The regional and distributional implications of the French carbon tax

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The global framework (1)

Policies against GHG: choice of the most suited instrument to mitigate GHG emissions

- The Kyoto protocol (1997): European countries committed themselves to reduce their emissions by 5,2% during the period 2008-2012 compared with their 1990's emissions
- The EU ETS (2005): Its objective is to allow the European countries to fulfil their commitment taken under the Kyoto protocol. This goal was reached but:
  - The price of carbon permits was relatively low during the three phases of the EU ETS (2005-2007; 2008-2012; 2013-2020). The price carbon allowances do not reflect the social value of carbon emissions.
  - The EU ETS is dominated by firms involved in electricity-generation. Many sectors are excluded from the scheme, especially the residential and tertiary sector.
- One controversial policy issue in Europe : the choice of the most suited instrument to mitigate GHG emissions of non regulated sectors

The global framework (2)

European carbon price policies

France, like many Scandinavian countries, considered to implement since 2014 a carbon tax

Country	Carbon Tax rate 2013-2014 (€ / ton of $CO2$)	Year of adoption:
Finland	35	1990
Sweden	160	1991
Denmark	30	1992
Ireland	20	2010
UK	15	2013
France	7	2014

The global framework (3)

The French carbon pricing projects

- July 2009 : Climate Energy Contribution (Rocard and Pdt Sarkozy). $\rightarrow$ Quinet Report: recommends to implement a carbon tax, initial rate = 32€/ton. Then, progressive increase $\mapsto$ 52€ in 2020, 100€ in 2030.
- September 2009 : French government proposes a carbon tax, initial rate = 17€/ton, tax base: carbon contents of all energy consumption, all sectors outside the EU ETS. Finally, not adopted for legal reasons.
- September 2013 : launch of the french carbon tax with progressive increase (7€/ton in 2014, 14,50€/ton in 2015, then 22€/ton in 2016)
- Important role played by the redistribution of the tax revenues...

The global framework (4)

Debates on difficulties to implement carbon taxes and their solutions

- The implementation of carbon taxes faces problems related to social acceptability.
- Many fears when considering carbon taxation:
  - loss of purchasing power for households
  - loss of competitiveness for firms
- Increase of economic inefficiencies and social inequalities
- Solutions may emerge with adequate redistribution of the tax revenues: the double dividend literature (Goulder, 1995)

Objectives of the paper

Assessment of the impacts of the french carbon tax on the residential and tertiary sector

- What are the impacts the French carbon tax (France, 2016), assuming:
  - A homogenous tax of 22€/ton of CO_2 emitted by the residential and tertiary sectors
  - The tax is added to gas and heating oil prices
  - Energy consumption depends on heating needs (Climatic variables), income (income per capita) and heating technology (energy mix)

Objectives of the paper: the details

1. Highlight regional heterogeneities (climatic, economic, technological, other unobservable) that explain differences in energy consumption
2. Measure the consequences of these heterogeneities on CO2 emissions
3. Assess the regional effects of a carbon tax policy
4. Analyze the accompanying schemes to correct inequalities caused by this policy

About the literature...

1. EKC: The Environmental Kuznets Curve
2. Econometrics of energy demand
3. Regressive characteristics of the carbon tax and the role of redistribution

EKC literature (1)

- Analyzes the environmental consequences of economic growth: Grossman and Krueger (1993), Shafik and Bandyopadhyay (1992)
- Several empirical studies have suggested that there is an inverted U-shaped relationship between income per capita and pollutant emissions: Panayotou (1993), Selden and Song (1994)
- However, the empirical results and conclusions are ambiguous.
- Many studies affirm that there is no evidence supporting the EKC, monotonically increasing or decreasing relationship: Holtz-Eakin and Selden (1995), Torras and Boyce (1998), Hettige *et alii* (1999), de Bruyn *et alii* (1998), and Roca *et alii* (2001)

Energy demand literature (2)

- Analyzes the determinants of the energy demand and the impacts of energy price variations on energy demand, welfare and equity.
- Most part of econometric studies usually takes into account revenue and climatic determinants separately.
- Interactions between energy demand and incomes: significant inverted U-shaped relationship (Ang (1987) or Destais *et alii.* (2009)).
- Conversely, no consensus concerning relations between the climatic variables and the energy demand (Engle *et alii.* (1986), Bessec and Fouquau (2008))
- Tol *et alii.* (2012) combines climatic conditions, revenues and energy prices and find significant relations among all these variables.

Carbon tax and redistributive properties (3)

- Environmental taxes appear to be regressive (Metcalf et alii (2008) and Metcalf (2009))
- Wier et al. (2005) confirms the regressive properties of such reforms for the Danish case.
- Ekins and Dresner (2004) consider the distributional impact of introducing a carbon tax and increasing fuel duty for UK: the tax would make those currently worst affected by fuel poverty more badly off, even under specific compensation.
- French case: a tax on energy or transport consumption harms the lowest wage households three times more than the highest wage households (Ruiz and Trannoy (2008)).
- Bureau (2011) also shows that the distributional effects of a carbon tax on car fuels are likely to be regressive before revenue recycling
- More recently, OECD 2015 (The Effect of environmental taxes on income inequality: an empirical cross-country analysis) : panel of 34 OECD countries from 1994 to 2011.

Our contribution

- Assessment of the impact of carbon taxation when:
  - Geographical and economic heterogeneities are considered.
  - An additional source of inequalities.
- Geographical heterogeneities exacerbate the regressive characteristic of carbon taxation.

Why? In which manner?

Available data

- A panel data on:
  - 22 French administrative regions
  - Annual data for years: 1995, 1997, 1999, 2002, 2004-2009
- Regional data:
  - Gas and heating oil consumptions of residential (housing) and tertiary (services) sectors
  - GDP per capita and population
  - Temperatures and the number of frost days during the year
- National data: Energy prices

Construction of variables of interest

- CO2 emission per capita:

$$\frac{Emissions_{it}}{Population_{it}} = \frac{Cgaz_{it} * 2.3 + CHoil_{it} * 3.2}{Population_{it}}$$

- Heating technology (*proxy*) :

$$Tech_{it} = \frac{gas\ consumption_{it}}{heating\ oil\ consumption_{it}}$$

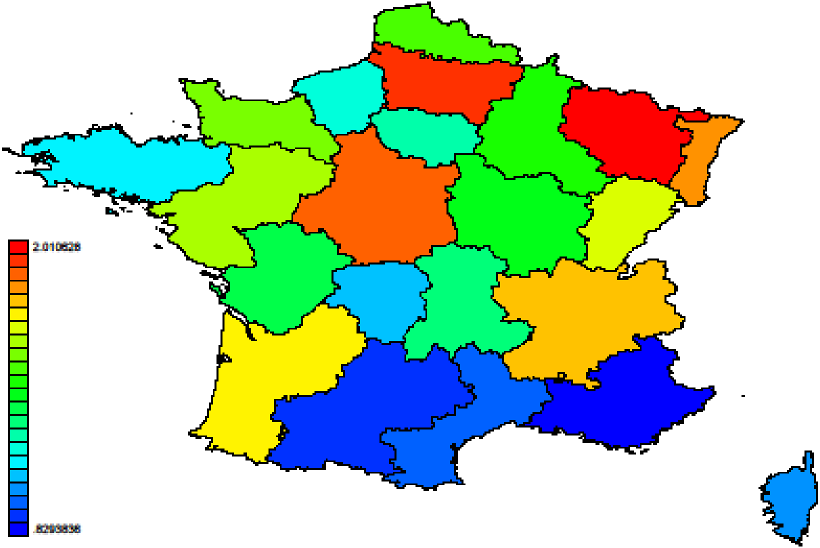


Figure: Emission per capita in 2009 by region (in tons)

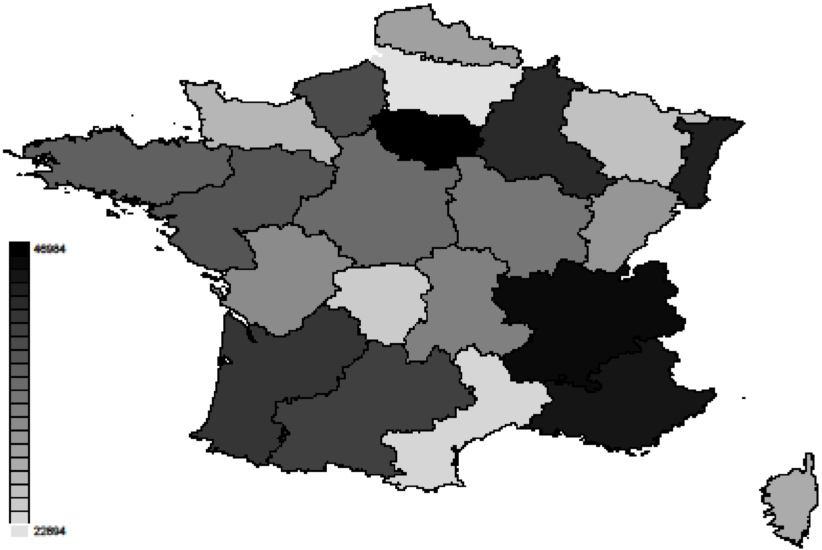


Figure: Regional GDP per capita in 2009

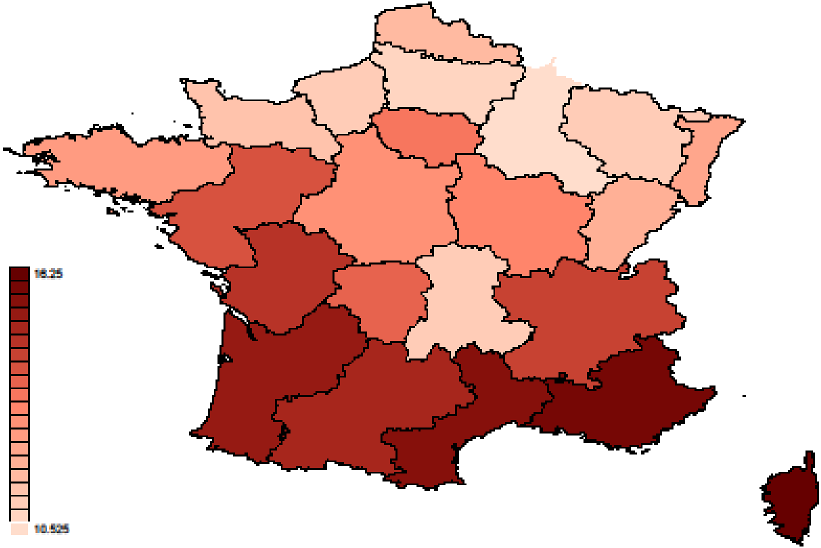


Figure: Regional temperatures in 2009

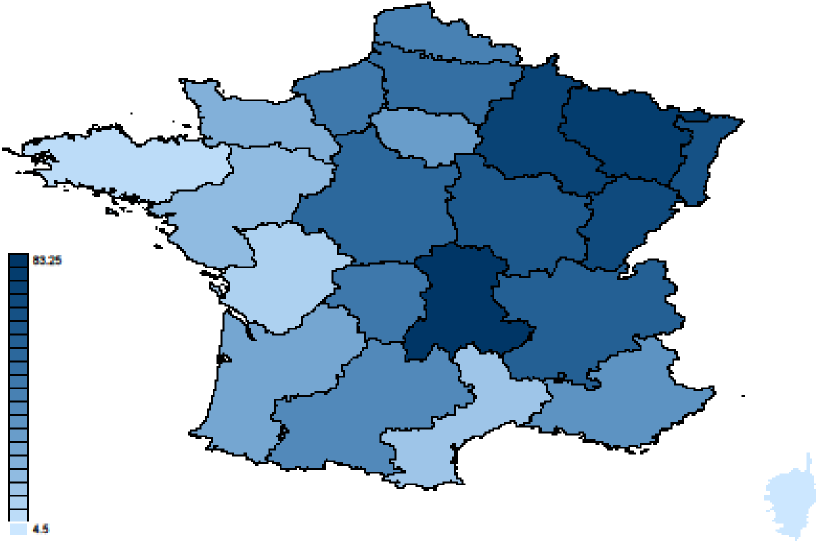


Figure: Number of annual frost days by region in 2009

The empirical model

- Extension of the empirical model of energy consumption by Ang (1987):
  $E_{it} = \alpha_0 + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 P_t^{gas} + \alpha_4 P_t^{oil} + \alpha_5 Tech_{it} + \alpha_6 T_{it} + \alpha_7 G_{it} + \varepsilon_{it}$
- Choice between FE and RE models:
  - If unobserved heterogeneity is correlated with regressors, FE model:
    $E_{it} = \alpha + \alpha_{0i} + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 P_t^{gas} + \alpha_4 P_t^{oil} + \alpha_5 Tech_{it} + \alpha_6 T_{it} + \alpha_7 G_{it} + \varepsilon_{it}$
  - RE model, otherwise:
    $E_{it} = \alpha_0 + \alpha_1 Y_{it} + \alpha_2 Y_{it}^2 + \alpha_3 P_t^{gas} + \alpha_4 P_t^{oil} + \alpha_5 Tech_{it} + \alpha_6 T_{it} + \alpha_7 G_{it} + \varepsilon_{it}$

    $\varepsilon_{it} = \mu_i + \omega_{it}$

Table: OLS estimation results of random effect and fixed effect models

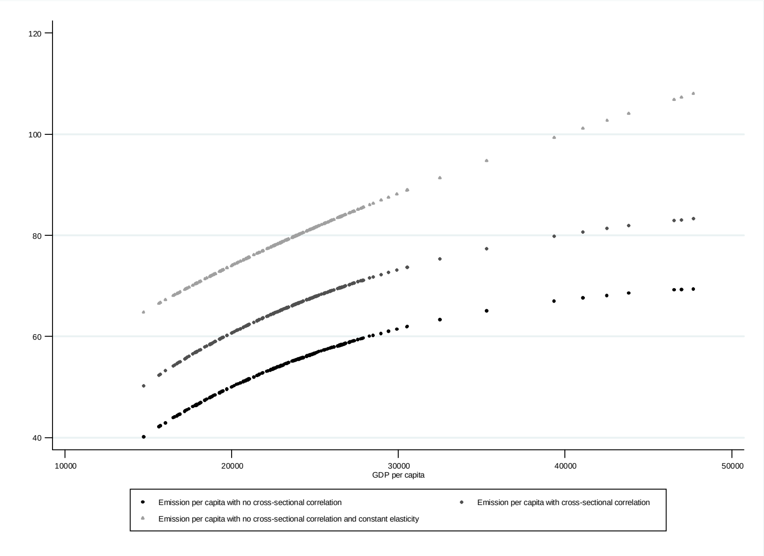
Model	Random effects		Fixed effects	
GDP	9.158***	(3.012)	9.141***	(3.258)
GDP^2	-0.433***	(0.151)	-0.432**	(0.165)
Gas price	-0.350***	(0.100)	-0.409***	(0.107)
Heating oil price	-0.066	(0.064)	-0.034	(0.069)
Technology	-0.052**	(0.021)	-0.044**	(0.022)
Temperature	-0.053***	(0.017)	-0.020	(0.025)
Frost days	0.001	(0.001)	0.0006	(0.0007)
Constant	-44.494***	(15.04)	-44.73***	(16.20)
	F-test for individual effects			
F(21,191)	17.09 [0.000]			
	Breusch Pagan test for random effects			
$\chi^2_{(1)}$	329.99 [0.000]			
	Hausman test of fixed effects versus random effects			
$\chi^2_{(6)}$	6.03 [0.420]			

Table: FGLS estimation results of the random effect model

	Panel Groupwise Heteroskedasticity				
	No cross-sectional cor.		Cross-sectional cor.		
GDP	6.270**	(2.500)	4.742**	(2.268)	0.434***
GDP^2	-0.285**	(0.123)	-0.211*	(0.111)	
Gas price	-0.397***	(0.046)	-0.415***	(0.045)	-0.372***
Technology	-0.111***	(0.017)	-0.115***	(0.014)	-0.122***
Temperature	-0.080***	(0.007)	-0.085***	(0.006)	-0.086***
Frost days	0.0009**	(0.0004)	0.0008***	(0.0003)	0.001***
Constant	-30.23**	(12.56)	-22.08*	(11.454)	-0.458

Note: Standard errors are in () ; *, ** and *** refer respectively to the 10%, 5% and 1% significance levels.

EKC


120
100
80
60
40
10000
20000
30000
40000
50000
GDP per capita
Emission per capita with no cross-sectional correlation
Emission per capita with cross-sectional correlation
Emission per capita with no cross-sectional correlation and constant elasticity

Specific regional effects

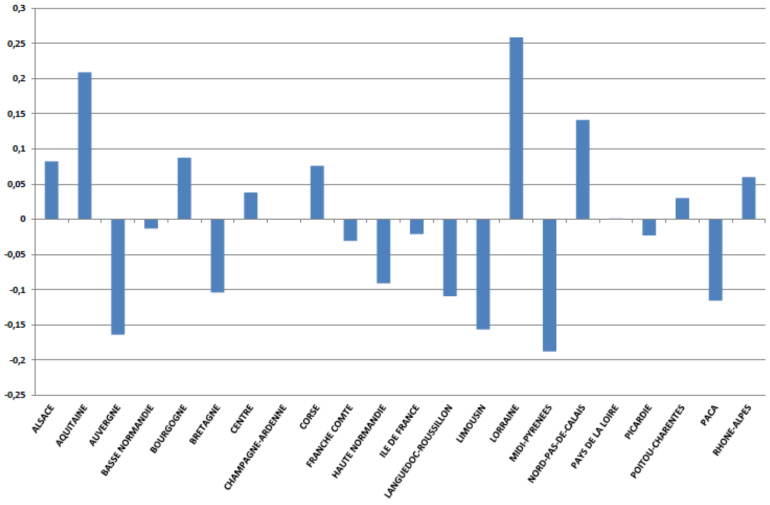
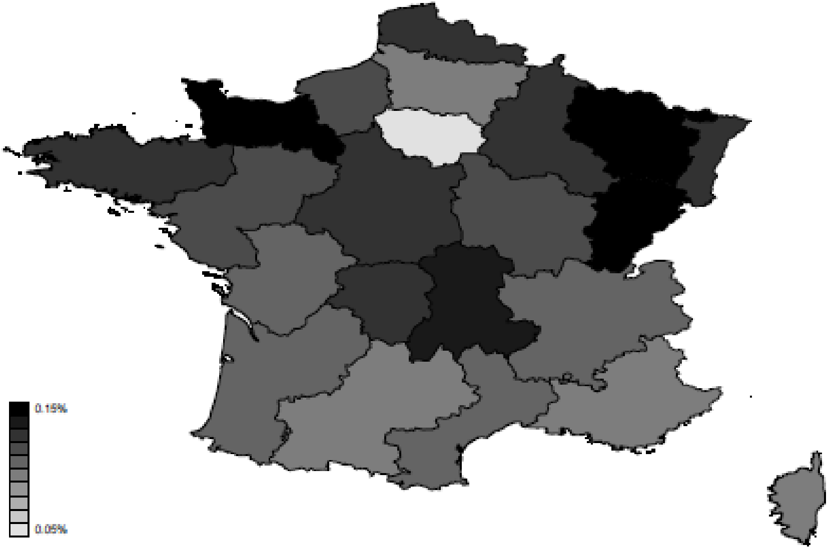
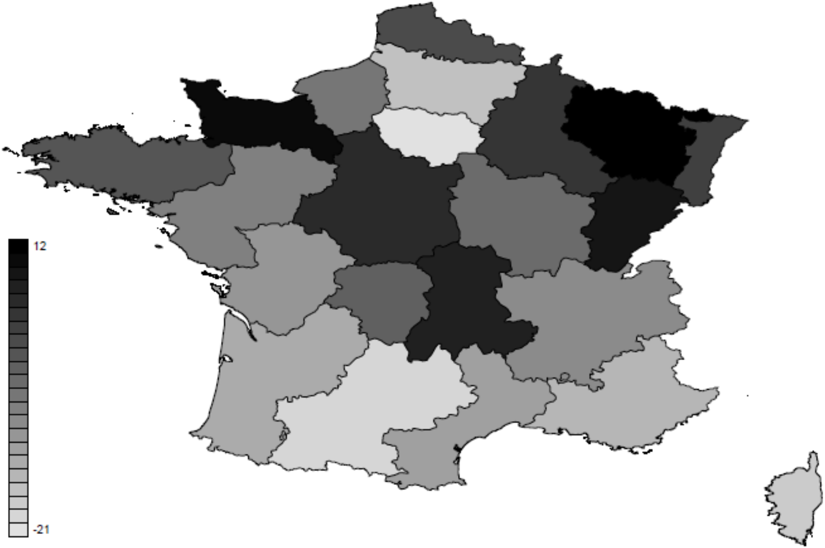


Figure: Specific regional effects

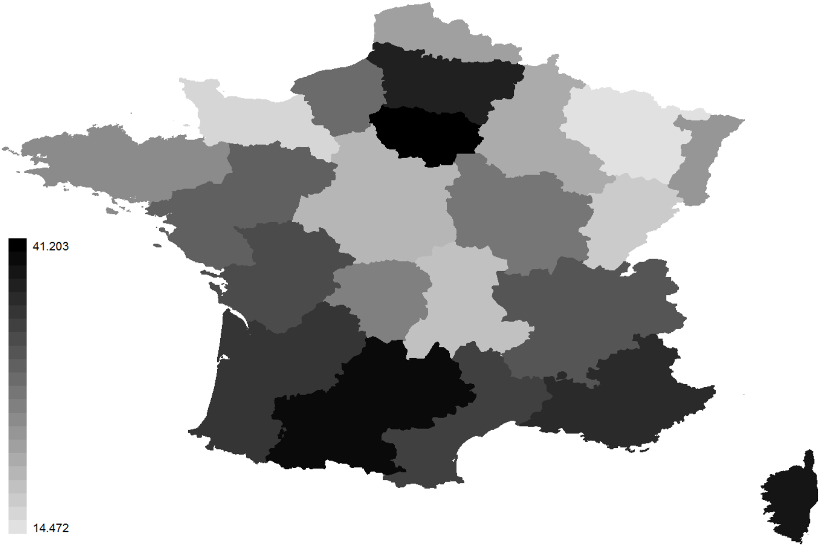
Highlighting inequalities in terms of tax revenue / GDP



The correction of inequalities: lump sum redistribution



The correction of inequalities: regional taxation



Specific regional effects: lump sum redistribution

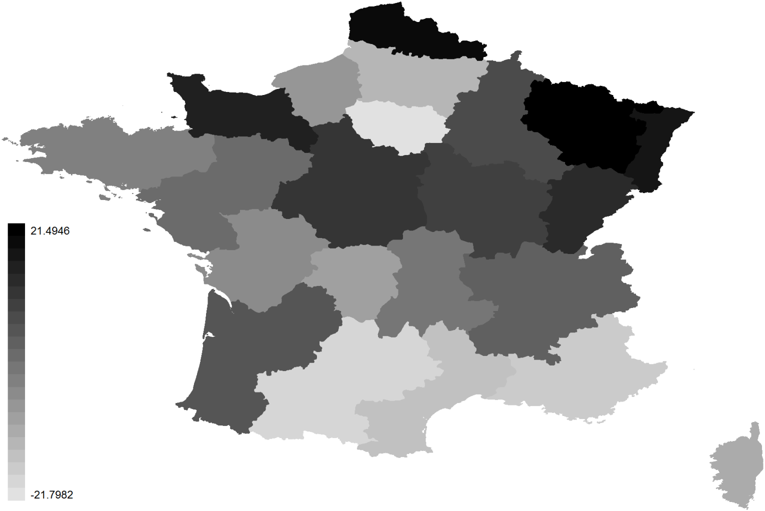


Figure: Redistribution/additionnal taxation per capita, with *SE*

Specific regional effects: regional taxation

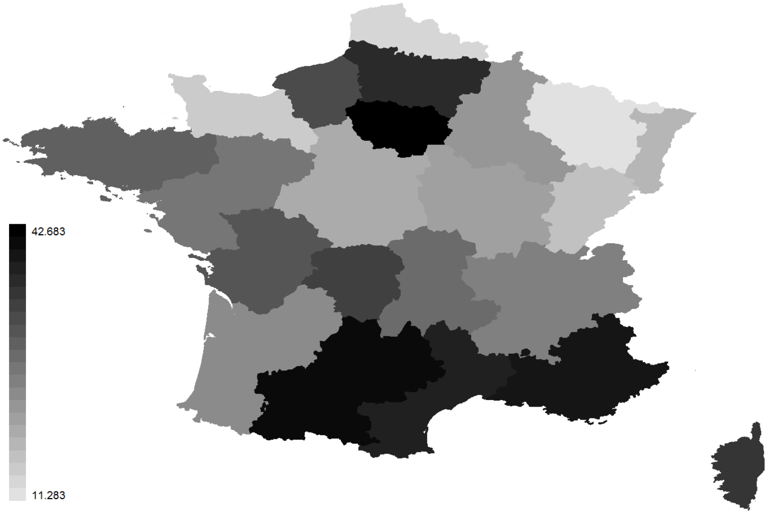


Figure: Regional carbon taxes ensuring equity

Conclusion

The French carbon taxation should be accompanied by redistributional policy. This policy should take into account the specific regional effects in order to increase social acceptability of the environmental policy.

Thank you for your attention

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