *cap and share* policy to the respondents and **ask the respondent to either say "I support *cap and share*", "I oppose *cap and share*"**, or decline to answer. **In the second part, the interviewer will discuss the pros and cons of a *cap and share.*** At the beginning of the discussion, the interviewer will inform that there will be a time to debrief the first and second parts at the end of the interview and ask if the respondent has any questions about the *cap and share* proposal. After clarifying potential misunderstandings, the interviewer will **ask what are the pros and cons of the policy**. Then, the interviewer will **give arguments in favor or against *cap and share*, taking the position opposite to the respondent's if they expressed one, or taking a randomly drawn position for those who declined to answer. After at most 14 minutes, the interviewer will present again the pre-recorded question on support or opposition to the *cap and share***. The interviewer will only reveal at the end of the interview that they were tasked to take a specific side in the discussion.

At the end of each interview, the interviewer will code the second part. In particular, **the interviewer will record the initial and final position on the *cap and share*, will note which arguments they used, and which ones (if any) convinced the respondent**. Then, each interview will be **automatically transcribed into text** using Whisper and classified using ChatGPT-4. **On top of replicating the coding done by the interviewer, ChatGPT-4 will be tasked with classifying the arguments** used by the respondent in the second part, assessing whether the respondent respected the instructions, **counting the number of words** used to answer each question, **and coding the respondent's speech type** (tone, style, prosody). Mismatches between ChatGPT's and the interviewer's coding will be resolved by my team.

Finally, I will process the coded data to study **the correlations between respondents' concerns, their socio-demographic characteristics, speech type, and the content of their answers**. The second part will enable me to **estimate the proportion of respondents whose position** regarding a *cap and share* **is influenceable**, their characteristics, **and the most effective arguments**. Each of the two parts should lead to a separate research paper, written in collaboration with PD2.

Overall, this task will make use of **mixed methods** (Small 2011), with a systematic first part and a focused second part, although the current project is conceived as a **crossover analysis (quantitizing qualitative data)**.

Furthermore, my team will **perform** an integrative analysis by enhancing the correlational regressions with a **narrative analysis: the postdoc shall conduct 30 in-depth interviews** on a diverse sample of volunteers selected from the 300 interviewees. In-depth interviews may reveal reasoning or beliefs that people might conceal in short interviews. I **will compare the results obtained from both types of interviews with those from the surveys** to determine the extent to which they converge, a strategy called **concurrent triangulation** (Creswell and Creswell 2018). This last piece of work will lead to a third research paper in collaboration with PD2.

Addressing the limitations

The main limitation that I might face is a high non-response. If I do not succeed in recruiting 300 respondents from the pool of a thousand volunteers that I already have and from an equivalent pool of volunteers that I will build with the survey of Task 1.1, I may recruit additional respondents using a company specialized in providing panels.

Task I.3 The role of elites

Main Contributions

There are three possible explanations **why politicians do not propose global redistribution** policies such as *cap and share*, despite strong public support. First, **political elites could ignore or underestimate this support**. Second, they may **believe** (or know) **that key countries will never accept** such a proposal. Third, they may **hold specific knowledge that** would justify their opposition to such policies, as **these would be counter-productive or technically unfeasible**. To test these hypotheses, **I will send out a survey to climate negotiators** from all countries, Members of the European Parliament (**MEPs**) and Members of Parliament (**MPs**) **from various countries**.

Relation to the literature

This work would be in line with other surveys that have highlighted misperceptions by the U.S. Congress of the opinions of their constituents (Hertel-Fernandez et al., 2019; Mildenberger & Tingley, 2019) or uncovered varying discourses on justice depending on the origin of the climate negotiators (Lange et al., 2010).

Research plan

Obtaining the data should pose no difficulty, as I already have access to the list of e-mail addresses of climate negotiators, MEPs, and German, French, and Spanish MPs. I will **ask them** what is the best climate treaty that could happen, **whether they** would personally **support a *cap and share*, which countries are likely to participate, in which countries there would be majority support**, as well as the **pros and cons** of a *cap and share*. I will then analyze the knowledge, attitudes, and expectations of relevant elites regarding a *cap and share* and why such a proposal is not being discussed. This project should take 6 months and I may work with PD1 on it.

Addressing the limitations

Here again, the non-response may be the biggest challenge. If non-response remains high despite follow-up invites, I will send invites to a broader audience, such as MPs from more high-income countries, which can be scrapped on official websites.

WP II. The implications of a *cap and share*

Duration: **48 months**; Personnel: **72 person.months (PD3, PD4, PhD1)**.

Even without presuming the results of the first part of the project, the strong support for a *cap and share* revealed in my earlier surveys justifies serious modeling of such a policy. **In the first task** of this work package, **I will model the effects of a *cap and share* on each country's GDP, inequality and poverty**, assuming away any strategic behavior on the oil market, and assuming that all countries participate. **In the second task, I will explore different scenarios of geopolitical alliances, combining a climate coalition** (establishing a *cap and share*), **a cartel of oil producers, and oil producers allied to the coalition. For each scenario, I will estimate the surpluses of the coalition as well as each oil producer, and assess whether the scenario is viable** or whether deviations are profitable for some countries. The two tasks go hand in hand. Indeed, the model developed in the first task will inform the second task on the trajectory of oil demand. In turn, the results of the second task will be passed onto the first task's model to estimate the distributive effects of each scenario.

Task II.1 The economic effects of a *cap and share*

Main Contributions

The broad effects of a *cap and share* are well known: the policy **will bring carbon emissions down to zero and involve large transfers from high-emitters to low-emitters**, i.e. from the Global North to the Global South. The implied decarbonization and redistribution will foster profound changes on the structure of the world economy. To accurately understand this transformation, I need to **quantify the carbon price that will emerge from emissions trading as well as the effects of a *cap and share* on each country's GDP, trade balance and income distribution**. To model these effects, I **will push the research frontier on integrated assessment modelling, with** new features that will be openly available to the integrated assessment community. These features combine **the modelling of consumption-based emissions, purchasing power parity, and disaggregation at the country level**, in a model with endogenous production. Therefore, I will not only contribute to the understanding of *cap and share*, but of any future policy path.

Relation to the literature

The international transfers involved in a *cap and share* have already been estimated, but these estimates suffer from several shortcomings. Fabre et al. (2023) simulates the distributive effects between countries of a *cap and share*. Going a step further, **Young-Brun, Méjean & Zuber** (2023) extend the model NICE (Budolfson et al., 2021; Dennig et al., 2015) and **estimate the distributive effects of a *cap and share* not only between countries but also within country**, at the level of income decile in each of 179 countries. However, **Fabre et al.** (2023) **and Young-Brun et al.** (2023) **take the GDP trajectories as given**, and therefore do not model the feedback of

international transfers on each country's investment and growth. In other words, they assume that GDP trajectory is unaffected by transfers, even though the transfers received in a given year can be as large as half of GDP in the lowest income countries and would spur savings and investment in productive capacity. **Taking GDP trajectories as exogenous likely underestimates the reduction of poverty** implied by a *cap and share*. Using the REMIND model with endogenous GDP trajectories, Leimbach & Giannousakis (2019) estimate the mitigation costs and distributive effects of different burden-sharing principle, including a *cap and share*. However, with only 11 world regions, the regional aggregation of REMIND remains coarse. **The model KLEM, developed by Frédéric Ghersi and his team in my research institute, is one of the most disaggregated integrated assessment model that endogenises GDP trajectories, with 66 world regions** (Soummane, Ghersi, and Lefèvre 2019; Su et al. 2021). Furthermore, it has been coupled with POLES, a bottom-up model of the world energy system developed at the GAEL (in Grenoble). KLEM-POLES offers a detailed model of the economy-energy system which can be used to simulate the effects of an international emissions trading system on the production and consumption of oil, gas, coal, and electricity by country as well as on GDP trajectories.

To date, **databases of projections of climate–economy pathways** suffer from a limitation. First, they **project territorial emissions and not consumption-based emissions**. Yet, in the case of international carbon pricing, consumers incur a cost proportional to their carbon footprint (also called consumption-based emissions). Therefore, current data is ill-suited to model the effects of cross-border climate policies or carbon border adjustments. In particular, existing data underestimate the costs for net importing countries like the U.S. and overestimate the costs for exporting countries like China.

Second, integrated assessment models generally express their monetary variables either in nominal terms or in real terms. While inequality assessments are preferable in real terms, international transfers should be modelled in nominal terms. Indeed, in a *cap and share*, the carbon price would be uniform globally in nominal terms. **As their models are expressed in real terms,** Leimbach & Giannousakis (2019), Fabre et al. (2023), and Young-Brun et al. (2023) implicitly assume a carbon price expressed in real terms, i.e. a non-uniform carbon price. Consequently, **existing simulations of the effects of a *cap and share*** underestimate the financial gain expected in low-income countries**.

Research plan

To obtain a fine-grained model of the income distribution, purchasing power parity, and consumption-based emissions with endogenous production, I **will feed the model of Young-Brun, Méjean & Zuber** (2023) **with endogenous GDP trajectories from KLEM-POLES. I will hire a postdoc** (*PD3*, M13–36, experienced in integrated assessment modelling). While I will supervise PD3 and help take decisions, they will be the main person in charge of developing the code. We will jointly write (at least) two research papers. I plan to proceed as follows:
1. While monetary values are expressed in nominal terms in KLEM, this model also projects production in real terms and country-level price indices. Taking advantage of this feature, I **will express monetary values both in real and in nominal terms**, and obtain purchasing power parity conversion factors as the ratio of these two values.
2. To estimate consumption-based emissions, I will change the closure of KLEM, which currently assumes linear convergence of exogenous (non-energy) trade balances toward zero in 2050 (a strong but standard hypothesis). I will try alternative closures. First, I will simply delay the date of converge to 2100 or 2200. Second, I will feed the model's exogenous trade balances with projections of trade balances from the literature (Bekkers et al. 2020). Then, I **will pursue two strategies in parallel to estimate consumption-based emissions** and check that they yield comparable results:
2.a. I **will predict the ratio of consumption-based over territorial emissions of a country using its GDP per capita and trade balance** from recent data, and apply this prediction to the model's projections.

2.b. I will impute the world's carbon intensity to non-energy imported goods. As KLEM-POLES projects the trade balance in energy and non-energy goods as well as the purchasing power parity in each region, I will be able to **compute the carbon content of imports** of each energy and non-energy goods.

3. I will run KLEM-POLES and obtain its projected trajectories for each of the 66 regions' GDP and consumption-based emissions.

4. For the regions which combine several countries, I will downscale the projected trajectories at the country level following the canonical procedure (van Vuuren et al., 2007).

5. I will feed the model by Young-Brun et al. (2023) with the national projections, run it, and estimate the evolution of the income distribution as well as climate damages country by country.

Finally, I will obtain the total net gains of a *cap and share* at the decile-country-decade level, with its different components: the revenue from the lump-sum transfer, the cost of carbon pricing, and that of climate damages. Although the focus of my project is *cap and share*, my model will be readily usable to project non-global climate policies as well as other burden-sharing principles.

Addressing the limitations

In this project, I will build a state-of-the-art model to estimate the economic effects of international climate policy. However, the model will still suffer from some limitations that will call for further improvements. First, the model by Young-Brun et al. (2023) assumes a lognormal distribution of income in each country, estimated using data on Gini coefficients. Yet, it is well-known that income distribution is more skewed than a lognormal distribution and that, although lognormality is an accurate description of the bottom and middle of the distribution, the very top of the distribution is more accurately described by a power law. I **intend to refine the representation of a country's income distribution in Young-Brun et al.** (2023) **by injecting percentile-level data on the post-tax income distribution from the World Inequality Database**.

Second, the redistribution implied by a *cap and share* will entail a structural transformation of the world economy, with a decrease in the consumption of luxury goods like flights, an increase in the consumption of basic goods like staple food, and associated changes in relative prices**. To accurately capture** these **structural transformations and estimate the effects on employment and inflation in each country, I would need to use a Computable General Equilibrium model** with multiple sectors. **The model IMACLIM-R developed at CIRED (my research institute) would be fit for that purpose,** and as the second deliverable (and research paper) of this task, **I will model a *cap and share* in IMACLIM**.

Task II.2 Cartels and oil prices in the event of a climate coalition

Main Contributions

If a climate coalition covering most of the world's emissions comes into being and defines the coalition's emissions trajectory in advance, oil producers will be able to accurately predict future demand. Depending on the structure of the oil market, two polar cases are conceivable. Either the market is competitive and oil producers, knowing that some reserves will remain unexploited, reduce their rents in order to sell their reserves before their competitors. Or oil exporters form a cartel, adjust their production to the coalition's demand, and pocket maximum rents. **In the case of a cartel, the carbon price within the coalition could be close to zero, with potential carbon pricing revenues captured by the cartel. One solution for the coalition would be to enter into long-term oil purchase contracts** with certain exporters (hereafter their *partners*), in order to get them to deviate from the cartel: although they would get a lower price for their oil, these deviating exporters would gain since they would sell their entire reserve. A credible threat of such contracts could be enough to prevent cartelization and make the market close to competitive.

A first output of this project will consist of **an online tool** allowing the user **to** define a carbon budget, a climate coalition, and the coalition's oil producer partners, which would then **estimate the coalition's oil demand and the oil reserves of the coalition together with its partners'**. This will provide a **first indication of the energy security that the partners would bring to the coalition**. I would also simulate the associated temperature trajectory and the coalition's carbon revenues, making simplifying assumptions on oil prices and demand outside the coalition.

The final output of this project will be a characterization of the possible geopolitical alliances and their implications on the carbon price, fossil fuel prices, and the gains and losses by country.

Relation to the literature

Theoretical literature has already described the various scenarios and mechanisms at work but realistic simulations have yet to be conducted. Tahvonen (1996) shows that cartelization of the producers reduces the carbon price (and carbon revenues) that the buyers implement to limit climate damages, but also finds that buyers' monopsony power mitigates this effect. In a Hotelling model without a substitute for fossil fuels, Asheim (2013) argues that fossil resources will be depleted unless they are bought or confiscated by a benevolent government. Asheim (2013) also shows that confiscating resources in excess of the carbon budget is distributionally equivalent to grandfathering the extraction quotas to resource owners and leaves their wealth unaffected, as the increase in price compensates the lower quantity. Studying the interplay between a climate coalition and a cartel of fossil resource owners, Harstad (2012) shows that it is first-best that the coalition buys resources to the owners in a static model, while Eichner et al. (2023) finds it second-best in a dynamic one. A strand of the theoretical literature analyzes the interplay between the carbon price and the oil price depending on the oil market structure (Benchekroun, van der Meijden, and Withagen 2019; 2020; Benchekroun and Withagen 2012; van der Meijden, van der Ploeg, and Withagen 2015; van der Meijden, Withagen, and Benchekroun 2022; van der Ploeg 2020). Benchekroun, van der Meijden & Withagen (2023) generalize over preceding models by studying the case with oligopolists, a price-taking fringe and a renewable backstop, where oil extraction costs are convex and stock-dependent. These assumptions are justified by the empirical literature on the behavior of OPEC, which finds that OPEC producers act more often like oligopolists than a collusive cartel (Almoguera et al., 2011; Griffin, 1985; Kisswani, 2016; Smith, 2005). Okullo & Reynès (2016) derive a numerical model of the oil market, with decisions in 18 regions on production and expansion of production capacity, given their geological constraints but without a renewable substitute. As they run the model under different market structures, from competitive to full collusion, including oligopoly and imperfect collusion, they show that most OPEC members gain the most under imperfect collusion, which may explain the empirical findings that OPEC does not behave as a perfect cartel. While Okullo & Reynès (2016) calibrate their model using country-level data sources (from BP, OPEC, USGS); Coulomb et al. (2023) use proprietary data (from Rystad) that includes reserves and extraction costs by deposit. In their work assessing the misallocation of oil extraction, Coulomb et al. (2023) also estimate the production capacity and marginal cost curve for each deposit.

Research plan

I will hire a postdoc (*PD4*, M37–M60, specialized in game theory or reinforcement learning) **and a PhD candidate** (*PhD1*, M13–M48, trained as an economist). **To conduct realistic simulations of the oil market in different scenarios,** I **will combine the most detailed models and data sources to build a state-of-the-art model of the oil market**. I will incorporate the realistic extraction cost functions and the modelling of extraction capacity of Okullo & Reynès (2016) into a numerical version of the model of Benchekroun, van der Meijden & Withagen (2023). The oil producers will be made asymmetric and their characteristics calibrated using the fine-grained procedure used by Coulomb et al. (2023). Note that even if producers are oligopolists by default,

the model can accommodate a cartel by merging several producers into one. Although the OPEC does not generally behave as a cartel, it has been able to collude at times (e.g. in 1980-1981). Therefore, I **will simulate scenarios with an oil cartel to study how the climate coalition would be affected in the worst case**.

Once the model is ready, here is how I plan to analyze the geopolitical struggle for the oil rent and carbon price revenues. I compare a couple of plausible scenarios. **Each scenario is a combination of** geopolitical alliances, where each country is either member of the **climate coalition** (which respects a carbon budget) or not, and each oil producing country is either member of the **oil cartel**, **partner to the coalition**, or (by default) oligopolist. **Each coalition's partner** negotiates a long-term purchase contract with the coalition, modelled as the **sale** of **their oil reserves to the coalition** at a pre-agreed price. The coalition is assumed to manage its partners' reserves in perfect collusion and to restrict their use to the coalition's market. The coalition purchases oil in the world market if the marginal extraction cost of its partners exceeds the world oil price. In this case, the oil price (net of carbon pricing) in the coalition equals the world price; otherwise, it is lower. The coalition's surplus is the net present value of its carbon price revenues plus its oil rent (including its partners' rent) minus the purchase of its partners' reserves. The surplus of oligopolists and of the cartel is their respective cumulative oil rent (i.e. the product of their sales by the world price net of extraction costs). To estimate how the cartel's surplus is shared among its members, I compute two benchmark surpluses for each cartelist: the Nash bargaining solution and the maximum surplus, i.e. the best share that the member can get in a feasible agreement – where all other members are just better off than being oligopolist).
To study this game for a given scenario, I proceed as follows:

A. Set up the model
1. Given the carbon budget, I **compute the coalitions' oil demand** and consumer price (i.e. the oil price plus the carbon price). As a first approximation, I derive them using the model of Section II.1, which optimizes the coalition's consumption of oil, gas and coal in an oligopolistic energy market.
2. Given the scenario and taking the coalition's oil demand as exogenous, I **solve the model and obtain the trajectories of the world oil price and oil extraction by country**.
3. I **deduce the surpluses** of oligopolists and cartelists.
4. Before estimating the reserve (or minimum) price at which a partner would accept to sell its reserves, I run the steps 1 to 3 for all the scenarios considered. I then define the reserve price of a partner as the highest surplus it can get in an alternative scenario with: the same *coalition*, a subset for the *partners* (which excludes at least the partner under consideration) and a superset for the *cartel*. In particular, the reserve price is at least equal to the surplus of the partner if it deviates and becomes an oligopolist or a cartelist. By considering more scenarios than these two, I conservatively allow for joint deviation of multiple partners or oligopolists (into cartelists or oligopolists).
5. I compute the coalition's maximum surplus using its partners' reserve prices.

B. Distributive analysis
Assuming that the purchase contracts are set so that the coalition obtains its maximum surplus**, I obtain a set of scenarios with their associated surpluses. I can now feed these results into the model of Section II.1 to estimate the distributive effects of selected scenarios**. I **expect to** find out that part of the coalition's carbon price revenues estimated in integrated assessment models will be captured by the cartel, and to **identify some countries that would make good partners for the coalition**.

C. Applied analysis
To begin this analysis, one can take **one scenario of reference**, with the coalition formed by the EU, China, South Asia, South-East Asia, Africa, and South America; OPEC+ as a cartel; and no oil partner. Then, one can consider close scenarios where oil partners are introduced. This allows to answer a key research question: **What reserves should the coalition buy** (i.e. what partnerships should it form) **to** maximize its welfare and **secure its oil supply?** In particular, should it form partnerships with countries that have low, middle, or high extraction costs? Then, one can study

what happens if the U.S. enters the coalition, if China does not enter it, or if the coalition breaks down entirely. What if one OPEC+ country deviates and becomes a partner? What are the effects of these alternative coalitions on the surplus of OPEC+ and on oil prices?

D. Full model solving

After this second research output, I systematize the analysis and improve the estimation of surpluses. While step 4 compute reserve prices such that deviations of *partners* are not profitable, I now also consider possible deviations of the coalition and cartelists from the scenario of reference:

6. I run all such scenarios until step 5 and build the directed acyclic graph of scenarios, where edges from one scenario to another represent a unilateral deviation out of a partnership or into the cartel. I **sort the scenarios by** (the reverse of an arbitrary) **topological ordering**, from the scenario with all oil producers in the cartel to the one with all producers as partners.

7. I **purge scenarios that are unviable** by checking each scenario in that (topological) order. To assess whether the scenario is viable, I **check that there is no profitable deviation for a cartelist to become an oligopolist; no profitable deviation for the coalition to revoke a partner** (and make it an oligopolist or a cartelist); **and that the coalition's surplus is positive**. If a scenario is unviable, I propagate updated (and lower) reserve prices through scenarios with just one additional partner (switching one of the scenario's cartelists or oligopolists), by replacing its surplus by the highest surplus it would obtain in the remaining descendent scenarios.

8. Note that by definition, **the scenario with only oligopolists is viable**, so the set of viable scenarios is non-empty. I push the analysis further by iteratively purging Pareto-dominated scenarios.

9. For a given climate coalition, I **select three scenarios: the one with only oligopolists; the one that maximizes the coalition's maximum surplus; and the one that maximizes the coalition's maximum surplus among viable scenarios with the largest cartel**. In the two latter cases, I borrow from the theory of auctions and define the coalition's expected surplus as its "second-highest surplus", i.e. its highest maximum surplus among scenarios where some partner deviates. **I deduce the expected purchase contracts** from the expected surplus by assuming Nash bargaining between partners. Rather than by a brute force algorithm, I may find these scenarios using multi-agent reinforcement learning or evolutionary algorithms (Zhang et al. 2022).

Finally, I **obtain a complete characterization of viable scenarios with their associated expected surpluses, which I feed into the model of Section II.1 to estimate their distributive effects**.

I will supervise PhD1 and PD4 in setting up the model, putting it to the data, and running it. The three of us will jointly develop the (open-source) code. I plan to write four joint research papers to describe the model set-up, the full solving, derive some extensions (described below), and run the distributive analysis. On top of that, I will encourage PhD1 to write a *job market paper* as sole author, by combining a toy model to study analytically a research question from part C, and an applied analysis to numerically solve this question using the fully-fledged model.

Addressing the limitations

While the above model will already expand the research frontier, I will refine the analysis further to **address two limitations**. First, I **will extend the model to gas and coal**. As a first approximation, I will model one world oligopolistic market for coal and several regional ones for gas.

Second, I will consider potential retaliations by countries outside the coalition: non-partners may try to undersell their oil to make some partnerships unprofitable to the coalition, while countries outside the coalition may attempt to poach some partners by overbidding the coalition. While both types of retaliations risk jeopardizing some partnerships, they act through opposite effects on the world oil price. The overall effect on the world oil price and the coalition's surplus will depend on the oil demand share of the coalition and the oil reserves of non-partners. A first step will consist of **identifying with expert judgment key potential retaliations** in the most credible scenarios. The ultimate objective is to obtain convergence of a fully-fledge model where countries outside the coalition can also form purchase contracts, using reinforcement learning or evolutionary algorithms.

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Appendix: All current grants and on-going / submitted grant applications of the PI (Funding ID)

<u>Mandatory information</u> (does not count towards page limits)

Current research grants (Please indicate "No funding" when applicable):

Project Title	Funding source	Amount (Euros)	Period	Role of the PI	Relation to current ERC proposal[5]
cap_and_share	Agence Nationale de la Recherche (ANR)	264,460.68€	01/2025 – 12/2028	PI	While it shares its overall objective, the ERC grant would considerably broaden and deepen the ANR project, by funding new tasks as well as more sophisticated and refined modelling thanks to more personnel, by funding more data collection (in particular allowing for qualitative interviews, oil data, and expanded country coverage in the surveys), and improved dissemination (book, workshops, infographics, open access publications). I would renounce to the ANR grant if I obtain the ERC one.

On-going / submitted grant applications (Please indicate "None" when applicable):

Project Title	Funding source	Amount (Euros)	Period	Role of the PI	Relation to current ERC proposal[2]
None					

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[5] Describe clearly any scientific overlap between your ERC application and the current research grant or on-going grant application.