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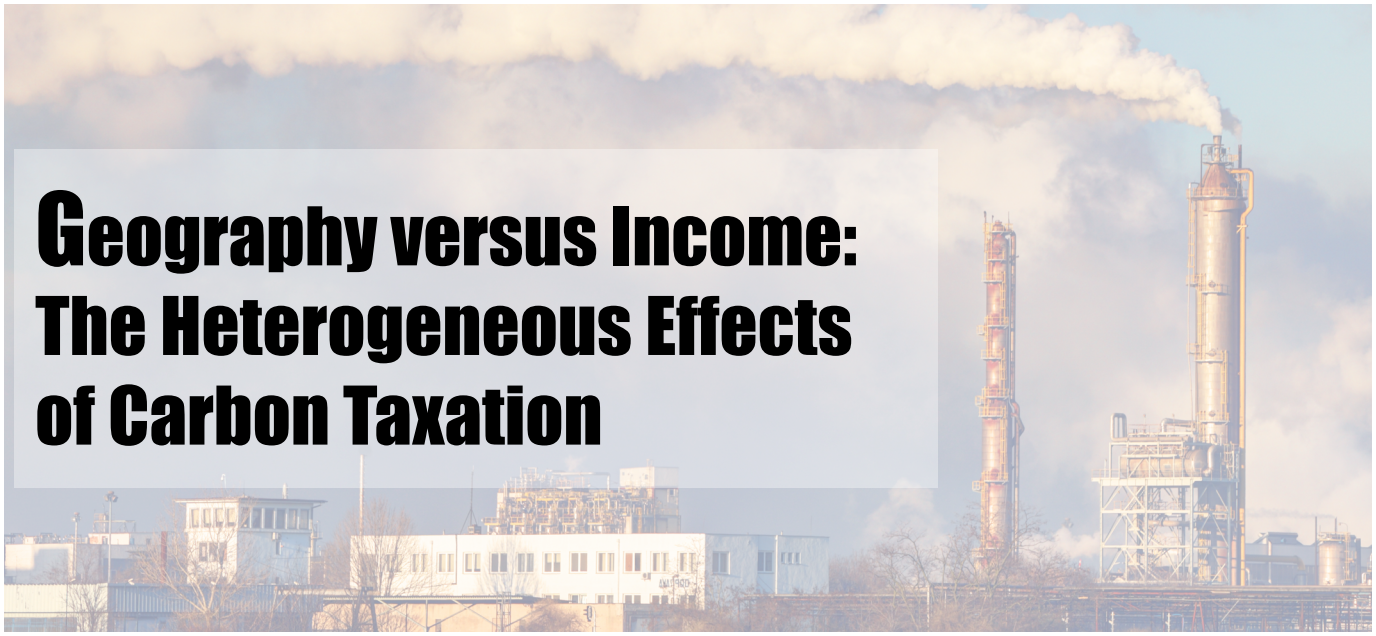


Geography versus Income: The Heterogeneous Effects of Carbon Taxation

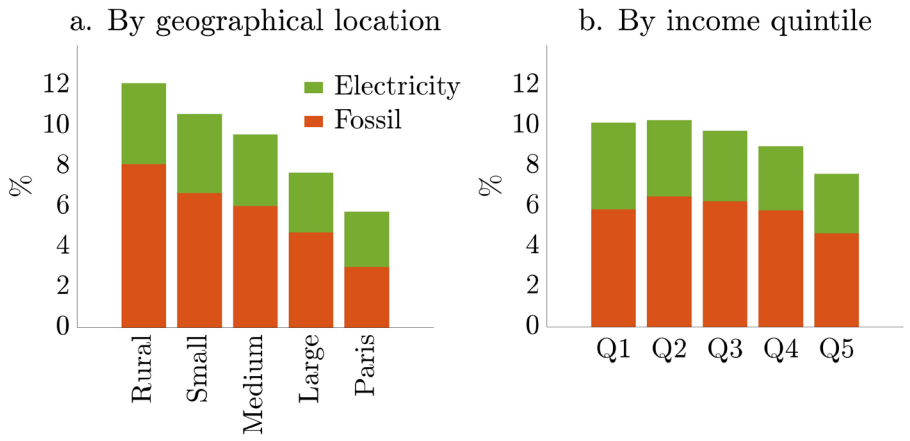
Carbon taxes reduce emissions but create unequal costs for households, as energy represents a larger share of expenditures for low-income and rural households. These distributional effects are likely to reduce the political acceptability of carbon taxation, as illustrated in France with the Yellow Vests Protests and the subsequent carbon tax freezing. Consequently, designing socially acceptable carbon taxes requires careful consideration of its distributional impacts.

To understand the distributive effects of carbon taxation, several features must be considered. First, energy is a necessary good, which consumption is unevenly distributed across households *(Figure 1)*. While existing literature has predominantly focused on the "rich versus poor" dimension of the energy transition burden, the geographical heterogeneity of energy consumption patterns remains a crucial feature. Second, firms' production account for 65% of total emissions, against 35% for households' consumption. Therefore, carbon taxation considers these two sources of emissions, with possibly different effective rates and economic effects *(Figure 2)*. Third, a complete analysis of the distributional impact of carbon taxation must account for the use of carbon tax revenues: if used to increase public spending, transfers, green subsidies, or to decrease existing taxes, it is likely to have very different impacts *(Figure 3)*.

To address these facts, our recent paper Labrousse and Perdereau (2024)[1] develops a dynamic general equilibrium model with both income and geographical heterogeneities, calibrated using French micro data. Both imported fossil energy and locally produced cleaner energy are consumed as a necessity good by households and an intermediate input by firms. We simulate a gradual and permanent increase in carbon taxes on fossil energy, as if the government had successfully implemented the Quinet (2019) report. We compute the aggregate and distributional welfare costs associated with this transition, considering various revenue-recycling policies. Three key results emerged from our analysis.

[1]The last version of the paper can be found in the authors' websites here and here.

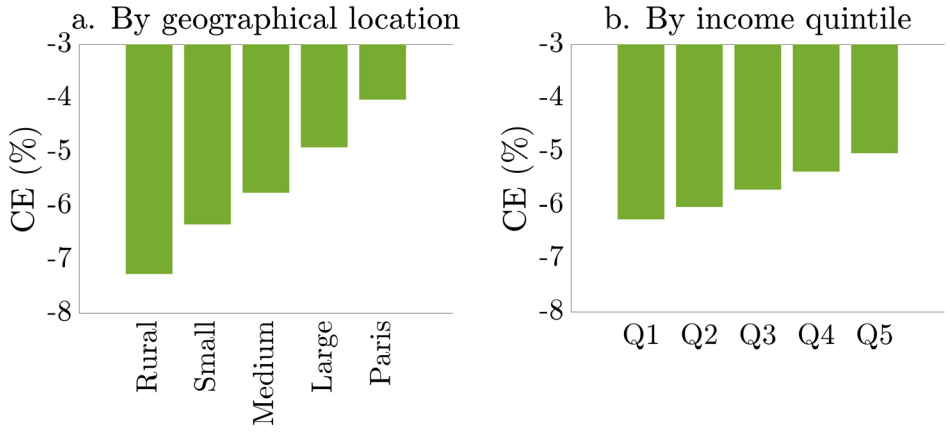
Figure 1.
Energy share in total consumption



Source: Metropolitan France, Insee, "Budget des Familles" survey (2017).

First, geography outweighs income or wealth in determining the distributive effects of carbon taxation. Income does influence energy expenditures, with the bottom 20% income group in France allocating 10.1% of their expenditures to energy compared to 7.6% for the top 20% *(Figure 1.a.)*. However, city densities play an even more crucial role. Indeed, rural households (*i.e. households living in cities of less than 2.000 inhabitants*) allocate 12.1% of their expenditures in energy compared to 5.7% for households in Paris *(Figure 1.b.)*. This disparity is attributed to higher minimum energy requirements for transportation and heating in rural areas, whereas urban households benefit from public transportation and smaller housing units. Moreover, the energy mix varies across regions. While Parisian households have a balanced energy mix between fossil fuels and electricity (52% and 48% respectively), rural households rely more heavily on fossil fuels (67% compared to 33% for electricity)[2]. This heterogeneity is not observed across income quintiles, reinforcing the need to account for geography.

Figure 2.
Welfare change after an increase in carbon taxes of 250€/tCO_2

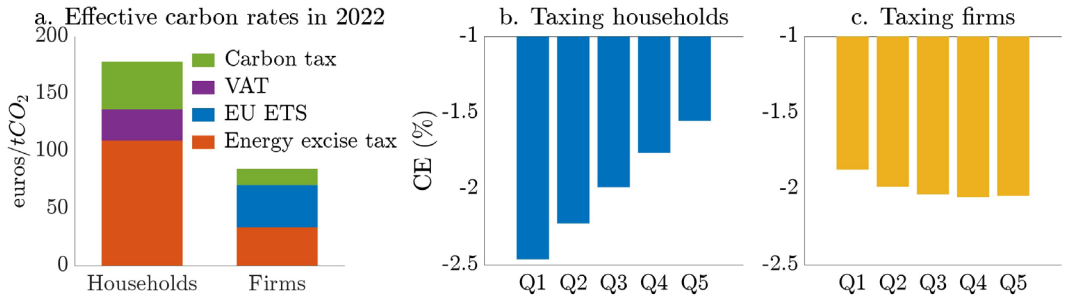


Source: Authors' results.

[2]Electricity is mainly produced in France using nuclear (64.8% in 2023), renewables (16.7%) and hydropower (11.9%), see the 2023 RTE report.

Our simulation of welfare costs[3] aligns with our empirical findings *(Figure 2)*. As energy is a necessary good, it weighs more in low-income households' expenditures. Following the tax increase, the lowest income quintile experiences a welfare drop of -6.3%, compared to -5.0% for the highest income quintile. However, the disparity in welfare losses is more significant across different geographical areas. Rural households, characterized by higher inelastic energy needs, experience a welfare decrease of -7.3%, in contrast to -4.0% for households residing in large cities. We also find that geographical location accounts for 77% of welfare losses variability, while disposable income only explains 12% and wealth 16%. Therefore, when implementing carbon taxes, it is essential to consider targeted compensating policies in favor of rural households (such as housing insulation, public transportation improvements or targeted transfers).

Figure 3.
Effective carbon taxes and welfare losses



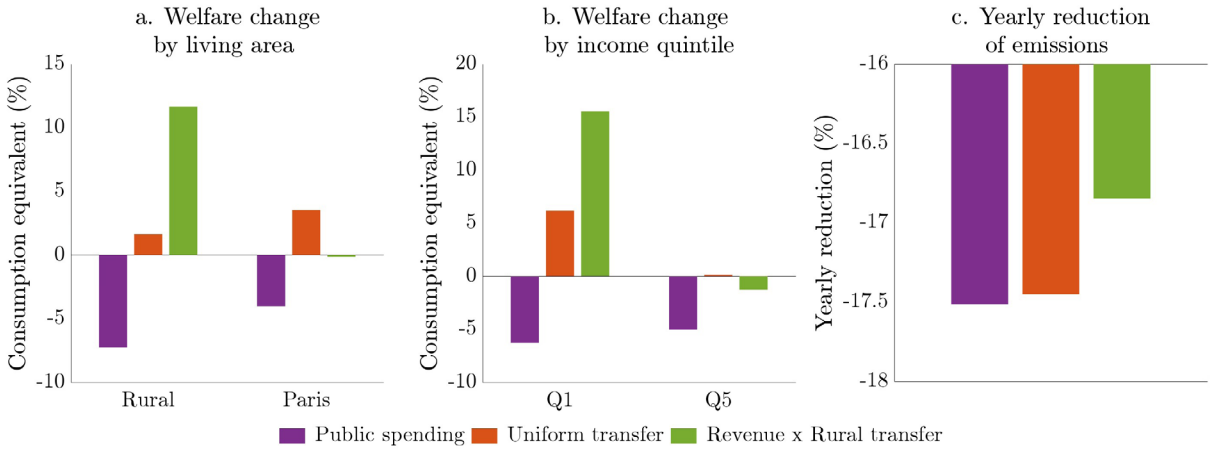
Sources: *Figure 3.a.*: Green Budget from 2024 French Budget Bill (2023). *Figures 3.b. and 3.c.*: authors' results.

Second, fossil energy serves both as a consumption good for households and as an intermediate input used by firms in production processes. Additionally, in the French context, firms' and households' direct emissions are not taxed at the same level. As computed in the 2024 French Budget Bill[4], firms pay on average 84.4€ in taxes for each tCO_2 emitted, while households pay 178.1€/tCO_2[5] *(Figure 3.a.)*. Furthermore, both taxes yield different economic effects: taxing households' direct emissions is regressive, whereas taxing firms' direct emissions is progressive *(Figures 3.b. and 3.c.)*. Taxing fossil fuel energy consumed directly by households disproportionately affects low-income individuals, due to the decreasing expenditure share of energy with income, and rural households, who exhibit higher energy needs and rely more heavily on fossil fuels in their energy mix. Consequently, taxing direct household emissions is regressive, with a welfare change of -2.5% for the bottom income quintile compared to -1.6% for the top quintile.

Conversely, taxing fossil energy used as an intermediate input by firms is progressive. Intermediate input taxation distorts firms' optimal input allocation, reducing activity incomes. Households with higher labor and capital income shares are more affected than low-income households, for whom public transfers represent a higher income share. When increasing only the tax on firms' emissions, welfare losses amount to -1.8% for low-income households (Q1) against -2.1% for high-income ones (Q5). While previous studies focused on the distributional implications of final consumption taxes, our paper emphasizes the general equilibrium effects from taxing firms' direct emissions.

[3]All welfare losses are expressed in consumption equivalent terms, i.e. consumption change required at each period of the transition to return to the level of welfare without the tax increase.
[4]The "Commissariat général au développement durable" (CGDD) computes effective energy and carbon tax rates each year for the French government.
[5]Reasons for this gap are fourfold: (i) energy mix differences: households use more oil, especially gasoline, firms consume more electricity and gas, (ii) some firms are part of the EU ETS system, (iii) there exist multiple reduced rates and exemptions for some firms, and (iv) firms do not pay VAT taxes while households do.

Figure 4.
Comparison of different revenue-recycling scenarios



Source: authors' results.

Third, it is possible to reduce emissions and make the policy progressive with respect to income, through an appropriate use of the carbon tax revenue. In France, the carbon tax revenue amounted to 38 billion euros in 2023[6], despite its rate being only one-fifth of the 2030-level envisaged by 2018 French budget bill. Directing this revenue towards compensating the most adversely affected households can alleviate the carbon tax burden, bolstering its political acceptability. In our benchmark scenario, where the carbon tax revenue is used to increase public expenditures, CO_2 emissions decrease by 17.5% per year after the carbon tax increase. As shown in *Figure 4.c.*, a uniform lump-sum rebate yields a modest 0.1% yearly increase in emissions compared to the benchmark, while enhancing overall welfare and reducing income inequality. Therefore, a uniform transfer of the carbon tax revenue across households can improve overall welfare, at a low environmental cost.

However, this uniform transfer widens the rural-urban gap, and benefits mostly to Parisian households who receive the transfers without supporting the cost of the transition. Compensating the welfare loss incurred by rural households through targeted transfers entails a trade-off between equity and climate efficiency, as rural households exhibit a higher marginal propensity to consume energy. The most welfare-improving scenario, with transfers contingent on location and income, greatly benefits poor and rural households, but comes with a 0.8% increase in annual emissions compared to the uniform transfer.

Therefore, improving welfare and reducing carbon emissions are not incompatible objectives. We believe that transfers are of primary importance for communication and political acceptability. By explicitly separating the carbon tax revenue from the state budget, transfers clarify that the purpose of this tax is to influence behavior rather than to finance public deficits.

In conclusion, our research emphasizes the pivotal role played by geography in assessing the aggregate and distributive effects of carbon taxes, suggesting that future carbon tax designs should take geographical constraints into account. In that respect, we propose an equitable and socially acceptable framework for carbon taxation, using targeted transfers contingent on both income level and geographical location.

[6]See estimation in the 2023 French Budget Bill Report on the Environmental Impact of the Central Government Budget, page 166, confirmed in the 2024 French Budget Bill Report, page 260.

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