The gender distributive effects of climate policy

M. T. Benkhodja[1], Johan Gustafsson[2], Xiaofei Ma[3], Junior Maih[4]

26 July 2024, RISE Workshop 2024, University of Pretoria

[1]ESSCA School of Management, France
[2]Umeå University, Sweden
[3]ESSCA School of Management, France
[4]Norges Bank, Norway

Road map

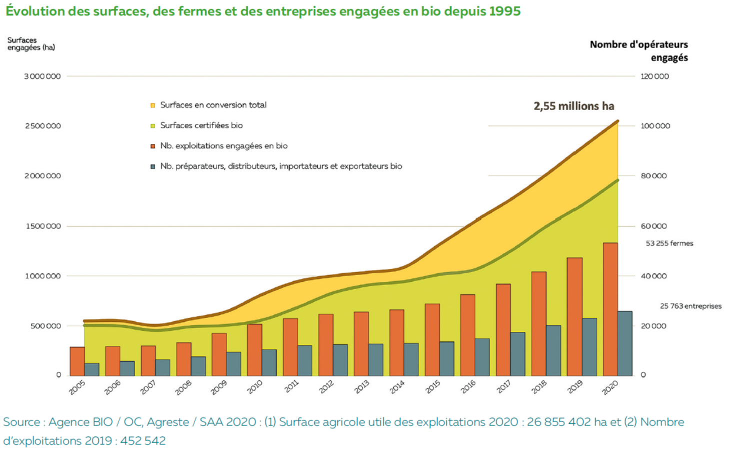
Research question

What are the gender distributive effects of climate policy?

Motivation

- A worldwide consensus stresses the need for ambitious climate policy
- Increasing attention given to the distributive effects of climate policy

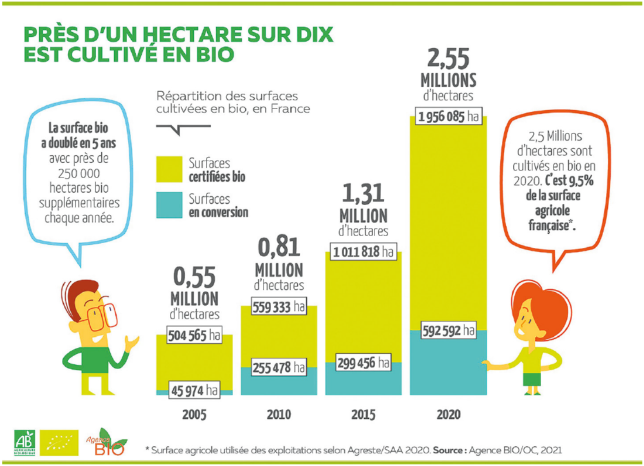
Stylized facts



France : farms and firms engaged in organic production since 1995

Source : Agence Bio, 2020

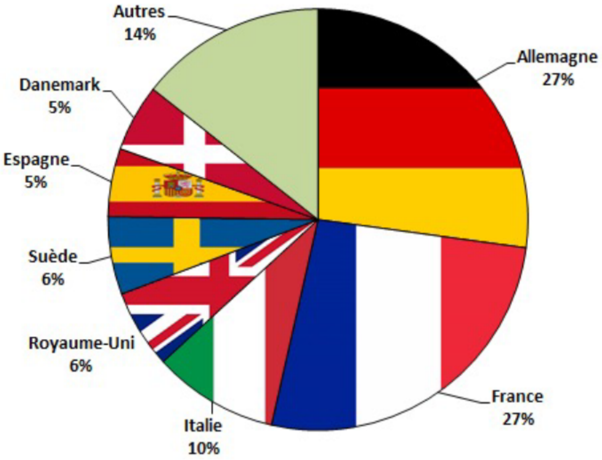
Stylized facts



Evolution of organic farms in France Source : Agence Bio, 2020

Stylized facts

Market repartition of organic goods in EU, 2019



Source : Agence Bio, 2020

Stylized facts

France : consumption of organic products by gender, December 2021

	ENSEMBLE	SEXE	
		Homme	Femme
Base	**2112**	**1001**	**1111**
ST Consommateurs (dont rarement)	**91%**	**90%**	**91%**
ST Consommateurs au moins une fois par mois	**76%**	**74%**	**78%**
ST Consommateurs au moins une fois par semaine	**52%**	**49%**	**54%**
Oui, tous les jours	15%	13%	16%
Oui, régulièrement (au moins une fois par semaine)	37%	36%	37%
Oui, de temps en temps (environ une fois par mois)	24%	25%	24%
ST Non consommateurs (moins d'une fois par mois)	**24%**	**26%**	**22%**
Oui, rarement (moins souvent qu'une fois par mois)	15%	16%	14%
Non, jamais	9%	10%	9%

Source : Agence Bio, 2022

Background

- Our paper follows from two observations:
  - Gender differences in environmental and ecological awareness regarding consumption.[5]
  - Women, on average, have a comparative advantage in less carbon-intense sectors.[6]
- Likely that climate policy and the green transition will affect men and women differently.

[5] e.g., Bravo et al. (2013), Sanchéz et al. (2016) OECD (2021)
[6] e.g., Fan and Lui (2003), Somuncu (2024), our data

Question

Will environmental policies influence the gender income inequalities ?

Key findings

The green transition can reduce gender-based income inequality

Literature review

- Distributional effects of environmental policy:
    - Cremer et al. (2003)
    - Aubert et al. (2019)
    - Douenne et al. (2023)
- Accounting for employment effects:
    - Yamazaki (2017)
    - Curtis (2018)
- Gender effects:
    - Somuncu (2023)

Our contribution

We study the distributional effects between men and women of climate policy, accounting for both consumption and employment channels.

Our approach

- Build a structural model that includes:
  - gender heterogeneity in consumption and occupation choice
  - firm heterogeneity in emission intensity
- Environmental Dynamic Stochastic General Equilibrium (E-DSGE) model
- Calibrate the model to the French economy

Model

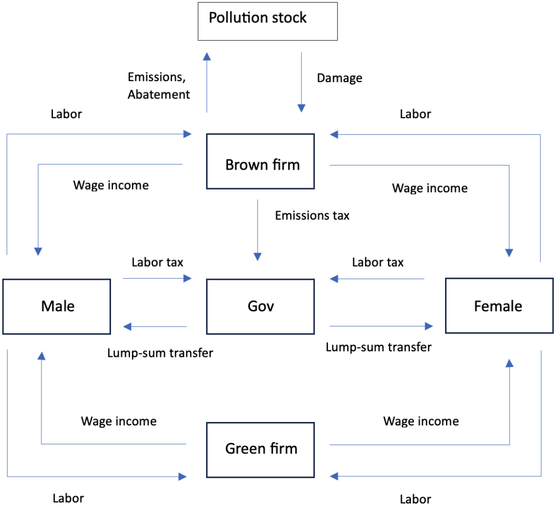
- Two production sectors with stochastic TFP
  - Carbon-intense ("brown") goods
  - Carbon-neutral ("green") goods
- Male and female individuals
  - Consume a composite of green and brown goods
  - Works in both sectors
- Government
  - Un-anticipated climate policy shocks

Environmental policies

Following Benkhodja et al.(2022) & (2023) :

- Carbon tax
- Labor cost subsidy for green firms

Model illustration

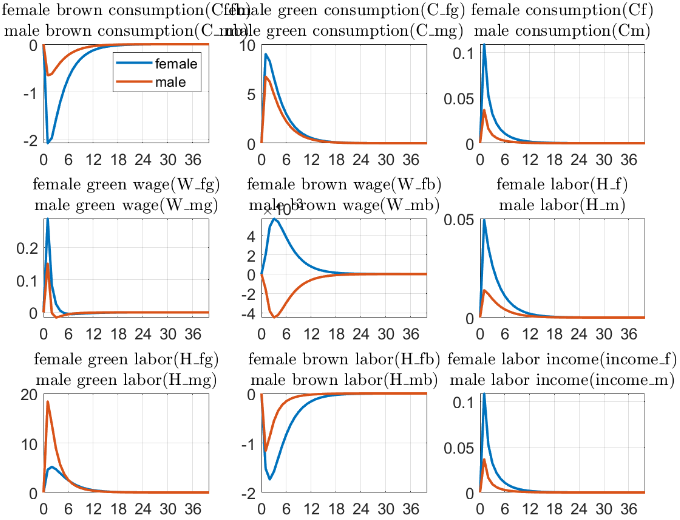


Calibration

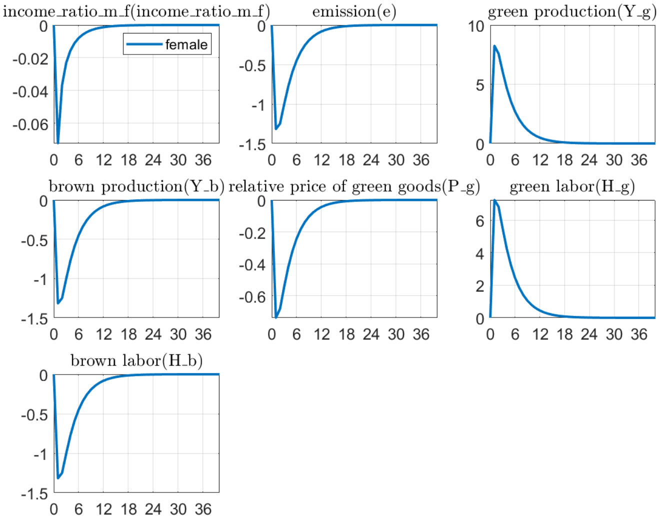
Table 1. Calibration of structural parameters

Description	Parameters	Values	Source
The subjective discount factor	β	0.997	steady state interest rate of 1.2%
The inverse of the elasticity of intertemporal substitution of consumption	γ	0.5	[Gruber, 2013]
The inverse of the wage elasticity of labor supply	σ	2	[Chetty et al., 2011]
The weight of labor in households' utility function	χ	61.67	steady state labor supply intensity of 0.33
The weight of green goods in the female's consumption basket	$\mu_{f,c}$	0.2	French data
The weight of green goods in the male's consumption basket	$\mu_{m,c}$	0.1	French data
Male elasticity of substitution between different types of consumption goods	$\epsilon_{m,c}$	10	Author's assumption
Female elasticity of substitution between different types of consumption goods	$\epsilon_{f,c}$	15	Author's assumption
The payroll tax rates in green and brown sectors	ω	0.3	French data
Carbon tax rate	τ_e	0.009	[Benkhodja et al., 2023]
The proportion of female workers in the green sector	$\mu_{f,g,h}$	0.63	French data
The proportion of female workers in the brown sector	$\mu_{f,b,h}$	0.24	French data
Constant elasticity of substitution between female/male labor in green sector	$\epsilon_{g,h}$	100	Author's assumption
Constant elasticity of substitution between female/male labor in brown sector	$\epsilon_{b,h}$	100	Author's assumption
The level of emissions per unit of production	φ	0.002	Author's calibration
First technological parameter of abatement cost	ψ_1	0.002	Author's calibration
Second technological parameters of abatement cost	ψ_2	2.8	[Annicchiarico and Di Dio, 2015]
Constant in damage function	d_0	1.3950×10^{-3}	[Heutel, 2012]
Linear term in damage function	d_1	-6.6722×10^{-6}	[Heutel, 2012]
Quadratic term in damage function	d_2	1.4647×10^{-8}	[Heutel, 2012]
The pollution depreciation rate	δ_x	0.0035	[Carattini et al., 2021]
Labor mobility costs for females	ϕ_f	0.01	Author's assumption
Labor mobility costs for males	ϕ_m	0.01	Author's assumption

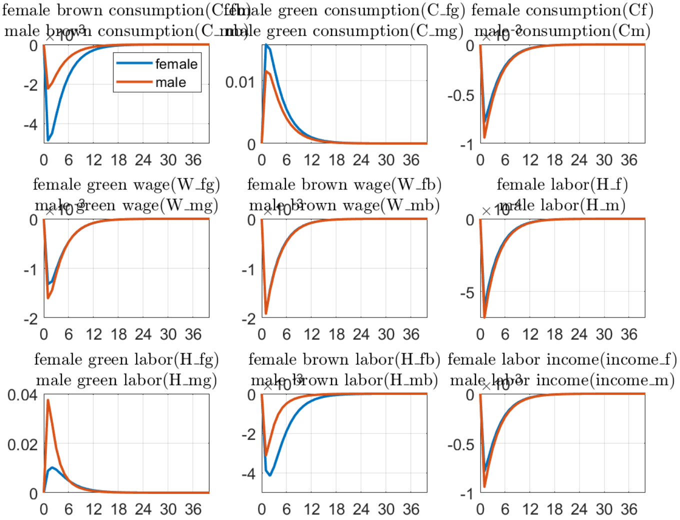
+1pp Positive green productivity shock



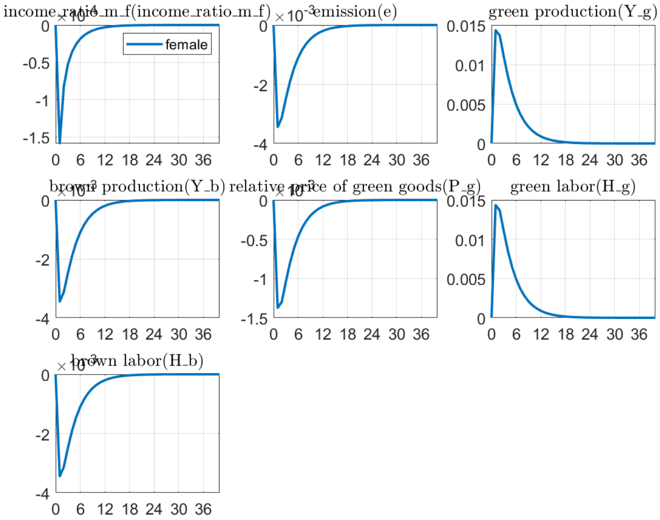
+1pp Positive green productivity shock



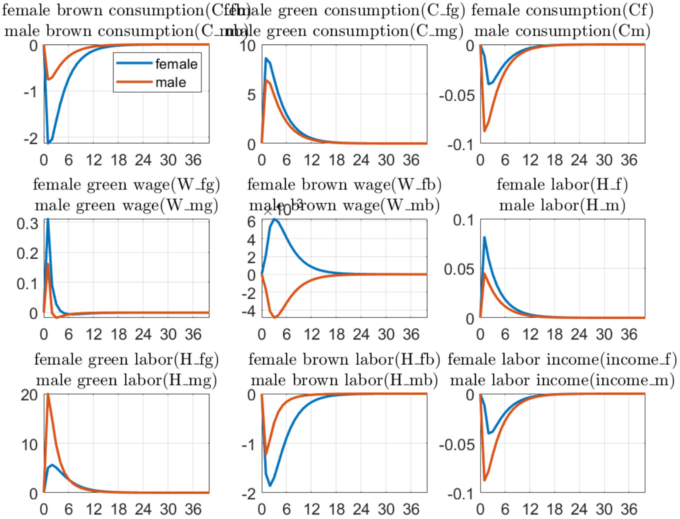
+1pp Positive shock to carbon tax



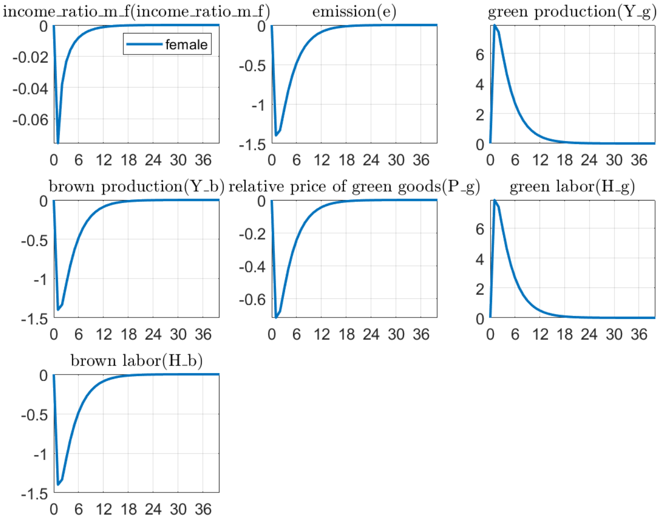
+1pp Positive shock to carbon tax



+1pp Labor cost subsidy for green firms



+1pp Labor cost subsidy for green firms



Welfare analysis

Table: Welfare analysis, % deviation from baseline

	female	male
+1pp green TFP shock	$+76.8$	$+32.8$
+1pp carbon tax	$-5.48E-05$	$-1.34E-04$
+1pp labor cost subsidy for green firms	-17.1	-64.7

Conclusions

Environmental policies help reducing the income gap between female and male workers.

Appendix: Emissions and abatement

As in Heutel (2012), we assume that the pollution caused by firms affects negatively output through the following damage function:

$$d(x_t) = d_0 + d_1 x_t + d_2 x_t^2,$$

Where the emissions stock evolve according to the following process:

$$x_t = (1 - \delta_x) x_{t-1} + e_t + e_t^{row}$$

where δ_x is the pollution decay rate, e_t the level of domestic emissions, and e_t^{row} the emissions in the rest of the world.

Appendix: Emissions and abatement

The level of domestic emissions depends on the output and of the abatement effort η_t

$$e_t = \varphi(1 - \eta_t)Y_{b,t}, \tag{1}$$

The emission in the rest of the world is assumed to follow an AR process. That is,

$$\log(e_t^{row}) = (1 - \rho_{e_t^{row}})\log(e^{row}) + \rho_{e_t^{row}}\log(e_{t-1}^{row}) + \epsilon_{e_t^{row}}. \tag{2}$$

Individuals

Each gender type i have preferences over consumption and labor supply:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{C_{i,t}^{1-\gamma}}{1-\gamma} - \chi \frac{H_{i,t}^{1+\sigma}}{1+\sigma} \right\}, \tag{3}$$

where total consumption is a composite of green (g) and brown (b) goods:

$$C_{i,t} = \left(\mu_{i,c}^{1/\epsilon_{i,c}} C_{i,g,t}^{(\epsilon_{i,c}-1)/\epsilon_{i,c}} + (1-\mu_{i,c})^{1/\epsilon_{i,c}} C_{i,b,t}^{(\epsilon_{i,c}-1)/\epsilon_{i,c}} \right)^{\epsilon_{i,c}/(\epsilon_{i,c}-1)}. \tag{4}$$

and labor is perfectly mobile between green and brown firms:

$$H_{i,t} = H_{i,g,t} + H_{i,b,t}, \tag{5}$$

Individuals

Capital markets are completely missing. So the budget constraint of each individual is:

$$C_{i,b,t} + P_{g,t} C_{i,g,t} \leq (1 - \omega) W_{i,t} H_{i,t} + T_{i,t} \quad (6)$$

That is, the trade-offs are entirely instantaneous.

Green sector

The firm maximizes profits:

$$\max_{H_{f,g,t}, H_{m,g,t}} P_{g,t} Y_{g,t} - W_{f,t} H_{f,g,t} - W_{m,t} H_{m,g,t} \tag{7}$$

where output is a linear function of labor:

$$Y_{g,t} = A_{g,t} H_{g,t}, \tag{8}$$

and technology follows a stochastic process:

$$\log(A_{g,t}) = (1 - \rho_{A_g}) \log(A_g) + \rho_{A_g} \log(A_{g,t-1}) + \epsilon_{A_{g,t}},$$

Green sector

The green firm employs male and female workers such that the value of the marginal products are equal to their wage rates.

$$W_{f,t} = P_{g,t} MP_{H_{f,g,t}} \tag{9}$$
$$W_{m,t} = P_{g,t} MP_{H_{m,g,t}} \tag{10}$$

Brown sector

Output is linear in labor $H_{b,t}$:

$$Y_{b,t} = A_{b,t} H_{b,t}, \tag{11}$$

The variable $A_{b,t}$ is a technology specific to the brown sector and is defined as:

$$A_{b,t} = (1 - d(x_{t-1}))a_{b,t},$$

where d is an environmental damage function which affects productivity negatively. x_t represents the emission stock.

Brown sector

The productivity shock $a_{b,t}$ follows a stochastic process that is given by:

$$\log(a_{b,t}) = (1 - \rho_{a_b}) \log(a_b) + \rho_{a_b} \log(a_{b,t-1}) + \epsilon_{a_{b,t}}, \qquad (12)$$

Emissions and abatement

Abatement costs Z_t are a function of the abatement effort η_t and output. It takes the following form:

$$Z_t = \psi_1 {\eta_t}^{\psi_2} Y_{b,t},$$

Polluting firms are taxed by the government depending on the level of domestic emissions $\tau_{e,t} e_t$ where $\tau_{e,t}$ represents the carbon-tax.

Brown sector

The polluting firm maximizes its profits:

$$\max_{H_{f,b,t},H_{m,b,t},\eta_t} Y_{b,t} - Z_t - \tau_{e,t}e_t - W_{b,t}H_{b,t} \tag{13}$$

Labor demand and abatement effort are given by:

$$W_{f,t} = A_{b,t}MP_{H_{f,b,t}} \tag{14}$$

$$W_{m,t} = A_{b,t}MP_{H_{m,b,t}} \tag{15}$$

$$\eta_t = \left(\frac{\tau_e \varphi}{\psi_1 \psi_2}\right)^{\frac{1}{\psi_2 - 1}} \tag{16}$$

Government

The budget constraint of the public sector is given by:

$$T_t = \tau_{e,t} e_t + \omega (W_{f,t} H_{f,t} + W_{m,t} H_{m,t}) \tag{17}$$

That is, revenue from carbon and payroll taxes finance lump-sum transfers.

Market clearing

In equilibrium, we have market clearing in green and brown goods markets:

$$C_{g,t} = Y_{g,t}, \tag{18}$$
$$C_{b,t} = Y_{b,t}. \tag{19}$$

Market clearing in different labor markets:

$$H_{f,t} = H_{f,g,t} + H_{f,b,t} \tag{20}$$
$$H_{m,t} = H_{m,g,t} + H_{m,b,t} \tag{21}$$

[Annicchiarico and Di Dio, 2015] Annicchiarico, B. and Di Dio, F. (2015).
Environmental policy and macroeconomic dynamics in a new keynesian model.
Journal of Environmental Economics and Management, 69:1–21.

[Benkhodja et al., 2023] Benkhodja, M. T., Fromentin, V., and Ma, X. (2023).
Macroeconomic effects of green subsidies.
Journal of Cleaner Production, 410:137166.

[Carattini et al., 2021] Carattini, S., Heutel, G., and Melkadze, G. (2021).
Climate policy, financial frictions, and transition risk.
National Bureau of Economic Research.

[Chetty et al., 2011] Chetty, R., Guren, A., Manoli, D., and Weber, A. (2011).

Are micro and macro labor supply elasticities consistent? a review of evidence on the intensive and extensive margins.
American Economic Review, 101(3):471–475.

[Gruber, 2013] Gruber, J. (2013).
A tax-based estimate of the elasticity of intertemporal substitution.
The Quarterly Journal of Finance, 3(01):1350001.

[Heutel, 2012] Heutel, G. (2012).
How should environmental policy respond to business cycles? optimal policy under persistent productivity shocks.
Review of Economic Dynamics, 15(2):244–264.