The personal airplane carbon exchange (PACE):

Design and CO2 emissions reduction: The French example

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Motivation

- Suppose we aim for net zero in 2050 as signed in the Paris Agreement. (Ten years ago)
- Policy Improvements have been made (in Europe, in China,…)
- But the path of global warming seems to be ahead of projections ten years ago
- The distributive effects of green policy have been challenged
  - At the national level: the « Yellow Vest » demonstration in France
  - At the international level, a conflict about how much the rich countries should fund the least developed countries' transition to a decarbonized economy.

Upstream vs downstream policies

- Either you regulate the supply side through mix of price and regulation
  - Example of the EU-ETS for industry and car industry in EU
  - The « good » aspect is that the household redistributive impact is quite obscure…
  - The bad is that you may hinder your domestic industry at least in the short run.

- Or you regulate the demand side through mix of price and regulation
  - The good aspect is that all providers national or foreign are put on the same footing
  - The bad aspect (at least from a political view) is that the distributive burden of the policy is clearer and the political cost may be high

The specific position of air transport

- Protected by the Chicago Convention
  - International mobility is good (mobility of goods and persons)
- The kerosene is no taxed
- Efficient upstream and downstream policies are almost absent
- The increase in demand: the airplane traffic is estimated to double in the next 20 years
- No technological leap over the next 20 years
- Up to now, the users disproportionately affluent people

The air travel barrier

- For any attempt to follow a carbon pricing policy on the demand side, air travel is a good candidate
  - Climate externalities are not internalized
  - The working class and the poor are not the main clients
  - Not a primary good
  - Growth seems uncontrolled
- Meaning that, on the opposite, a carbon pricing policy on the demand side without air travel seems a no-way

Our proposal: PACE at a national level

- Looking at the feasibility of a personal carbon account for air travel
- Uniform Quota of CO2 allowance in each year
- Exchanges possible at social cost of carbon each year
- Different from mechanism where the price is an equilibrium price
- The social cost of carbon follows a trajectory to reach the net-zero target

Outline

1. The policy framework of air transportation in France and EU
2. The PACE design
3. An estimation of the decrease in emissions following the PACE introduction after one year
4. Open issues
5. Concluding comments

1. The policy framework of air transportation in France and EU

Obeys national, EU and international regulations

French policies

- Regulation, fast train subsidies between big cities, and taxes
- 2023 decree: Forbidden to take a domestic flight if your French destination (maybe an airport) can be reached by a less than 2H30 train trip.
- High-speed train investment policies
- Different taxes about €2.5 bn revenues with an increase to €3 bn in 2025 (with a more progressive impact but no direct link with flight emission)
- Domestic air traffic in 2024 is still more than 10% down on 2019

French Policy (cont'd): French opinion

- French people are keen to increase taxes on air travel
  - According to Dechezleprêtre et al. (2022), 45% favor a tax increase against 35%
  - But they are the least to support a carbon tax (29%) against (37% for other countries)

- Asked whether a carbon tax with transfers will be fair, only 22% of French people say yes (Western countries 35%)

- Policies supported by the French
  - Limiting air travel by 56% in favor
  - Change of attitude of the affluent by 59%

EU policy

- Since 2013, flights over the European Economic Area are covered by EU-ETS
- Airline quotas are distributed free of charge for 85% of the total carbon budget allocated to an airline in 2024
- Taking into account the air traffic increase since 20 years, it represents less than 50% of emissions free of charge
- First semester 2023, the carbon ton price = €85.
- Fageda and Teixido (2022) estimate the ETS system helps save 3 million tons of CO2 at the European scale.

EU policy (cont'd)

- Ramping-up of EU-ETS with less and less free quotas, meaning that its pressure in Europe will increase over time.
  - But the EU-ETS do not account for the effect of aircraft contrails (over 70% more equivalent CO2 emissions)
  - But the proposal of the European Commission of a kerosene tax blocked by several countries in 2024.
  - Incertainty about the commitment of the actual European Commission and Parliament to a Green policy
- Air traffic in Europe is likely under control but no guarantee that the emissions will decrease

International Commitments

- CORSIA 2020 (IATA)
  - Countries commit to limit emissions in 2050 to 2020 level
  - Comparison: France has to divide them globally by a factor of 5.
  - If both promises are kept, air travel 1/3 of total emissions in 2050
  - Proost and Van der Loo (2023): many weaknesses (lack of control of offsets)
- No breaking mechanism for intercontinental air traffic.

2. PACE design

- Evil in the details
- Points to watch
  - Being easily massively bypassed
  - Being too complex to manage
  - Being contrary to national laws or international commitments
- At the end, is it a white elephant?

How would it work?

- Commercial flights
- It would be inconceivable that private jet flights will not pay the same social cost of carbon.
- Air freight covered by EU-ETS

- Depending crucially on the characteristics of air transport, airline tickets are nominative. Then your air-travel carbon emissions are traceable.

Who is concerned?

- French nationals (living in France or abroad) plus foreign residents (to avoid nondiscrimination)
- Domestic flights and international flights from and to French airports
- Airlines serving the French airports
- Each concerned person (adult, a special treatment for minors) (French ID card or resident permit in France) becomes the holder of an air carbon account, through an app called PACE (they will receive a message on their cell phone)
  - It keeps your record of carbon allowances and carbon permit purchases.
  - A uniform carbon allowance is granted for free
  - You can buy and sell air carbon at a given price fixed each year by the national agency.
  - The public cost of running this app is estimated to be less than 1% of the total carbon exchanges in a given year

Carry over policy

- Carbon credits are purely personal and are not transferable even within a family
- They cannot be carried forward from one year to the next, at least at the beginning of operating the system
- To avoid retention and speculation.
- The statutory carbon price will increase over time. In case of retention, the mechanism can be blocked and the state agency should sell much more carbon credits than those initially emitted.

What about business flights? (28% of total trips)

- All companies operating in France would have a carbon account but with no free allowances.
- They can buy at the same social cost of carbon any air carbon amount for business flights.
- Better to introduce this at the EU-level. Increasing operating costs for French firms
- International company can bypass by organizing meetings in person in France !

What does PACE change for the traveler?

1. *Ticket purchase*: Nothing changes except the information about the carbon emission of the flight and French ID card or resident permit in France. The airline asks the app whether the traveler has to declare his trip on Page App.

2. Declaration of the trip on the PAGE app. The traveler is informed of the carbon footprint of her flight and if she hasn't enough carbon credits on her account, she has to buy them. Then the PAGE app generates a QR code.

3. Check-in: The airline is informed by the App whether a person has to register. The traveler has to show the QR code to get her boarding pass. The carbon account is then debited.

4. *Boarding*: The airline controls the identity. Nothing new

Possibilities of avoidance

- For French citizens, for the return trip, choose a foreign airport close to France and use an alternative means of transport (London, Bruxelles, Luxembourg, Frankfurt)

- For a citizen from a non-EU country, having a residence permit is compulsory. If a register of foreigners in France is established, they are included in the PACE App.

- For a citizen from an EU country living in France, not compulsory to have a resident permit. So no register, and then they can avoid PACE

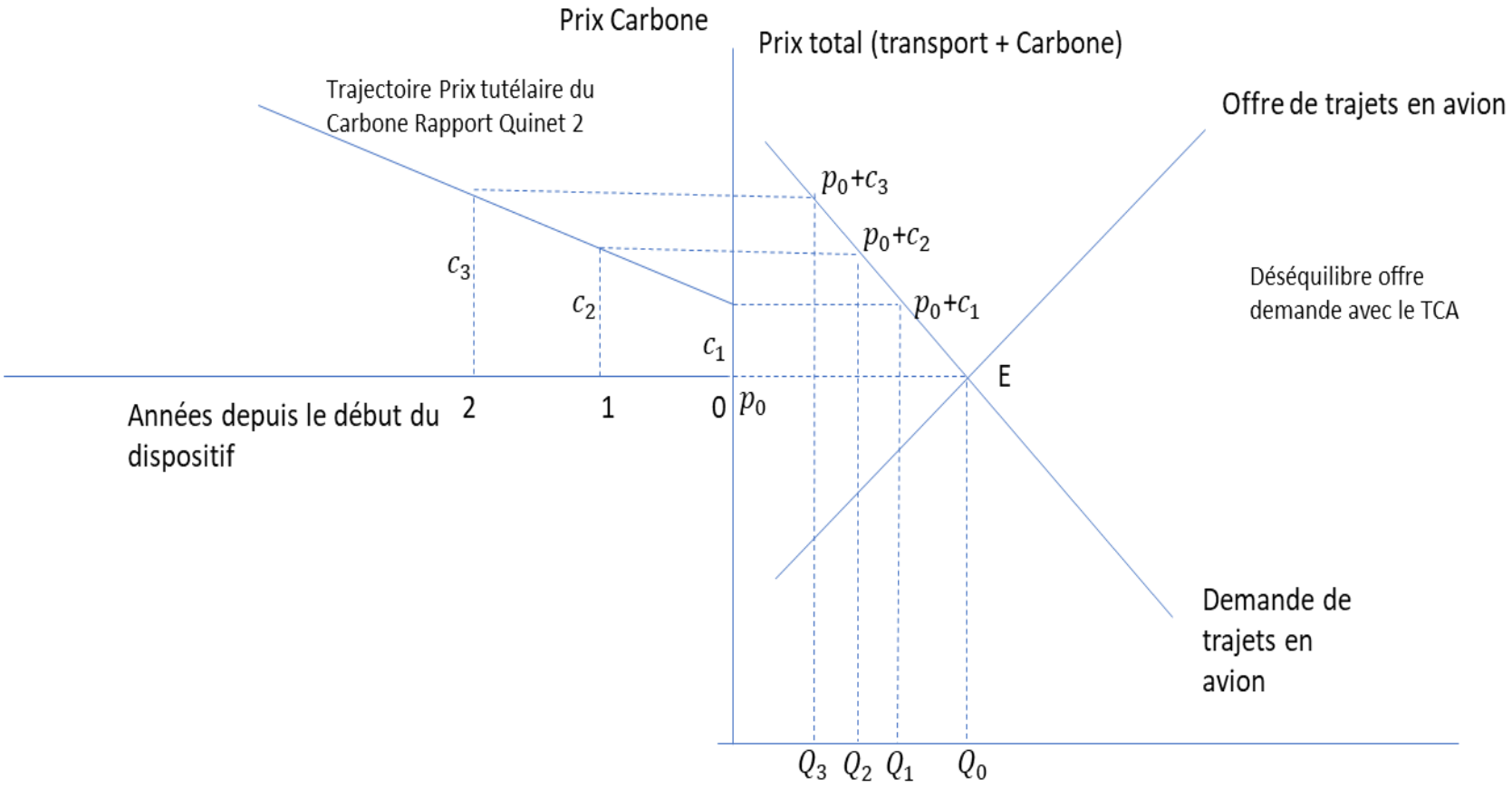
Pricing and the dynamics of the system

- Carbon price for the initial year: €100
- The number of concerned individuals (incl. overseas): 69 million
- The air carbon emission (DGAC) in 2019 the same level in 2025 or 2026: 25 million tons
- The ratio = 0.360, equivalent to the emissions of a return trip Paris-Marrakech
- Rounded up 0.4 ton
- Paris New York about 1 ton, then costs €60 more

Excess of supply over demand

- You can sell or buy at any time at the statutory price. The state agency is the counterparty.
- The initial year, the emitted carbon credits are equal to the carbon emissions of the previous year.
- The year before introducing PACE, carbon was free
- Since the year after, carbon no more free, then the demand for air carbon is expected to be lower than the amount of distributed quotas
- Induce an excess of supply over demand and a deficit for the state agency?
- To account for a non-take-up rate, the elderly, in particular, may not be able to sell.

The dynamics



The linkage with EU-ETS (1)

- 2 adjustments to make PACE and EU-ETS complementary

1. Reduce the total quota reserved for airlines operating in Europe by the exact diminution of French air carbon emissions in Europe.

    - Quotas to an airline are granted according to the relative share of emissions of this airline in the total emissions.

    - Otherwise, the PACE won't have any effect in Europe, the quotas increase for operating in other European countries, offsetting the decrease in France

The linkage with EU-ETS (2)

Suppose that in the future

- (1) no more free permits will be allocated to the airline industry
- (2) the price of carbon in the EU-ETS approaches €100

- The airlines in Europe can say: we don't want our consumers to pay twice, once indirectly through the EU-ETS and the second time with PACE. They will have a point

- In that case, still a role for PACE for European flights.PACE will serve to internalize the contrail impact.

- So instead of a carbon price of €100, fix a reference carbon price of €170
    1. For non-EU travel, the PACE buying price will be €170
    2. For EU travel, the PACE buying price will €170 - the EU-ETS price
    3. The PACE selling price will be a convex average of both, reflecting the share of air travel EU vs Non-EU

Legal considerations

- PACE is kind of bonus-malus system applied to the purchase of airline tickets linked to be a French citizenship or French residency.
- Not contrary to constitutional principles
- Not contrary to the Chicago convention (non-taxation of kerosene for international flights)
- Not contrary to the « excise duties » European directive: fuel used for air navigation exempted
- Domestic mechanism for organizing inter-individual transfers

3. The PACE impact on carbon emissions

- Estimate the reduction of passenger air traffic
- Assuming full pass-through to the traveler of the social price of carbon and no reduction of flights
- Assuming that the traveler understands that the opportunity cost of air flight increases by €100 per CO2 ton emitted.
  - Neglecting the income effect of the PAGE mechanism
- Translating this decrease in demand into a decrease in carbon emissions

Two data sets

1. DGAC (Directorate of Civil Aircraft) data set for 2023
   - All recorded flights from and to the 15th most busy French airports
   - The origin and the destination and the effective distance which is crucial for carbon emissions
   - The price missing

2. Data from the aviation integrated model (UCL) for 2015

Record the prices for economy class for 760,000 flights worldwide

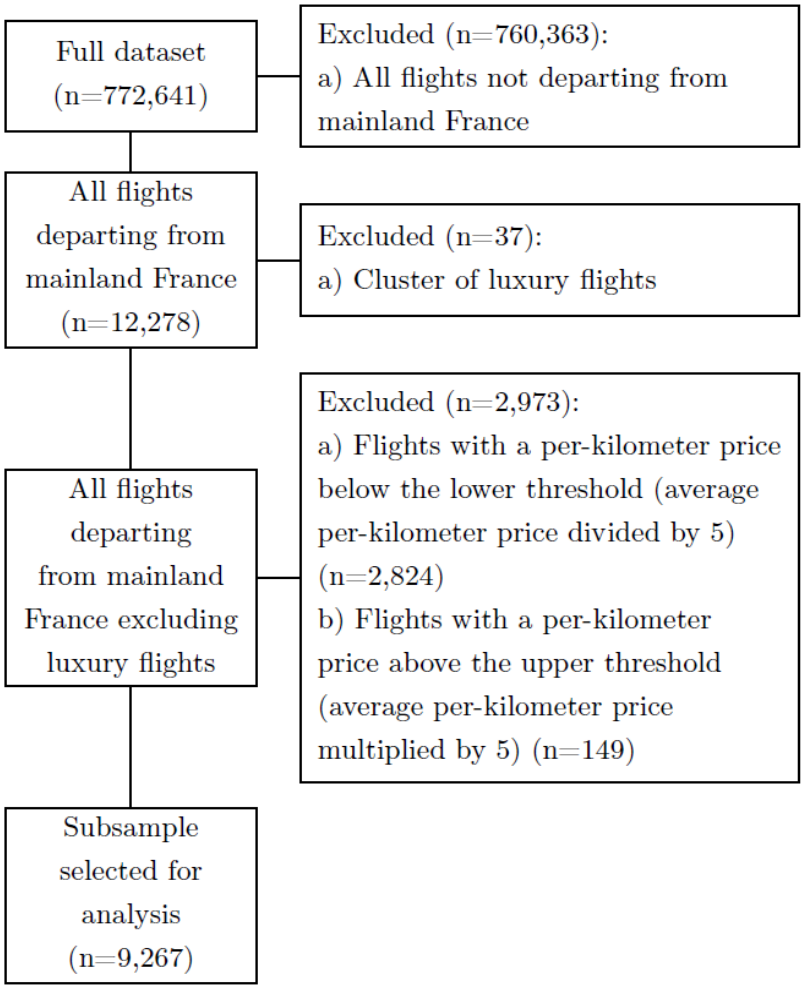
The main idea and assumption

- Regression analysis to explain the airfare in the UCL database with a bunch of covariates (distance, continent, country) for the subset of flights from and to France

- To impute airfares in 2015 for the flights present on the DGAC basis using the UCL regression.

- Then, uprate the imputed airfare with a specific inflation rate net for each flight category for the period 2015-2023. (inflation rates provided by the DGAC)

The selecting sample



	(1) log_Fare_2023
Distance	0.000160*** (0.00000795)
Distance_squared	-2.91e-09*** (3.93e-10)
log_PIB_hab_23	0.0792*** (0.00809)
East Asia & Pacific	(.)
Europe outside the Schengen Area and Central Asia	-0.0697** (0.0349)
Intra_Schengen	-0.0816** (0.0404)
Latin America & Caribbean	0.274*** (0.0203)
Middle East & North Africa	0.237*** (0.0371)
North America	0.238*** (0.0252)
South Asia	0.107*** (0.0335)
Sub-Saharan Africa	0.657*** (0.0318)
Minimum elevation of the urban area	0.00207*** (0.000147)
Maximum elevation of the urban area	-0.0000549*** (0.0000180)
Average elevation of the urban area	0.0000382 (0.000129)
Origin population in 2015 (GHS)	1.27e-08*** (1.88e-09)
Destination population in 2015 (GHS)	1.97e-08*** (1.37e-09)
Distance to the sea from the origin (meters)	-0.00000119*** (8.66e-08)
Distance to the sea from the destination (meters)	6.03e-08*** (1.53e-08)
Constant	4.551*** (0.0932)
Observations	8940
R-squared	0.590

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

The uprate

Departure	Zone_INSEE	Travel	Traffic flows	2015	2023
Mainland_France	Total Domestic Traffic	Domestic	Domestic Metropolitan	100	127,182
Mainland_France	Total Domestic Traffic	Domestic	DOM&COM	100	129,5367
Mainland_France	TotalInternational	Medium_haul	Total	100	133,823
Mainland_France	TotalInternational	Autres_long_haul	Total	100	130,398

The increase of price after PACE

- Carbon emissions (included contrails) vary with distance

Emissions	Distance
0.22522 kgCO2eq/km/passenger	Short Haul (< 1500 km)
0.20499 kgCO2eq/km/passenger	Medium Haul (1500 - 5000 km)
0.26204 kgCO2eq/km/passenger	Long Haul(> 5000km)

Table 4: CO_2 emissions as a function of flight distance estimated by Chanel et al. (2022a)

The Marshallian price elasticities

	Personal reason	Professional reason
Short-medium Haul (<2414 km)	-1.5	-0.7
Long Haul (>2414 km)	-1.04	-0.3

Table 3: Elasticity of demand based on the flight distance and the purpose of the trip (personal or professional) by Gillen et al. (2003)

-1.6 Berry and Jia (2010) and Bontemps et al.(2024)

The decrease in demand

Airport	Short leisure	Short business	Long leisure	Long business
CDG	-7.92%	-3.46%	-12.23%	-3.53%
ORY	-9.31%	-4.07%	-10.22%	-2.95%
NCE	-7.58%	-3.31%	-5.13%	-1.48%
MRS	-7.31%	-3.20%	-8.32%	-2.40%
TLS	-7.70%	-3.37%	-4.24%	-1.22%
LYS	-7.54%	-3.30%	-9.14%	-2,64%
BSL	-8.16%	-3.57%	-11.22%	-3.24%
BOD	-7.90%	-3.46%	-10.33%	-2.98%
NTE	-8.50%	-3.72%	-10.50%	-3.03%
BVA	-9.82%	-4.30%	-10.36%	-2.99%
LIL	-10.74%	-4.70%	-11.12%	-3.21%
MPL	-8.36%	-3.66%	NA	NA

Table 5: Estimations of the effective demand reductions induced by the PACE for the twelve largest french metropolitan airports, by flight category and purpose of travel.

Going from demand to emissions reducing

- We apply Hofer et al. (2010) methodology
- Apply the demand decrease to the passenger kilometers for the considered year.
- Then, according to Chanel et al. (2022), a passenger-kilometer emits about 0,22 kg CO2.

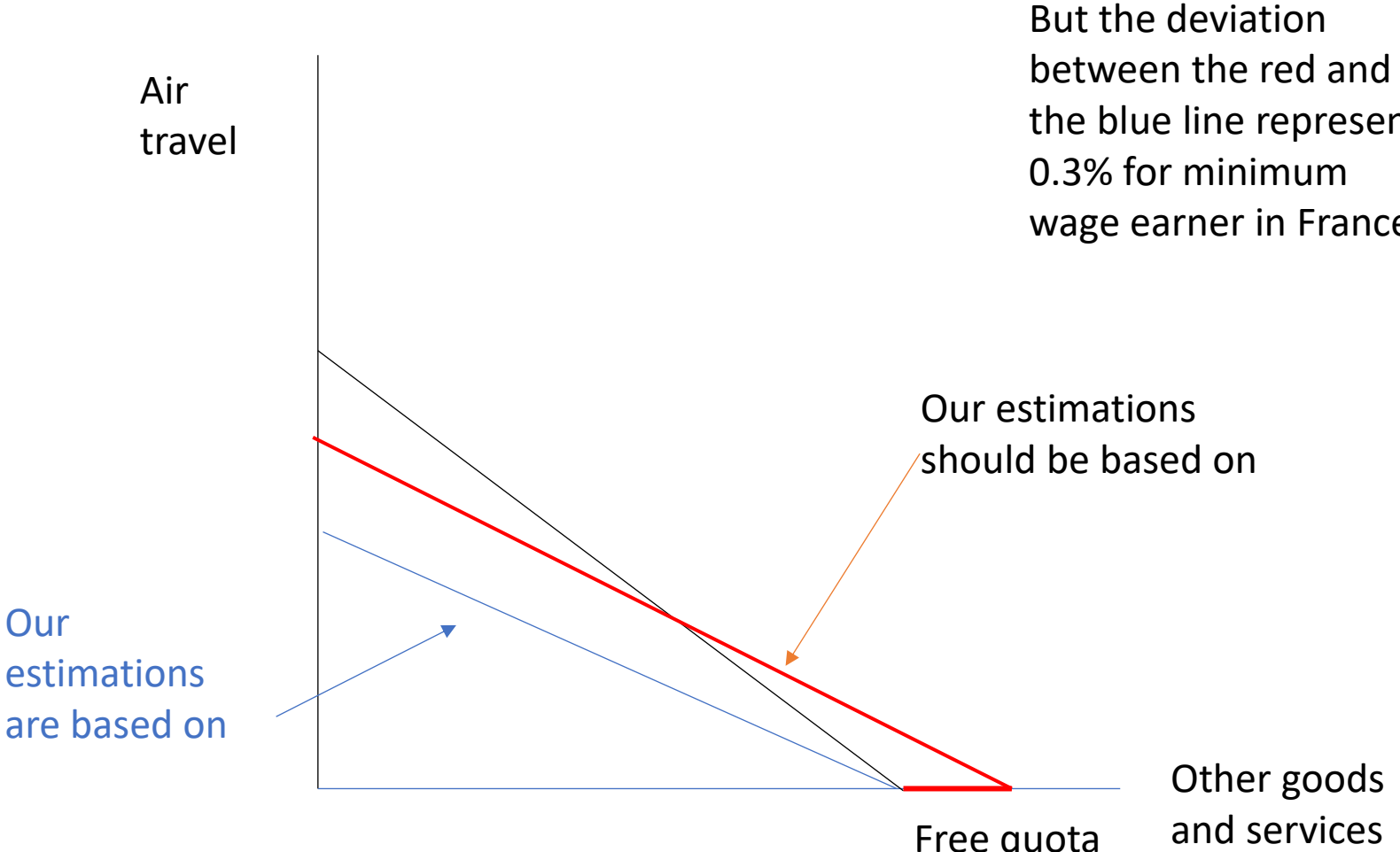
The PACE impact by airport: 4 million carbon (around 2 million for DGAC)

		Decrease demand				
Airport	PKTeq (billion)	Short-medium haul	Long haul	Total	Decrease in PKTeq (billion)	Avoided CO_2 emissions (tonnes)
CDG	167	-7.07%	-10.58%	-7.99%	13.35	2937624
ORY	36.8	-8.31%	-8.84%	-8.33%	3.06	674076.3
NCE	7.9	-6.77%	-4.44%	-6.76%	0.53	117527.4
MRS	5.8	-6.53%	-7.20%	-6.54%	0.38	83392.7
TLS	3.7	-6.88%	-3.67%	-6.86%	0.25	55820.71
LYS	6.2	-6.73%	-7.91%	-6.79%	0.42	92582.79
BSL	5.1	-7.29%	-9.70%	-7.38%	0.38	82815.41
BOD	3.1	-7.06%	-8.93%	-7.10%	0.22	48446.98
NTE	3.5	-7.59%	-9.08%	-7.67%	0.27	59045.44
BVA	3.8	-8.77%	-8.96%	-8.78%	0.33	73380.63
LIL	1.1	-9.59%	-9.62%	-9.59%	0.10	23215.78
MPL	0.7	-7.47%	NA	-7.47%	0.05	11499.18
Total	244.7	-7.5% (mean)	- 7.4%(mean)	- 7.6%(mean)	19.4	4 259 427.6

Table 6: Estimates, via PKTeq, of the reduction in CO_2 emissions by airport induced by the PACE for the twelve largest airports in the metropolitan area

4. Open issues (1)

1. The omission of income effects in the demand change estimation



Omission income effects (cont'd)

- A small problem now with a relative low carbon price.
- But with an ascendant trajectory of social price of carbon, the free allowance can become more pregnant.
- With a carbon price of €400 per ton, with the same quota, it represents a lump sum transfer of €160, which is not so much negligible

Omission income effects (cont'd)

- The behavioral effect can blur the consumer neoclassical analysis
- People may perceive the free allowance as a voucher for air travel.
- While the marginal cost of using air travel (integrating the opportunity cost) has increased.
- We plan to survey people on that point and maybe organize an experiment.

Open issues (2)

- What reaction from airlines?
  - Full pass-through to the consumer?

- A difference in behavior between traditional airlines and low costs?
  - Faced with the French Tax increase
    - Air France and Transavia full pass-through on the consumer
    - Ryanair is closing several flight paths in small French airports
    - Why? A threat to obtain more subsidies from small airports?

- What about charters?

Open issues (3)

- The redistribution issue
- What are the net redistributive effects integrating the behavioral response?
- To disaggregate the demand response by SES
- Exploiting
  - The DGAC national survey 2023 about air passengers
  - The survey on personal mobility 2019 (Ministry of Sustainable Development)
  - Far from perfect

Conclusive comments: Political equilibrium

- The European Commission has selected it as a citizens' initiative (Air Quotas, petition https://citizens-initiative.europa.eu/initiatives/details/2024/000006_en)

- A green light from the left?
  - A carbon tax is simpler
  - But the PAGE advantage is that the redistributive impact is embedded in the mechanism and cannot be manipulated by the Gvt
  - Solve the trust (and commitment) problem of the GVt for a carbon tax plus redistribution of the revenues to consumers

- No net gain for the Treasury.

- Airlines operating in France, airports and the airline industry against. Maybe mitigated by directing part of the revenues for air industry R&D

- A tax on French tourism abroad (protectionist tax)

Perspectives afterwards (within France)

- Once it has been introduced successfully, then it unlocks the extension to other goods and services.

- First extension
  - To all goods purchased not anonymously. Your name is printed on your online ticket

- Second extension
  - To goods purchased anonymously but with a barcode.
  - On the barcode, the quantity of carbon emission.

- A distribution of uniform carbon allowances that the individual can allocate as she want among all goods and services

Perspectives (Outside France)

- The experiment in France might have a ripple effect on other countries
- We will see if other countries are willing to cooperate for running the French PACE.
- Serve as a full-scale test
- Influence the treatment of air transportation at the European, international level (COP, IATA) in the green strategy.